OBE Curriculum
for the
Undergraduate Program of
Department of Electrical and
Electronic Engineering, BUET

Prepared by

Department of EEE, BUET

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Outcome Based Education (OBE) Curriculum

Department of Electrical and Electronic Engineering

Bangladesh University of Engineering and Technology (BUET)

PART A: Overview of the Program

1. Vision of BUET

To be a leader in education, research and innovation in science, engineering and technology for sustainable future.

2. Mission of BUET

- To provide advanced transformative education, promote cutting-edge research and foster innovation for producing competent graduates with ethical values.
- To create an inspiring, diverse and inclusive learning environment for planning, design and innovation.
- To enhance collaboration for improving knowledge and skill ensuring lifelong learning opportunity.
- To contribute towards reshaping for wellbeing of the society.

3. Title of the Academic Program/Degree

Bachelor of Science in Electrical and Electronic Engineering

4. Name of the Department

Department of Electrical and Electronic Engineering

5. Vision of the Department

To be at the forefront of electrical and electronic engineering education, research and innovation to address national and global challenges.

6. Mission of the Department

The mission of the Department of Electrical and Electronic Engineering is to pursue excellence in electrical and electronic engineering education, research and applications for the benefit and betterment of the society. We achieve our mission by:

M1	Educating future graduates who can adapt to a fast-changing technological environment with engineering skills, ethics, and professionalism.
M2	Performing impactful research that would enhance knowledge, develop technologies, and foster innovation for the benefit and betterment of humanity.
M3	Providing creative, pragmatic, and sustainable engineering solutions to local and global challenges ensuring national interests.

7. Description of the Program

Department of EEE, BUET is well known for producing some of the finest electrical engineers of the country. Our rigorous coursework and focus on innovation in experimental projects give students a holistic understanding of the field and prepare them to become leaders in any career they chose to pursue from academia, industry, government, and corporate sector jobs. Moreover, our state-of-art research allows our graduates to consistently get admitted to the world's most prestigious graduate schools. Department of EEE curriculum details are available in the undergraduate engineering handbook.

8. Program Educational Objectives (PEOs)

Within 3 to 5 years of graduation, graduates of the department will be able to:

PEO1	Develop the technical proficiency required to pursue a diverse range of careers.
PEO2	Apply innovative Electrical and Electronic Engineering solutions to meet specific needs of the society exercising high ethical and professional standards.
PEO3	Be competent members and/or leaders of their teams, organizations, and communities.
PEO4	Maintain and enhance professional and technical knowledge through continuous and life-long learning.

9. Mapping Mission of BUET with the Mission of the Department

	BUET Mission 1	BUET Mission 2	BUET Mission 3	BUET Mission 4
EEE Mission 1	✓	✓		
EEE Mission 2		✓		✓
EEE Mission 3			✓	✓

10. Mapping Missions of the Department with the PEOs

PEOs	Mission 1	Mission 2	Mission 3
PEO 1	✓	✓	✓
PEO 2	✓	✓	✓
PEO 3	✓	✓	✓
PEO 4	✓	✓	✓

11. Program Outcomes (PO)

Upon completion of the four years B.Sc. degree in Electrical and Electronic Engineering, a graduate will be able to:

PO(a)	**Engineering knowledge:** Apply knowledge of mathematics, science, and engineering to solve complex electrical and electronic engineering problems. (*K1 to K4).
PO(b)	**Problem analysis:** Identify, formulate, research literature, interpret data, and analyze complex electrical and electronic engineering problems using principles of mathematical, natural and engineering sciences. (K1 to K4).
PO(c)	**Design/development Solution:** Design solutions to complex engineering problems and design systems, components, or processes that meet the needs relevant to

	electrical and electronic engineering with appropriate considerations to public health and safety, cultural, societal, and environmental considerations. (K5).
PO(d)	**Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions. (K8).
PO(e)	**Modern tool usage:** Use techniques, skills, and modern engineering tools to solve complex and practical engineering problems related to electrical and electronic engineering with understanding of the limitations. (K6).
PO(f)	**The Engineer and Society:** Apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (K7).
PO(g)	**Environment and sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (K7).
PO(h)	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7).
PO(i)	**Individual work and team work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO(j)	**Communication:** Communicate effectively on complex engineering activities with the electrical and electronic engineering and other inter-disciplinary communities and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO(k)	**Project management and finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO(l)	**Life-long Learning:** Recognize the need for, and ability to engage in life-long learning and know contemporary aspects related to the field of electrical and electronic engineering.

[*]Table: Knowledge Profile

	Attribute
K1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
K5	Knowledge that supports engineering design in a practice area

K6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability
K8	Engagement with selected knowledge in the research literature of the discipline

12. Mapping of PEOs with POs

POs	PEO 1	PEO 2	PEO 3	PEO4
PO(a)	✓			
PO(b)	✓			
PO(c)	✓			
PO(d)				✓
PO(e)				✓
PO(f)		✓		
PO(g)		✓		
PO(h)		✓		
PO(i)			✓	
PO(j)			✓	
PO(k)			✓	
PO(l)				✓

PART B: Overview of the Curriculum

13. Structure of the Curriculum

13.1 Admission Requirements:

Students are admitted in undergraduate curricula in the Electrical and Electronic Engineering, as per existing rules of the University. The Registrar's Office serve as the Admission Office.

13.2 Duration of the Program:

Years: 04 Semesters: 08

13.3 Total Minimum Credit Requirement to Complete the Program:

Minimum credit hour requirements for the award of BSc degree in Electrical and Electronic Engineering is proposed by the BUGS and approved by the Academic Council. However, at least 157.5 credit hours for engineering must be earned to be eligible for graduation, and this must include the specified core courses.

13.4 Total Class Weeks in a Term:

There will be two terms (Term I and Term II) in an academic year. The duration of each Term will be 18 weeks which will be used as follows:

Classes	14 weeks
Recess before term final exam	02 weeks

Term final exam	02 weeks
Total	18 weeks

13.5 Minimum CGPA Requirements for Graduation:

The minimum CGPA requirement for obtaining a bachelor's degree in Electrical and Electronic Engineering, is 2.20.

13.6 Maximum Academic Years of Completion:

Time allowed for a student included in Course System from Annual System to complete studies leading to a bachelor's degree will be proportional to the remaining credits to be completed by him/her.

A student in engineering, for example, having earned 40 credit hours through equivalence and exemption (of previously completed courses) out of a total requirement of 160 credits for bachelor's degree will get (7 yrs* 120/160 = 5.25) ≈ 5.5 years (rounded to next higher half a-year) or 11 (eleven) Regular Terms to fulfill all requirements for bachelor's degree.

14. Course Requirements for Bachelor of Science in Electrical and Electronic Engineering

14.1 Natural Science

Requirement 12 credits (9+3)		
Theoretical		
Core Courses (Physics)		
PHY 121	Waves and Oscillations, Optics and Thermal Physics	3.0 credits
PHY 165	Electricity and Magnetism, Modern Physics and Mechanics	3 .0 credits
Core Courses (Physics)Sessional		
PHY 102	Physics Sessional	1.5 credits
Core Courses (Chemistry)		
CHEM 101	Chemistry	3.0 credits
Core Courses (Chemistry) Sessional		
CHEM 114	Inorganic, Quantitative Analysis Sessional	1.5 credits

14.2 Mathematics

Requirement 15 credits		
MATH 157	Calculus I	3.0 credits
MATH 159	Calculus II	3.0 credits
MATH 257	Ordinary and Partial Differential Equations	3.0 credits
MATH 259	Linear Algebra	3.0 credits
MATH 357	Probability and Statistics	3.0 credits

14.3 Humanities and Social Sciences

Requirement 10.5 credits (9+1.5)		
Theoretical		
HUM 127	Sociology	3.0 credits

HUM 137	Professional Ethics	3.0 credits
HUM 277	Fundamental of Economics	3.0 credits
HUM 135	English	3.0 credits
HUM 279	Financial and Managerial Accounting	3.0 credits
Sessional		
HUM 272	Developing English Skills Laboratory	1.5 credits

14.4 Departmental Compulsory Courses

Requirement 75 credits (54+21)		
Theoretical		
EEE 101	Electrical Circuits I	3.0 credits
EEE 102	Electrical Circuits I Laboratory	1.5 credits
EEE 105	Electrical Circuits II	3.0 credits
EEE 106	Electrical Circuits II Laboratory	1.5 credits
EEE 201	Electronic Circuits I	3.0 credits
EEE 202	Electronic Circuits I Laboratory	1.5 credits
EEE 203	Energy Conversion I	3.0 credits
EEE 205	Energy Conversion II	3.0 credits
EEE 206	Energy Conversion Laboratory	1.5 credits
EEE 207	Electronic Circuits II	3.0 credits
EEE 208	Electronic Circuits II Laboratory	1.5 credits
EEE 209	Engineering Electromagnetics	3.0 credits
EEE 211	Continuous Signals and Linear Systems	3.0 credits
EEE 212	Numerical Technique Laboratory	1.5 credits
EEE 303	Digital Electronics	3.0 credits
EEE 304	Digital Electronics Laboratory	1.5 credits
EEE 305	Power System I	3.0 credits
EEE 306	Power System I Laboratory	1.5 credits
EEE 307	Electrical Properties of Materials	3.0 credits
EEE 309	Communication Systems I	3.0 credits
EEE 310	Communication Systems I Laboratory	1.5 credits
EEE 311	Digital Signal Processing I	3.0 credits
EEE 312	Digital Signal Processing I Laboratory	1.5 credits
EEE 313	Solid State Devices	3.0 credits
EEE 315	Power Electronics	3.0 credits
EEE 316	Power Electronics Laboratory	1.5 credits
EEE 317	Control System I	3.0 credits
EEE 318	Control System I Laboratory	1.5 credits
EEE 414	Electrical Services Design	1.5 credits
EEE 415	Microprocessors and Embedded Systems	3.0 credits
EEE 416	Microprocessors and Embedded Systems Laboratory	1.5 credits
EEE 439	Communication Systems II	3.0 credits

14.5 Departmental Optional Courses

Requirement 25.5 credits (21+4.5)		
Power Group		
EEE 411	Power System II	3.0 credits
EEE 412	Power System II Laboratory	1.5 credits
EEE 471	Energy Conversion III	3.0 credits
EEE 473	Renewable Energy	3.0 credits
EEE 475	Power Plant Engineering	3.0 credits
EEE 477	Power System Protection	3.0 credits
EEE 478	Power System Protection Laboratory	1.5 credits
EEE 479	Power System Reliability	3.0 credits
EEE 481	Power System Operation and Control	3.0 credits
EEE 483	High Voltage Engineering	3.0 credits
EEE 484	High Voltage Engineering Laboratory	1.5 credits
EEE 485	Power Transmission and Distribution	3.0 credits
EEE 487	Nuclear Power Engineering	3.0 credits
EEE 489	Smart Grid	3.0 credits
Electronics Group		
EEE 451	Processing and Fabrication Technology	3.0 credits
EEE 455	Compound Semiconductor Devices	3.0 credits
EEE 459	Optoelectronics	3.0 credits
EEE 460	Optoelectronics Laboratory	1.5 credits
EEE 461	Semiconductor and Nano Devices	3.0 credits
EEE 463	Nano-electronics and Nanotechnology	3.0 credits
EEE 465	Analog Integrated Circuits and Design	3.0 credits
EEE 466	Analog Integrated Circuits Laboratory	1.5 credits
EEE 467	VLSI Circuits and Design	3.0 credits
EEE 468	VLSI Circuits and Design Laboratory	1.5 credits
Communication and Signal Processing Group		
EEE 417	Random Signals and Processes	3.0 credits
EEE 431	Digital Signal Processing II	3.0 credits
EEE 433	Microwave Engineering	3.0 credits
EEE 434	Microwave Engineering Laboratory	1.5 credits
EEE 435	Optical Communications	3.0 credits
EEE 437	Wireless Communications	3.0 credits
EEE 438	Wireless Communication Laboratory	1.5 credits
EEE 441	Telecommunication Engineering	3.0 credits
EEE 443	Radar and Satellite Communication	3.0 credits
EEE 445	Multimedia Communications	3.0 credits
EEE 447	Introduction to Digital Image Processing	3.0 credits
EEE 449	Information and Coding Theory	3.0 credits

EEE 491	Introduction to Medical Imaging	3.0 credits
EEE 493	Digital Filter Design	3.0 credits
EEE 495	Speech Communications	3.0 credits
EEE 497	Telecommunication Networks	3.0 credits
EEE 498	Telecommunication Networks Laboratory	1.5 credits
EEE 499	Wireless and Mobile Networks	3.0 credits
Interdisciplinary Courses		
EEE 401	Artificial Intelligence and Machine Learning	3.0 credits
EEE 402	Artificial Intelligence and Machine Learning Laboratory	1.5 credits
EEE 403	Robotics and Automation	3.0 credits
EEE 404	Robotics and Automation Laboratory	1.5 credits
EEE 421	Control System II	3.0 credits
EEE 422	Control System II Laboratory	1.5 credits
EEE 425	Biomedical Signals, Instrumentation and Measurement	3.0 credits
EEE 427	Measurement and Instrumentation	3.0 credits
EEE 428	Measurement and Instrumentation Laboratory	1.5 credits
CSE 451	Computer Networks	3.0 credits
CSE 452	Computer Networks Laboratory	1.5 credits

14.6 Thesis

Requirement 6 credits		
EEE 400	Thesis	6.0 credits

14.7 Non-departmental Engineering Courses

Requirement 13.5 credits (9+4.5)		
Core Courses (CSE)		
CSE 109	Computer Programming	3.0 credits
CSE 110	Computer Programming Sessional	1.5 credits
Core Courses (ME)		
ME 267	Mechanical Engineering Fundamentals	3.0 credits
ME 268	Mechanical Engineering Fundamentals Sessional	1.5 credits
Core Course (IPE)		
IPE 493	Industrial Management	3.0 credits
Core Course (CE)		
CE 106	Engineering Drawing	1.5 credits

14.8 Summary of the Requirements for Bachelor of Science Degree in Electrical and Electronic Engineering

Courses	Requirements (Credit Hours)
A. Natural Science	12.0 credits

Courses	Requirements (Credit Hours)
B. Mathematics	15.0 credits
C. Humanities and Social Sciences	10.5 credits
D. Departmental Core Courses	75.0 credits
E. Departmental Optional Courses	25.5 credits (Min. 5 courses from major group)
F. Non-departmental Engineering Courses	13.5 credits
Total	151.5 credits
UG Thesis	6.0 credits
Grand Total	157.5 credits

15. Courses Offered in Different Terms

Level	Term	Course No.	Course Title	Credit Hours	Remarks
1	I	EEE 101	Electrical Circuit 1	3.0	
		EEE 102	Electrical Circuits I Laboratory	1.5	
		CSE 109	Computer Programming	3.0	
		CSE 110	Computer Programming Sessional	1.5	
		CE 106	Engineering Drawing	1.5	
		PHY 121	Waves and Oscillations, Optics and Thermal Physics	3.0	
		MATH 157	Calculus I	3.0	
		MATH 159	Calculus II	3.0	
			Total	19.5	

Level	Term	Course No.	Course Title	Credit Hours	Remarks
1	II	EEE 105	Electrical Circuits II	3.0	
		EEE 106	Electrical circuits II Laboratory	1.5	
		PHY 165	Electricity and Magnetism, Modern Physics and Mechanics	3.0	
		PHY 102	Physics Sessional	1.5	
		CHEM 101	Chemistry	3.0	
		CHEM 114	Inorganic Quantitative Analysis Sessional	1.5	
		MATH 257	Ordinary and Partial Differential Equations	3.0	
		HUM 127/ HUM 277/ HUM 137	Sociology/ Fundamental of Economics/ Professional Ethics	3.0	
			Total	19.5	

Level	Term	Course No.	Course Title	Credit Hours	Remarks
2	I	EEE 201	Electronic Circuits I	3.0	
		EEE 202	Electronic Circuits I Laboratory	1.5	
		EEE 203	Energy Conversion I	3.0	
		EEE 211	Continuous Signals and Linear Systems	3.0	
		EEE 212	Numerical Technique Laboratory	1.5	
		MATH 259	Linear Algebra	3.0	
		HUM 135	English	3.0	

		HUM 272	Developing English Skills Laboratory	1.5	
			Total	19.5	

Level	Term	Course No.	Course Title	Credit Hours	Remarks
2	II	EEE 205	Energy Conversion II	3.0	
		EEE 206	Energy Conversion Laboratory	1.5	
		EEE 207	Electronic Circuits II	3.0	
		EEE 208	Electronic Circuits II Laboratory	1.5	
		EEE 209	Engineering Electromagnetics	3.0	
		ME 267	Mechanical Engineering Fundamentals	3.0	
		ME 268	Mechanical Engineering Fundamentals Laboratory	1.5	
		MATH 357	Probability and Statistics	3.0	
			Total	19.5	

Level	Term	Course No.	Course Title	Credit Hours	Remarks
3	I	EEE 305	Power System I	3.0	
		EEE 306	Power System I Laboratory	1.5	
		EEE 307	Electrical Properties of Materials	3.0	
		EEE 309	Communication System I	3.0	
		EEE 310	Communication System I Laboratory	1.5	
		EEE 311	Digital Signal Processing I	3.0	
		EEE 312	Digital Signal Processing I Laboratory	1.5	
		HUM 279	Financial and Managerial Accounting	3.0	
			Total	19.5	

Level	Term	Course No.	Course Title	Credit Hours	Remarks
3	II	EEE 303	Digital Electronics	3.0	
		EEE 304	Digital Electronics Laboratory	1.5	
		EEE 313	Solid State Devices	3.0	
		EEE 315	Power Electronics	3.0	
		EEE 316	Power Elctronics Laboratory	1.5	
		EEE 317	Control System I	3.0	
		EEE 318	Control System I Laboratory	1.5	
		IPE 493	Industrial Management	3.0	
			Total	19.5	

Level	Term	Course No.	Course Title	Credit Hours	Remarks
4	I	EEE 400	Thesis	3.0	
		EEE 415	Microprocessors and Embedded Systems	3.0	
		EEE 416	Microprocessors and Embedded Systems Laboratory	1.5	
		EEE 439	Communication Systems II	3.0	
		EEE XXX	Elective I	3.0	

		EEE XXX	Elective II	3.0	Select from courses in 14.5
		EEE XXX	Elective II Laboratory	1.5	
		EEE XXX	Elective III	3.0	
			Total	21	

Level	Term	Course No.	Course Title	Credit Hours	Remarks
4	II	EEE 400	Thesis	3.0	
		EEE 414	Electrical Service Design	1.5	
		EEE XXX	Elective IV	3.0	Select from courses in 14.5
		EEE XXX	Elective IV Laboratory	1.5	
		EEE XXX	Elective V	3.0	
		EEE XXX	Elective VI	3.0	
		EEE XXX	Elective VI Laboratory	1.5	
		EEE XXX	Elective VII	3.0	
			Total	19.5	

Note: a student must take minimum of 5 elective courses from the major group

16 Course Wise Content as Approved by the Academic Council for the Department of Electrical and Electronic Engineering

16.1 Core/Compulsory Courses

EEE 101 Electrical Circuits I
3 Credit Hours, 3 Contact Hours per Week

Basic Concepts, Charge, Current and Voltage, Power and Energy, Circuit Elements, Applications; Basic Laws, Ohm's Law, Nodes, Branches, and Loops, Kirchhoff's Laws, Series Resistors and Voltage Division, Parallel Resistors and Current Division, Solution of simple circuits with both dependent and independent sources, Wye-Delta Transformations, Applications; Nodal and Mesh Analysis, Applications; Linearity Property, Superposition, Source Transformation, Thevenin's and Norton's Theorem, Maximum Power Transfer Theorem. Properties of Inductances and capacitances. Series-parallel combinations of inductances and capacitances; Concepts of transient and First Order Circuits, The Source-Free RL and RC Circuit, Step Response of an RL and RC Circuit, Second-Order Circuits, Finding Initial and Final Values, The Source-Free Series and Parallel RLC Circuit, Step Response of a Series and Parallel RLC Circuit, Duality, Applications of DC transients. Basic Magnetic Circuits: Magnetic quantities and variables: Field, Flux, Flux Density, Magnetomotive Force, Magnetic Field Strength, permeability and B-H Curve, reluctance, magnetic field strength. Laws in magnetic circuits: Ohms law and Amperes circuital law. Magnetic circuits: Composite series magnetic circuit, parallel and series-parallel circuits. Comparison between electrical and magnetic quantities, Hysteresis and hysteresis loss. Magnetic materials

EEE 102 Electrical Circuits I Laboratory
1.5 Credit Hours, 3 Contact hours per week

In this course students will perform simulation study and experiments to verify practically the theories and concepts learned in EEE 101.

EEE 105 Electrical Circuits II
3 Credit Hours, 3 Contact Hours per Week

Sinusoids and Phasors, Phasor Relationships for Circuit Elements, Impedance and Admittance, Impedance and Admittance, Kirchhoff's Laws in the Frequency Domain, Impedance Combinations, Applications; Sinusoidal SteadyState Analysis, Nodal and Mesh Analysis, Superposition Theorem, Source Transformation, Thevenin and Norton Equivalent Circuits; AC Power Analysis, Instantaneous and Average Power, Maximum Average Power Transfer, Effective or RMS Value, Apparent Power and Power Factor, Complex Power, Conservation of AC Power, Power Factor Correction, Applications; Transients in AC circuits. Three-Phase Circuits, Balanced Three-Phase Voltages, Balanced Wye-Wye Connection, Balanced Wye-Delta, Delta-Delta and Delta-Wye Connection, Power in a Balanced System, Unbalanced Three-Phase Systems, Power Factor Correction, Applications; Magnetically Coupled Circuits, Mutual Inductance, Energy in a Coupled Circuit and Ideal Transformers. Frequency Response, Transfer Function, The Decibel Scale, Bode Plots, Series and Parallel Resonance, Passive Filters; Scaling; Nonsinusoidal periodic Waveforms, Composite Waveforms, Average Power and RMS Values of a Nonsinusoidal periodic Waveform, Circuit Response to a Nonsinusoidal Waveform, Power factor of a non-linear load, RMS and True RMS values.

EEE 106 Electrical Circuits II Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

In this course students will perform simulation study and experiments to verify practically the theories and concepts learned in EEE 105.

EEE 201 Electronic Circuits I
3 Credit Hours, 3 Contact Hours per Week

Semiconductor diodes: semiconductor material and properties, pn junction, diode circuits: dc analysis and models, diode circuits: AC equivalent circuits, other diode types, single phase rectification and regulators, zener diode circuits, clipper and clamper circuits, multiple diode circuits, photo diodes and LED circuits, DC power supply; MOS Transistors: Structure of MOSFET, Current-Voltage Characteristics, MOS Device Models, DC circuit analysis, basic MOFET applications, Biasing, constant current biasing, multistage MOSFET circuits, Junction Field effect transistor (JFET), MOSFET amplifier: basic transistor amplifier configurations-Common-Source, Common-Gate Stage, Source Follower (common drain); single stage integrated circuit MOSFET amplifiers, multistage amplifiers, basic JFET amplifiers; Bipolar Junction transistor (BJT): BJT, DC analysis of BJT circuits, basic transistor applications, biasing, multistage circuits, BJT linear amplifiers-basic configurations, CE amplifiers, AC load lines, CC and CB amplifier, multistage amplifiers, power consideration; Frequency Response: Amplifier frequency response, system transfer function, frequency response: transistor amplifiers with circuit capacitors, frequency response-BJT, frequency response-FET, high frequency response of transistor circuits. Output stages and power amplifiers: power amplifiers, power transistors, classes of amplifiers, Class-A power amplifier, Class-AB push pull complimentary output stage.

EEE 202 Electronic Circuits I Laboratory
1.5 Credit Hours, 3 Contact Hour per week

In this course students will perform simulation study and experiments to verify practically the theories and concepts learned in EEE 201.

EEE 203 Energy Conversion I
3 Credit Hours, 3 Contact Hours per Week

Transformer: principle of operation, construction, no load and excitation current, behavior during loading, effect of leakage flux, ideal transformer, leakage reactance and equivalent circuit of a transformer, equivalent impedance, voltage regulation, per unit quantities, regulation, losses and efficiency, determination of parameters by tests, polarity of transformer windings, vector group, transformer parallel operation. Harmonics in excitation current, transformer inrush current, three phase transformer connections, three phase transformers, harmonic suppression in three phase transformer connection. Autotransformer, instrument transformers.

Three phase induction motor: rotating magnetic field, reversal of rotating magnetic field, synchronous speed, torque in induction motor, induction motor construction: squirrel cage, wound rotor; slip and its effect on rotor frequency and voltage, equivalent circuit of an induction motor, air gap power, mechanical power and developed torque, torque speed characteristic, losses, efficiency and power factor, classification, motor performance as a function of machine parameters, shaping torque speed characteristic and classes of induction motor, per unit values of motor parameters, determination of induction motor parameters by tests, methods of braking, speed control.

Induction generator: operation, characteristics, voltage build up, applications in wind turbine.

EEE 205 Energy Conversion II
3 Credit Hours, 3 Contact Hours per Week

Synchronous generator: construction, armature (stator) and rotating field (exciter), excitation system with brushes and brushless excitation system, cooling, generated voltage equation of distributed short pitched armature winding, armature winding connections and harmonic cancellation in distributed short pitched winding, equivalent circuit, synchronous impedance, generated voltage and terminal voltage, phasor diagram, voltage regulation with different power factor type loads, determination of synchronous impedance by tests, phasor diagram, salient pole generator d-q axes parameters, equivalent circuit, generator equations, determination of d-q axes parameters by tests, equation of developed power and torque of synchronous machines (salient and non-salient pole motor and generator). Parallel operation of generators: requirement of parallel operation, conditions, synchronizing, effect of synchronizing current, hunting and oscillation, synchronoscope, phase sequence indicator, load distribution of alternators in parallel, droop setting, frequency control, voltage control, house diagrams.

Synchronous Motors: construction, operation, starting, effect of variation of load at normal excitation, effect of variation of excitations, V curves, inverted V curves and compounding curves, power factor adjustment, synchronous capacitor and power factor correction.

DC motors: principle of operation, constructional features, back emf and torque equations, armature reaction and its effect on motor performance, compensating winding, problems of commutation and their mitigations, types of dc motors and their torque speed characteristics, starting and speed control of dc motors, applications of different types of dc motor.

Single Phase Induction Motor: operation, quadrature field theory, double revolving field theory, split phasing, starting methods, equivalent circuit, torque-speed characteristic and performance calculation.

Introduction to photovoltaic systems.

EEE 206 Energy Conversion Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 203 and EEE 205. In the second part, students will design simple systems using the principles learned in EEE 203 and EEE 205.

EEE 207 Electronic Circuits II
3 Credit Hours, 3 Contact Hours per Week

Ideal operational amplifier and op-amp circuits;

Op-amp applications: inverting amplifier, non-inverting amplifier, summing amplifier, differential amplifier, logarithmic amplifier, operational transconductance amplifiers exponential amplifier, differentiator, integrator, voltage to current converter, voltage follower, and other applications.

Non-ideality of op-amp: Non-ideal op-amp characteristics and its effects.

Integrated circuit biasing and active loads: BJT current sources, FET current sources, small signal analysis of active loads, design applications: an NMOS current source; differential and multistage amplifiers: BJT differential amplifier, FET differential amplifier, differential amplifier with active load, BiCMOS circuits, gain stage and simple output stage, BJT operational amplifier circuit,

Frequency response of amplifiers: Poles, zeros and Bode plots, amplifier transfer function, techniques of determining 3 dB frequencies of amplifier circuits, frequency response of single-stage and cascade amplifiers, frequency response of differential amplifiers;

Feedback and stability: Basic feedback concept, feedback topologies: voltage(series-shunt) amplifiers, current (shunt-series) amplifiers, transconductance (series-series) amplifiers, transresistance (shunt-shunt) amplifiers, loop gain, stability of feedback circuit, frequency compensation;

Applications and Design of Integrated Circuits: Active filter, Oscillators, Schmitt trigger Circuits, Nonsinusoidal oscillators and timing circuits, integrated power amplifier, voltage regulator, Design application: An active Band-pass filter.

555 Timer IC and its Applications

Introduction to power amplifier classes: class A, class B, class AB, class C operation.

EEE 208 Electronic Circuits II Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

In this course students will perform simulation study and experiments to verify practically the theories and concepts learned in EEE 207.

EEE 209 Engineering Electromagnetics
3 Credit Hours, 3 Contact Hours per Week

Static electric field: Postulates of electrostatics, Coulomb's law for discrete and continuously distributed charges, Gauss's law and its application, electric potential due to charge distribution, conductors and dielectrics in static electric field, flux density- boundary conditions; capacitance-electrostatic energy and forces, energy in terms of field equations, capacitance calculation of different geometries; boundary value problems- Poisson's and Laplace's equations in different co-ordinate systems. Steady electric current: Ohm's law, continuity equation, Joule's law, resistance calculation. Static Magnetic field: Postulates of magnetostatics, Biot-Savart's law, Ampere's law and applications, vector magnetic potential, magnetic dipole, magnetization, magnetic field intensity and relative permeability, boundary conditions for magnetic field, magnetic energy, magnetic forces, torque and inductance of different geometries. Time varying fields and Maxwell's equations: Faraday's law of electromagnetic induction, Maxwell's equations - differential and integral forms, boundary conditions, potential functions; time harmonic fields and Poynting theorem. Plane electromagnetic wave: plane wave in loss less media- Doppler effect, transverse electromagnetic wave, polarization of plane wave; plane wave in lossy media- low-loss dielectrics, good conductors; group velocity, instantaneous and average power densities, normal and oblique incidence of plane waves at plane boundaries for different polarization.

EEE 211 Continuous Signals and Linear Systems
3 Credit Hours, 3 Contact Hours per Week

Classification of signals and systems: signals- classification, basic operation on signals, elementary signals, representation of signals using impulse function; systems- classification. Properties of Linear Time Invariant (LTI) systems: Linearity, causality, time invariance, memory, stability, invertibility. Time domain analysis of LTI systems: Differential equations- system representation, order of the system, solution techniques, zero state and zero input response, system properties; impulse response- convolution integral, determination of system properties; state variable- basic concept, state equation and time domain solution. Frequency domain analysis of LTI systems: Fourier series- properties, harmonic representation, system response, frequency response of LTI systems; Fourier transformation- properties, system transfer function, system response and distortion-less systems. Applications of time and frequency domain analyses: solution of analog electrical and mechanical systems, amplitude modulation and demodulation, time-division and frequency-division multiplexing. Laplace transformation: properties, inverse transform, solution of system equations, system transfer function, system stability and frequency response and application.

EEE 212 Numerical Techniques Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

Laboratory on numerical techniques using computer solution of differentiation and integration problems, transcendental equations, linear and non-linear differential equations and partial differential equations.

EEE 303 Digital Electronics
3 Credit Hours, 3 Contact Hours per Week

Introduction to number systems and codes. Analysis and synthesis of digital logic circuits: Basic logic functions, Boolean algebra, combinational logic design, minimization of combinational logic. Introduction to Verilog Hardware Description Language programming and structural and behavioral design of digital systems using VerilogHDL, Verilog Timing analysis and test bench, MOSFET Digital circuits: NMOS inverter, CMOS inverter, CMOS logic circuits, Clocked CMOS logic circuits, transmission gates, sequential logic circuits, BJT digital circuits: ECL, TTL, STTL, BiCMOS, Memories: classification and architecture, RAM memory cells, Read only memory, data converters, Modular combinational circuit design: pass transistor, pass gates, multiplexer, demultiplexer and their implementation in CMOS, decoder, encoder, comparators, binary arithmetic elements and ALU design. Sequential circuits: latches, flipflops timing analysis and power optimization of sequential circuits. Modular sequential logic circuit design: shift registers, counters and their applications. Asynchronous and synchronous sequential circuits. Dual Inline Packaged and Surface Mount Device (SMD) Integrated Circuits, Introduction to System Integration and Printed Circuit Board design, Design of a Simple-As-Possible (SAP) computer: SAP-1, selected concepts from SAP-2 (jump, call, return).

EEE 304 Digital Electronics Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 303. In the second part of the course, the students will perform design projects related to EEE 303 course contents to achieve specific program outcomes.

EEE 305 Power System I
3 Credit Hours, 3 Contact Hours per Week

Network representation: Single line and reactance diagram of power system and per unit system. Line representation: equivalent circuit of short, medium and long lines, reactive compensation of lines, introduction to DC transmission.

Load flow: Gauss- Siedel and Newton Raphson methods. Power flow control.

Synchronous machines: transient and subtransient reactance and short circuit currents. Symmetrical fault calculation methods. Symmetrical components: power, unsymmetrical series impedances and sequence networks. Different types of unsymmetrical faults: solid faults and faults through impedance.

Protection: fault level calculation, selection of circuit breakers, introduction to relays and circuit breakers. Typical layout of a substation.

Power plants: types, general layout of a thermal power plant and major components of gas turbine, steam turbine and combined cycle power plants.

EEE 306 Power System I Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 305. In the second part of the course, the students will perform design projects related to EEE 305 course contents to achieve specific program outcomes.

EEE 307 Electrical Properties of Materials
3 Credit Hours, 3 Contact Hours per Week

Crystal structures: Types of crystals, lattice and basis, Bravais lattice and Miller indices. Classical theory of electrical and thermal conduction: Scattering, mobility and resistivity, temperature dependence of metal resistivity, Mathiessen's rule, Hall effect and thermal conductivity. Introduction to quantum mechanics: Wave nature of electrons, Schrodinger's equation, one-dimensional quantum problems- infinite quantum well, potential step and potential barrier; Heisenbergs's uncertainty principle and quantum box, Electron in a 3D box. Hydrogen Atom.
Band theory of solids: Band theory from molecular orbital, Bloch theorem, Kronig-Penny model, Brillouin zone, effective mass, density-of-states. Carrier statistics: Maxwell-Boltzmann and Fermi-Dirac distributions, Fermi energy. Modern theory of metals: Determination of Fermi energy and average energy of electrons, classical and quantum mechanical calculation of specific heat.

Dielectric properties of materials: Dielectric constant, polarization- electronic, ionic, orientational and interfacial; internal field, Clausius-Mosotti equation, spontaneous polarization, frequency dependence of dielectric constant, dielectric loss, piezoelectricity, ferroelectricity, pyroelectricity.

Magnetic properties of materials: Magnetic moment, magnetization and relative permitivity, different types of magnetic materials, origin of ferromagnetism and magnetic domains.

Introduction to superconductivity: Zero resistance and Meissner effect, Type I and Type II superconductors and critical current density. BCS theory. Magnetic recording materials, Josephson theory.

Introduction to meta-materials.

EEE 309 Communication Systems I
3 Credit Hours, 3 Contact Hours per Week

Overview of communication systems: Basic principles, fundamental elements, system limitations, message source, bandwidth requirements, transmission media types, bandwidth and transmission capacity.

Noise: Sources of noise, characteristics of various types of noise and signal to noise ratio.

Communication systems: Analog and digital. Continuous wave modulation: Transmission types- base-band transmission, carrier transmission; amplitude modulation- introduction, double side band, single side band, vestigial side band, quadrature; spectral analysis of each type, envelope and synchronous detection; angle modulation- instantaneous frequency, frequency modulation (FM) and phase modulation (PM), spectral analysis, demodulation of FM and PM. Sampling-

sampling theorem, Nyquist criterion, aliasing, instantaneous and natural sampling, flat-topped sampling; pulse amplitude modulation- principle, bandwidth requirements; pulse code modulation (PCM)- quantization principle, quantization noise, non-uniform quantization, signal to quantization error ratio, differential PCM, demodulation of PCM; delta modulation (DM)- principle, adaptive DM; line coding- formats and bandwidths.

Digital modulation and demodulation: Amplitude-shift keying- principle, ON-OFF keying, bandwidth requirements, detection, noise performance; phase-shift keying (PSK)- principle, bandwidth requirements, detection, differential PSK, quadrature PSK, noise performance; frequency-shift keying (FSK)- principle, continuous and discontinuous phase FSK, minimum-shift keying, bandwidth requirements, detection of FSK, Multilevel signalling

Multiplexing: Time-division multiplexing (TDM)- principle, receiver synchronization, frame synchronization, TDM of multiple bit rate systems; frequency-division multiplexing (FDM)- principle, de-multiplexing. PDH, SONET/SDH.

Multiple-access techniques: Time-division multiple-access (TDMA), frequency-division multiple access (FDMA); code-division multiple-access (CDMA) - spread spectrum multiplexing, coding techniques and constraints of CDMA.

EEE 310 Communication Systems I Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 309 course. In the second part of the course, the students will perform design projects related to EEE 309 course contents to achieve specific program outcomes.

EEE 311 Digital Signal Processing I
3 Credit Hours, 3 Contact Hours per Week

Introduction to digital signal processing. Sampling, quantization and signal reconstruction. Analysis of discrete-time system in the time domain: impulse response model, difference equation model. Correlation: power signal, energy signal, applications. Z-transform and analysis of LTI systems. Frequency analysis of discrete-time signals: discrete Fourier series and discrete-time Fourier transform (DTFT). Frequency analysis of LTI systems. Discrete Fourier transform (DFT) and fast Fourier transform (FFT). Minimum phase, maximum phase and all pass systems. Calculation of spectrum of discrete-time signals. Digital filter design- linear phase filters, specifications, design using window, optimal methods; IIR filters- specifications, design using impulse invariant, bi-linear z- transformation, least-square methods.

EEE 312 Digital Signal Processing I Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 311. In the second part of the course, the students will perform design projects related to EEE 311 course contents to achieve specific program outcomes.

EEE 313 Solid State Devices
3 Credit Hours, 3 Contact Hours per Week

Semiconductors in equilibrium: Energy bands, intrinsic and extrinsic semiconductors, Fermi levels, electron and hole concentrations, temperature dependence of carrier concentrations and invariance of Fermi level.

Carrier transport processes and excess carriers: Drift and diffusion, generation and recombination of excess carriers, built-in-field, recombination-generation SRH formula, surface recombination, Einstein relations, continuity and diffusion equations for holes and electrons and quasi-Fermi level.

PN junction: Basic structure, equilibrium conditions, contact potential, equilibrium Fermi level, space charge, non-equilibrium condition, forward and reverse bias, carrier injection, minority and majority carrier currents, transient and AC conditions, time variation of stored charge, reverse recovery transient and capacitance.

Bipolar Junction Transistor: Basic principle of pnp and npn transistors, emitter efficiency, base transport factor and current gain, diffusion equation in the base, terminal currents, coupled-diode model and charge control analysis, Ebers-Moll model and circuit synthesis. BJT non-ideal effects; Hetero-junction transistors.

Metal-semiconductor junction: Energy band diagram of metal semiconductor junctions, rectifying and ohmic contacts.

MOS structure: MOS capacitor, energy band diagrams and flat band voltage, threshold voltage and control of threshold voltage, static C-V characteristics, qualitative theory of MOSFET operation, body effect and current-voltage relationship of a MOSFET. Non-ideal characteristics of MOSFET: channel-length modulation and short-channel effects in MOSFETs. MOS scaling.

Introduction to Multigate FET architecture: Double gate MOSFET, FinFET, Surrounding gate FET, high-K dielectric FETs.

EEE 315 Power Electronics
3 Credit Hours, 3 Contact Hours per Week

Fundamental of power electronics, characteristics of static power semiconductor devices (BJT, MOSFET, IGBT, Thyristors). AC/DC power converters: uncontrolled rectifiers (single phase and three phase), controlled rectifiers (single phase and three phase), dual converter. AC/AC power converters: phase-controlled converters (single phase and three phase), AC switch, cycloconverter. DC/DC converters: choppers (step down and step up), switching regulators (buck, boost, buck-boost). DC/AC converters: types, single phase and three phase inverters. Various applications of converters.

EEE 316 Power Electronics Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 315. In the second part of the course, the students will perform design projects related to EEE 315 course contents to achieve specific program outcomes.

EEE 317 Control System I
3 Credit Hours, 3 Contact Hours per Week

Review of Laplace transform, Initial and Final value theorems, Transfer Functions: Open-loop stability, Poles, Zeros, Time response, Transients, Steady-state, Block diagrams and signal flow diagram, Feedback principles: Open versus Closed-loop control, High gain control, Inversion; State variables: Signal flow diagram to state variables, transfer function to state variable and state variable to transfer function, Stability of closed-loop systems: Routh's method, Root locus, PID control: Structure, Design using root locus, Pole assignment: Sylvester's theorem, PI and PID synthesis using pole assignment, Frequency Response: Nyquist plot, Bode diagram, Nyquist stability theorem, Stability margins, Closed-loop sensitivity functions, Model errors, Robust stability, Controller design using frequency response: Proportional control, Lead-lag control, PID control, Digital control systems: introduction, sampled data systems, stability analysis in Z-domain.

EEE 318 Control System I Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 317. In the second part of the course, the students will perform design projects related to EEE 317 course contents to achieve specific program outcomes.

EEE 414 Electrical Services Design
1.5 Credit Hours, 3 Contact Hours per Week

Familiarization with CAD tools for building services design. Introduction to building regulations, codes and standards: BNBC, NFPA etc. Terminology and definitions: fuses, circuit breakers, distribution boxes, cables, bus-bars and conduits. Familiarization with symbols and legends used for electrical services design. Classification of wiring. Design for illumination and lighting: lux, lumen, choice of luminaries for various applications- domestic building, office building and industry. Wattage rating of common electrical equipment.

Designing electrical distribution system for low and high rise domestic, office and academic buildings, for multipurpose buildings. Size selection of conductors and breakers, bus-bar trunking (BBT) system for various applications. Single line diagram (SLD) of a typical 11kV/0.415kV, 500kVA sub-station and a 200kVA pole-mounted transformer.

Earthing requirements, various earthing methods. Earthing and lightning protection system design.

Familiarization with indoor and underground telephone and fiber optic cables, UTP and CAT5/6 data cables. Designing routing layout and installation of intercom, PABX, telephone, public address (PA) systems, cable TV distribution, LAN and wireless data systems for a building.

Safety regulations, design of security systems including CCTV, burglar alarm.

Concept of fire prevention and its importance. Fire detection (smoke, heat etc.) and alarm system (with voice evacuation), firefighting system (sprinkler system, hose).

Installation of air-conditioning, heating, lifts and elevators.

EEE 415 Microprocessors and Embedded Systems
3 Credit Hours, 3 Contact Hours per Week

Fundamentals of microprocessor and computer design, processor data path, architecture, microarchitecture, complexity, metrics, and benchmark; Instruction Set Architecture, introduction to CISC and RISC, InstructionLevel Parallelism, pipelining, pipelining hazards and data dependency, branch prediction, exceptions and limits, superpipelined vs superscalar processing; Memory hierarchy and management, Direct Memory Access, Translation Lookaside Buffer; cache, cache policies, multi-level cache, cache performance; Multicore computing, message passing, shared memory, cache-coherence protocol, memory consistency, paging, Vector Processor, Graphics Processing Unit, IP Blocks, Single Instruction Multiple Data and SoC with microprocessors. Simple Arm/RISC-V based processor design with VerilogHDL Introduction to embedded systems design, software concurrency and Realtime Operating Systems, Arm Cortex M / RISC-V microcontroller architecture, registers and I/O, memory map and instruction sets, endianness and image, Assembly language programming of Arm Cortex M / RISC-V based embedded microprocessors (jump, call-return, stack, push and pop, shift, rotate, logic instructions, port operations, serial communication and interfacing), system clock, exceptions and interrupt handling, timing analysis of interrupts, general purpose digital interfacing, analog interfacing, timers: PWM, real-time clock, serial communication, SPI, I2C, UART protocols, Embedded Systems for Internet of Things (IoT

EEE 416 Microprocessors and Embedded Systems Laboratory
3 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 415 course. In the second part of the course, the students will perform design projects related to EEE 415 course contents to achieve specific program outcomes.

EEE 439 Communication Systems II
3 Credit Hours, 3 Contact Hours per Week

Baseband digital transmission, Limitations, Pulse shaping, Repeaters, Pulse equalization techniques, AWGN channel model, bit error rate of a baseband transmission system, channel capacity theorem.

Digital modulation techniques, detection and demodulation techniques, digital receivers, matched filter and correlator receiver, bit error rate calculation of a digital link, digital link design.

Error correction coding: block codes, cyclic codes, systematic and nonsystematic cyclic codes, decoding techniques.

Wireless digital communication system, wireless channel model, non-cellular and cellular communication, cellular concept, frequency reuse techniques.

Multiple access techniques: FDMA, TDMA, CDMA and SDMA. Introduction to 2G and 3G mobile communication systems.

Introduction to optical fiber communication and Satellite communication.

Local area network, OSI model, random access techniques, Aloha, slotted Aloha.

EEE 400 Thesis
3 Credit Hours, 6 Contact Hours per Week Level-4, Term-I
3 Credit Hours, 6 Contact Hours per Week Level-4, Term-II

The students will perform experimental and/or theoretical investigation of a research topic related to electrical and electronic engineering discipline. Students will attend seminars, review research literature and related contemporary aspects of the topic, identify problem, formulate a proposal to solve a specific problem related to the topic, interpret data, and analyze the problem using first principles of mathematical, natural or engineering sciences. Students will conduct investigations of the problem using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions. Students will understand and adhere to professional ethics and ethical principles of research. The students will be required to present a progress report at the end of the first semester, and present and submit a thesis at the end of the work.

16.2 Elective/ Optional Courses

Interdisciplinary

EEE 401 Artificial Intelligence and Machine Learning
3 Credit Hours, 3 Contact Hours per Week

Introduction to Artificial Intelligence (AI): perception and intelligence, history; intelligent agent, algorithms in AI; ethical AI. Search and Optimization: graph search, uniform search, heuristic search, adversarial search, local search with constraint satisfaction. Logical Intelligence: logical agents, propositional logic, syntax, semantics, logical statement, first order logic. Introduction to Machine Learning: supervised, unsupervised, and reinforcement learning; components of the learning problem. Data mining and statistical pattern recognition. Learning models: linear classification and linear regression; extending linear models through nonlinear transforms, logistic regression, maximum likelihood, and gradient descent. Supervised learning: parametric/non-parametric algorithms; support vector machines; kernels. Unsupervised learning: clustering; dimensionality reduction; recommender systems. Deep learning and neural networks: multi-layer perceptron, backpropagation; convolutional networks; recurrent networks; attention mechanism and transformers. Best practices in machine learning: bias/variance theory; hyperparameter tuning. Case studies and applications.

EEE 402 Artificial Intelligence and Machine Learning Laboratory
3 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 401 course. In the second part of the course, the students will perform design projects related to EEE 401 course contents to achieve specific program outcomes.

EEE 403 Robotics and Automation
3 Credit Hours, 3 Contact Hours per Week

History of robotics, elements of robotic systems, mathematics of manipulators, and classification of robots. Kinematic solutions, dynamic formulation, and computation of robot manipulators. Path planning and localization for autonomous mobile robots. Sensors, actuators, and vision for robotics. Robot control: linear, non-linear, and adaptive control methods. Control hardware and interfaces: microcontrollers, embedded systems, and programming for robotics. AI and machine learning for autonomous robotic systems. Robot applications for industry 4.0: underwater robot, unmanned aerial vehicle (UAV), humanoid robot.

EEE 404 Robotics and Automation Laboratory
3 Credit Hours, 3 Contact Hours per Week

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 403 course. In the second part of the course, the students will perform design projects related to EEE 403 course contents to achieve specific program outcomes.

EEE 421 Control System II
3 Credit Hours, 3 Contact Hours per Week

Compensation using pole placement technique. State equations of digital systems with sample and hold, state equation of digital systems, digital simulation and approximation. Solution of discrete state equations: by z-transform, state equation and transfer function, state diagrams, state plane analysis. Stability of digital control systems. Digital simulation and digital redesign. Time domain analysis. Frequency domain analysis. Controllability and observability. Optimal linear digital regulator design. Digital state observer. Microprocessor control. Introduction to neural network and fuzzy control, adaptive control. H^{α} Control, nonlinear control. Elements of System Identification, Introduction to Multivariable control (decoupling, interaction, analysis & design), Introduction to optimal control and estimation, Case studies.

EEE 422 Control System II Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 421. In the second part, students will design simple systems using the principles learned in EEE 421.

EEE 425 Biomedical Signals, Instrumentation and Measurement
3 Credit Hours, 3 Contact Hours per Week

Origin and major types of biological signals: Human body: cells and physiological systems, bioelectric potential, bio-potential electrodes and amplifiers, blood pressure, flow, volume and sound, electrocardiogram, electromyogram, electroencephalogram, phonocardiogram, vector cardiogram. Interpretation of bio-signals. Noise in bio-signals.

Measurement of bio-signals: transducers, amplifiers and filters. Measurement and detection of blood pressure. Blood flow measurement: plethysmograph and electromagnetic flow meter.

Measurement of respiratory volumes and flow, related devices. X-ray. Tomograph: positron emission tomography and computed tomography. Magnetic resonance imaging. Ultrasonogram. Patient monitoring system and medical telemetry. Therapeutic devices: cardiac pacemakers and defibrillators. Electrical safety in bio instrumentations and sensing.

EEE 426 Biomedical Signals, Instrumentation and Measurement Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 425. In the second part, students will design simple systems using the principles learned in EEE 425.

EEE 427 Measurement and Instrumentation
3 Credit Hours, 3 Contact Hours per Week

Introduction: Applications, functional elements of a measurement system and classification of instruments. Measurement of electrical quantities: Current and voltage, power and energy measurement. Current and potential transformer. Transducers: mechanical, electrical and optical. Measurement of non-electrical quantities: Temperature, pressure, flow, level, strain, force and torque. Basic elements of DC and AC signal conditioning: Instrumentation amplifier, noise and source of noise, noise elimination compensation, function generation and linearization, A/D and D/A converters, sample and hold circuits. Data Transmission and Telemetry: Methods of data transmission, DC/AC telemetry system and digital data transmission. Recording and display devices. Data acquisition system and microprocessor applications in instrumentation.

EEE 428 Measurement and Instrumentation Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 427. In the second part, students will design simple systems using the principles learned in EEE 427.

CSE 451 Computer Networks
3 Credit Hours, 3 Contact Hours per Week

Switching and multiplexing; ISO, TCP-IP and ATM reference models. Different Data Communication Services: Physical Layer- wired and wireless transmission media, Cellular Radio: Communication satellites; Data Link Layer: Elementary protocols, sliding window protocols. Error detection and correction, HDLC, DLL of internet, DLL of ATM; Multiple Access protocols, IEEE.802 Protocols for LANs and MANs, Switches, Hubs and Bridges; High speed LAN; Network layer: Routing, Congestion control, Internetworking, Network layer in internet: IP protocol, IP addresses, ARP; NI in ATM transport layer: transmission control protocol. UDP, ATM adaptation layer; Application layer: Network security; Email, Domain Name System; Simple Network Management Protocol; HTTP and World Wide Web.

CSE 452 Computer Networks Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in CSE 451. In the second part, students will design systems using the principles learned in CSE 451.

Communication and Signal Processing Group

EEE 417 Random Signals and Processes
3 Credit Hours, 3 Contact Hours per Week

Probability and Random variables: Sample space, set theory, probability measure, conditional probability, total probability, Bayes theorem, independence and uncorrelatedness. Expectation, Variance, moments and characteristic functions. Commonly used distribution and density functions. Central limit theorem. Transformation of a random variables: one, two and N random variables. Joint distribution, density, moments and characteristic functions. Hypothesis Testing.

Random Processes: Correlation and covariance functions. Process measurements. Gaussian, and Poisson random processes. Markov Process. Noise models. Stationarity and Ergodicity. Spectral Estimation. Correlation and power spectrum. Cross spectral densities. Response of linear systems to random inputs. Statistical Estimation Techniques (ML, MMSE, MAP).

EEE 431 Digital Signal Processing II
3 Credit Hours, 3 Contact Hours per Week

Spectral estimation of random processes: classical methods, minimum variance method, parametric methods: AR and ARMA spectral estimation, Levinson-Durbin algorithm, super resolution techniques: Pisarenko, and MUSIC.
Adaptive signal processing: Applications, e.g., equalization, interference suppression, acoustic echo cancellation. FIR and IIR adaptive filters. Recursive least squares algorithm, steepest descent and Newton algorithm, least mean-square (LMS) algorithm, convergence analysis. Variable step-size LMS algorithm.
Multirate DSP: Interpolation and decimation, single-stage and multistage implementation, design of anti-aliasing and anti-imaging filters. Polyphase representation of multirate systems. Multirate implementation of ideal LP filter, digital filter banks, narrowband filters. Perfect reconstruction filters banks. Short time Fourier transform, subband decomposition and wavelet transform, CWT, DWT, inter-scale relationship of DWT coefficients, multirate implementation. Applications of wavelet transform.

EEE 433 Microwave Engineering
3 Credit Hours, 3 Contact Hours per Week

Transmission Lines: The Lumped-Element Circuit Model for a Transmission Line, Field Analysis of Transmission Lines, The Terminated Lossless Transmission Lines, The Smith Chart, The Quarter-Wave Transformers, Generator and Load Mismatches, Impedance Matching and Tuning, Lossy Transmission Lines. Waveguides: General Formulation, Modes of Propagation and Losses in Parallel Plate, Rectangular and Circular Waveguides. Microstrip Lines: Structures and Characteristics. Microwave Resonators: Waveguide Cavity Resonators, Microstrip Resonators. Microwave Network Analysis: Scattering Matrices and Multiport Analysis Techniques. Radiation and Antennas: Types of Antenna and Their Applications, Radiating Field Regions, Radiation Pattern- Isotropic, Directional and Omni Directional Patterns, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency and Gain, Polarization, Vector Effective Length, Effective Aperture, Equivalent Circuit Model and Corresponding Parameters, Friis Transmission Equation, Mathematical Formalism for Far Field Analysis, Infinitesimal Dipole Antenna, Finite Length Dipole Antenna, Infinitesimal Loop Antenna, Antenna Array, N Element Linear Array, Endfire and Broadside Array- Array Factor and Directivity.

EEE 434 Microwave Engineering Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 433. In the second part, students will design simple systems using the principles learned in EEE 433.

EEE 435 Optical Communications
3 Credit Hours, 3 Contact Hours per Week

Introduction to optical communication. Guided and unguided optical communication system, Light propagation through guided medium, Optical Fibers: SMF and MMF, SI fibers and GI fibers. Fiber modes, mode theory for light propagation through fibers, single mode condition and multimode condition. Transmission impairments: fiber loss, chromatic dispersion in a fiber, polarization mode dispersion (PMD). Different types of fibers: DSF, DCF, Dispersion compensation schemes. Fiber cabling process, Fiber joints/connectors and couplers, Optical transmitter: LED and laser, Operating principles, Characteristics and driver circuits. Optical receivers: PN, PIN and APD detectors, Noise at the receiver, SNR and BER calculation, Receiver sensitivity calculation. IM/DD and Coherent communication systems. Nonlinear effects in optical fibers. Optical amplifiers, Optical modulators, Multichannel optical systems: Optical FDM, OTDM and WDM. Optical Access Network, Optical link design and Free space optical communication.

EEE 437 Wireless Communication
3 Credit Hours, 3 Contact Hours per Week

Introduction: Wireless communication systems, regulatory bodies. Radio wave propagation: Free-space and multi-path propagation, ray tracing models, empirical path loss models, large-scale and small-scale fading, power delay profile, Doppler and delay spread, coherence time and bandwidth. Statistical channel models: Time-varying channel models, narrowband and wideband fading models, baseband equivalent model, discrete-time model, space-time model, auto- and cross-correlation, PSD, envelope and power distributions, scattering function. Channel capacity: Flat-fading channels - CSI, capacity with known/partially known/unknown CSI. Frequency-selective fading channels - time-invariant channels, time-varying channels. Performance of digital modulations: Error and outage probability, inter-symbol interference, MPSK, MPAM, MQAM, CPFSK. Diversity techniques: Time diversity - repetition coding, beyond repetition coding. Antenna diversity - SC, MRC, EGC, space-time coding. Frequency diversity - fundamentals, single-carrier with ISI equalization, DSSS, OFDM. Space-time communications: Multi-antenna techniques, MIMO channel capacity and diversity gain, STBC, OSTBC, QOSTBC, SM, BLAST, smart antennas, frequency-selective MIMO channels. Broadband communications: DSSS, FHSS, spreading codes, RAKE receivers, MC-CDMA, OFDM, OFDMA, multiuser detection, LTE, WiMAX.

EEE 438 Wireless Communication Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

Laboratory experiments and design of wireless communication systems based on the syllabus of EEE 437 Wireless Communications.

EEE 441 Telecommunication Engineering
3 Credit Hours, 3 Contact Hours per Week

Introduction: Principle, evolution and telecommunication networks. National and International regulatory bodies, Telephone apparatus, telephone Exchanges, subscriber loop, supervisory tones, PSTN. Switching systems: Introduction to analog system: Strowger and Crossbar switching systems, Stored program control (SPC) systems, Digital switching systems: space division switching, time division switching, blocking probability and multistage switching, and digital memory switch. Traffic analysis: Traffic characterization, grades of service, network blocking probabilities, delay system and queuing. Integrated services digital network (ISDN): N-ISDN and B-ISDN, architecture of ISDN, B-ISDN implementation. Digital subscriber loop (DSL), Wireless local loop (WLL), FTTx, SONET/SDH, WDM Network, IP telephony and VoIP, ATM network and Next Generation Network (NGN).

EEE 443 Radar and Satellite Communications
3 Credit Hours, 3 Contact Hours per Week

Introduction to Satellite Communication, Satellite frequency bands, satellite orbits, satellite types, regulation of the spectrum and interference, propagation channel, air interfaces, link budget analysis, Digital Modulation, Error Correction Codes, Multiple Access, receiver synchronization, baseband processing, fixed and mobile applications, basics of satellite networking.

Radar equation, radar cross section, information contents in radar signals, noise and clutter, radar detectors, Doppler and MTI radar, pulse compression, CW and FM-CW radar, radar transmitter and receivers, introduction to polarimetric radar and synthetic aperture radar.

EEE 445 Multimedia Communications
3 Credit Hours, 3 Contact Hours per Week

Introduction and classification of multimedia signals, auditory and visual systems of humans, representations of text, audio and video signals, color representations of visual signals. Compression of multimedia signals for communication: sampling, orthogonal transforms and subband coding of signals. Techniques of compressions for communication: text compression using Huffman and Lempel Ziv coding, audio compression using LPC, GSM/CELP, MP3/AAC, image compression using JPEG, JPEG2000, video compression using H.363, MPEG-4. Mutlimedia communication networks and protocols: MPEG transport stream, H.221 framing, IP-based transport protocols such as UDP, TCP, RTP, DCCP, RTCP and VoIP. Quality of Services. Synchronization and signaling of multimedia communications using SS7, H.323, SIP, SDP, RTSP, Megaco. Digital television, HDTV. Multimedia content creation and management. Wireless communications of multimedia signals. Security issues of multimedia communications.

EEE 447 Introduction to Digital Image Processing,
3 Credit Hours, 3 Contact Hours per Week

History and background of digital image processing, image processing system and applications, visual perception, sensors for image acquisition, sampling and quantization, intensity transformation and enhancement of images in spatial domain, histogram equalization, Fuzzy techniques for image processing, 2D discrete Fourier transform, image restoration, Wiener and constraint least-square filters for images, homomorphic filters, image reconstruction from projections, multi-resolution image processing, sub-band coding and image compression.

EEE 449 Information and Coding Theory
3 Credit Hours, 3 Contact Hours per Week

Entropy and Mutual Information: Entropy, joint entropy and conditional entropy, Relative entropy and mutual information, chain rules for entropy, relative entropy and mutual information, Jensen's inequality and log-sum inequality

Differential Entropy: Differential entropy and discrete entropy, joint an conditional differential entropy, properties of differential entropy, relative entropy and mutual information

Entropy Rates of Stochastic Process: Markov Chain, Entropy rate and hidden Markov models

Source Coding: Kraft inequality, optimal codes, Huffman code and its optimality, Shannon-Fano-Elias coding, arithmetic coding

Channel Capacity: Binary symmetric channels and properties of channel capacity, channel coding theorems, joint source and channel coding theorem

Block coding and decoding, BCH, RS codes, Convolutional coding, Viterbi Decoder, Turbo codes, decoding techniques

STBC, SFBC, STFBC

Gaussian Channel: Introduction to Gaussian Channel, Band limited channel, Parallel Gaussian Channel, Gaussian Channel with feedback.

EEE 491 Introduction to Medical Imaging
3 Credit Hours, 3 Contact Hours per Week

Introduction to imaging, medical imaging modalities, Medical imaging before x-rays, Hippocratic thermography, dissection, laproscopy, X-radiography, Computed tomography (CT), evolution of CT scanner design, image reconstruction algorithms, filtered back-projection method, iterative method, low dose computed tomography, Ultrasound, Sonar and other early applications of acoustics, basic principles of ultrasound imaging, Evolution of ultrasound technology and clinical applications, Magnetic resonance imaging, Early use of nuclear magnetic resonance (NMR) spectroscopy, Principles of NMR and MRI, Evolution of magnetic resonance imaging (MRI) technology and clinical applications, development and applications of functional MRI, Introduction to Nuclear imaging.

EEE 493 Digital Filter Design
3 Credit Hours, 3 Contact Hours per Week

Application of digital filters, analog filters, linear phase FIR filters, optimal filter design, Remez exchange algorithm, multiband filters, approximately linear phase IIR filter, all pass filter, design of IIR filter using optimization methods: Newton's method, Quasi-Newton algorithms, Minimax algorithms, improved Minimax algorithms, filter design in time-frequency domain, design of special filters: Hilbert transformer, narrowband filter, fractional delay filter, Wiener filter, filter design using Kalman filter/parallel Kalman filter, Wavelet filter.

EEE 495 Speech Communication
3 Credit Hours, 3 Contact Hours per Week

Speech production and phonetics: articulatory and acoustic features; Speech analysis: formant, pitch, time and frequency domain analysis techniques, spectrogram; Speech coding: linear predictive coding, vocoders, vector quantization; Speech enhancement: spectral subtraction based techniques; Speech synthesis: formant synthesizers; Speech and speaker recognition: feature extraction and conventional recognition methods.

EEE 497 Telecommunication Networks
3 Credit Hours, 3 Contact Hours per Week

Introduction to Telecom System and Networks, Essentials of a Telecom Network. Telecommunication Switching system: TDM switching, Space division switching, Time-Space Switching, Circuit Switching and Packet Switching, Switching Fabrics. Integrated Services Digital Network (ISDN), Broadband ISDN (B - ISDN), Switching and Signaling Techniques in ISDN, Signaling System – 7 (SS - 7), ISDN Protocols and standards. Telecom Network Architectures, Network Topology: Ring, Bus, Tree, Star, Architecture of a node, Functions of a node; Routing & Switching, Principles of Routing; Hot Potato Routing, Deflection Routing, Virtual Path Routing, Shortest Path Routing etc. Access Technologies: Conflict free Multiple Access techniques: FDMA, OFDMA, TDMA, CDMA, Demand Assignment Multiple Access (DAMA), CSMA-CD, CSMA-CA. Network Protocol Stack, IP Protocol, Voice over IP (VoIP), Asynchronous Transfer Mode (ATM) technology, IP over ATM, Synchronous Optical Network (SONET) and Synchronous digital Hierarchy (SDH), IP over SONET, SONET over WDM networking Access Network Technologies: Hybrid Fiber Coax (HFC), Fiber to the X (FTTX), Ethernet Passive Optical Network (EPON), Gigabit PON (GPON). Next generation Networking (NGN), Next generation SONET/SDH, Networks and Standards, Multiple Protocol Label Switching (MPLS), MPLS over WDM.

(**Note: For total credit hour fulfillment of the degree of B. Sc. Engg. (EEE), credits of either EEE 497 or EEE 499 will be counted but not both.)**

EEE 498 Telecommunication Networks Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

Laboratory experiments and designs based on the course EEE 497 Telecommunication Networks.

EEE 499 Wireless and Mobile Networks
3 Credit Hours, 3 Contact Hours per Week

Overview of wireless networks, different generations of wireless networks. Wireless Transmission techniques: baseband transmission, Carrier modulated band pass transmission, Ultra wideband (UWB) transmission, wireless modems, Spread Spectrum techniques; direct system (DS) and Frequency Hopping (FH) Spread Spectrum Systems. Wireless Network topologies, Cellular networks, Cellular fundamentals, carrier to co channel interference ratio (C/CCI), Capacity expansion techniques. Access Techniques: FDMA, TDMA, CDMA, narrowband and wideband Access technologies, OFDMA, Hybrid multiple Access techniques: FDMA-TDMA, OFDMA-TDMA, MC-CDMA; Spectral Efficiency and Capacity of wireless networks. Diversity in Mobile networks: MIMO Wireless Networks, Space, Time and Frequency coding techniques. Switching technologies: Circuit switching, packet switching, Protocol Stack, Random Access Technology and Wireless LANs, Aloha, Slotted Aloha, CSMA-CA and W-LAN Protocols, Routing in Wireless Networks, Optimal Routing and Scheduling, Single-hop and Multi-hop Networks. Quality of Service (QoS) in Wireless Networks, Traffic Management, Wireless Adhoc Networks, Wireless Sensor Networks. Cellular Network standards: GSM, IS-95, UMTS, CDMA-2000, W-CDMA, 3G and future generation.

(**Note: For total credit hour fulfillment of the degree of B. Sc. Engg. (EEE), credits of either EEE 497 or EEE 499 will be counted but not both.)**

Electronics Group

EEE 451 Processing and Fabrication Technology
3 Credit Hours, 3 Contact Hours per Week

Substrate materials: Crystal growth and wafer preparation, epitaxial growth technique, molecular beam epitaxy, chemical vapor phase epitaxy and chemical vapor deposition (CVD).

Doping techniques: Diffusion and ion implantation. Growth and deposition of dielectric layers: Thermal oxidation, CVD, plasma CVD, sputtering and silicon-nitride growth.

Introduction to Semiconductor Characterization Tools.

Etching: Wet chemical etching, silicon and GaAs etching, anisotropic etching, selective etching, dry physical etching, ion beam etching, sputtering etching and reactive ion etching. Cleaning: Surface cleaning, organic cleaning and RCA cleaning. Lithography: Photo-reactive materials, pattern generation, pattern transfer and metalization. Steps of lithography. Non-optical lithography.

Discrete device fabrication: Diode, transistor, resistor and capacitor. Integrated circuit fabrication: Isolation - pn junction isolation, mesa isolation and oxide isolation. BJT based microcircuits, p-channel and n-channel MOSFETs, complimentary MOSFETs and silicon on insulator devices. Testing, bonding and packaging.

EEE 455 Compound Semiconductor Devices
3 Credit Hours, 3 Contact Hours per Week

Reviews of Compound semiconductor: Zinc-blend crystal structures, growth techniques, alloys, band gap, basic opto-electronic properties, density of carriers in intrinsic and doped compound semiconductors.

Introduction to Physics of Hetero-Junctions: Band alignment, band offset, Anderson's rule, single and double sided hetero-junctions, quantum wells and quantization effects, lattice mismatch and strain and common hetero-structure material systems.

Hetero-Junction diode: Band banding, carrier transport and I-V characteristics. Hetero-junction field effect transistor: Structure and principle, band structure, carrier transport and I-V characteristics. Nonideal effects, frequency response, high electron mobility transistor.

Hetero-structure bipolar transistor (HBT): Structure and operating principle, quasi-static analysis, extended Gummel-Poon model, Ebers-Moll model, secondary effects and band diagram of a graded alloy base HBT.

Resonant Tunneling diodes: physics and operation. Resonant Tunneling Transistors: device physics, operation and characteristics.

EEE 459 Optoelectronics
3 Credit Hours, 3 Contact Hours per Week

Optical properties in semiconductor: Direct and indirect band-gap materials, basic transitions in semiconductors, radiative and non-radiative recombination, optical absorption, photo-generated excess carriers, minority carrier life time, luminescence and quantum efficiency in radiation.

Properties of light: Particle and wave nature of light, polarization, interference, diffraction and blackbody radiation.

Light emitting diode (LED): Principles, materials for visible and infrared LED, internal and external efficiency, loss mechanism, structure and coupling to optical fibers. Double-Hetero-structure (DH) LEDs, Characteristics, Surface and Edge emitting LEDs.

Stimulated emission and light amplification: Spontaneous and stimulated emission, Einstein relations, population inversion, absorption of radiation, optical feedback and threshold conditions.

Semiconductor Lasers: Population inversion in degenerate semiconductors, laser cavity, operating wavelength, threshold current density, power output, elementary laser diode characteristics, hetero-junction lasers, optical and electrical confinement. single frequency solid state lasers-distributed Bragg reflector (DBR), distributed feedback (DFB) laser.

Introduction to quantum well lasers. Introduction to quantum well lasers, Vertical Cavity Surface Emitting Lasers (VCSELs), optical laser amplifiers.

Photo-detectors: Photoconductors, junction photo-detectors, PIN detectors, avalanche photodiodes, hetero-junction photodiodes, Schottky photo-diodes and phototransistors. Noise in photo-detectors. PIN and APD. Photo-detector design issues. Solar cells: Solar energy and spectrum, silicon and Schottkey solar cells. Modulation of light: Phase and amplitude modulation, electro-optic effect, acousto-optic effect and magneto-optic devices. Introduction to integrated optics.

EEE 460 Optoelectronics Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

Laboratory based on EEE 459

EEE 461 Semiconductor and Nano Device
Credit Hours, 3 Contact Hours per Week

Lattice vibration: Simple harmonic model, dispersion relation, acoustic and optical phonons. Free electron model: Electrical conductivity. Band structure: Isotropic and anisotropic crystals, band diagrams and effective masses of different semiconductors and alloys. Scattering theory: Perturbation theory, Fermi-Golden rule for static and oscillating potentials, scattering rates for impurity and phonons, inter-band and inter-sub-band optical absorption, mobility. Quantum mechanical model of carrier transport: Tunneling transport, current and conductance, resonant tunneling, resonant tunneling diodes, super-lattices and mini-bands. Introduction to inter sub-band transition devices.

EEE 463 Introduction to Nanotechnology and Nanoelectronics
3 Credit Hours, 3 Contact Hours per Week

Why Nanotechnology: importance, size scales, quantum size effects, revolutionary applications, potentials. Nanotools: scanning tunneling microscope, atomic force microscope, electron microscope, measurement techniques based on fluorescence, other techniques. Basics of Fabrication: fabrication and processing industry, wafer manufacturing, deposition techniques: evaporation, sputtering, chemical vapor deposition, epitaxy; Wet and dry etching techniques; photolithography, elctron beam lithography, stamp technology. Bottom-up processes: chemical and organic synthesis techniques, self-assembly, other techniques. Nanoelectronics: overview of quantum mechanics, Schrodinger equation, particle in a box. Band theory of solids. Importance of nanoelectronics, Moore's law, ITRS roadmap. Tunneling devices; quantum tunneling, resonant tunneling diodes. Single electron transistor: Coulomb blockade. Quantum confinement: wires and dots, carbon nanotubes, graphenes. Brief intorduction on Molecular electronics and nanobiology.

EEE 465 Analog Integrated Circuits and Design
3 Credit Hours, 3 Contact Hours per Week

Analog IC Design: Bipolar, MOS and BiCMOS IC technology and its impact, eggshell analogy, application areas and the future of analog IC design.
Review of transistors: Large and small signal models, compact models for Bipolar, FET, and BiCMOS. Amplifiers with passive and active loads, cascode stages.
Multiple current sources/sinks using Bipolar and FET technologies. Current mirrors: Basic, cascode and active current mirrors; influence of channel modulation, mismatched transistors and error in aspect ratios. Wilson current mirror.
Constant current or voltage references: Supply voltage and temperature independent biasing, band-gap references; constant-Gm biasing. Widlar band-gap voltage reference.

Differential pairs: Differential vs. single-ended operations of simple amplifiers, differential and common mode voltages, common mode rejection ratio (CMRR), input common mode range (ICMR), transfer characteristics, small signal analysis, and frequency response of differential pairs.
High-gain amplifiers: Design and analysis of operational amplifiers (Op Amps) using BJTs and FETs, hierarchy in analog integrated circuits for an Op-Amps, internal structure of IC Op-Amps, high-performance Op-Amps.
Switch capacitor circuits: Equivalent resistance of a switched capacitor, unity gain buffers, charge amplifiers and integrators. Sampling switches: Charge injection, clock feed-through, charge feed-through; quantized model and remedy of charge injection. Switched capacitor filters.
Origin of internally developed noises in ICs; shot, thermal, flicker, burst and avalanche noises in a device. Representation of noises in circuits, noises in single stage and differential amplifiers, noise bandwidth.

EEE 466 Analog Integrated Circuits and Design Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 465. In the second part, students will design simple systems using the principles learned in EEE 465.

EEE 467 VLSI Circuits and Design
3 Credit Hours, 3 Contact Hours per Week

Review of Basic CMOS circuits. Scaling of MOS transistor and interconnect: RC delay modeling, repeaters and cascaded drives. Buffer chain design to drive large capacitive load. Logical efforts of paths and the best number of stages. Integrated circuit fabrication technology: photolithography, CMOS process flow, design rules. Advanced CMOS nanometer process flow and enhancement of CMOS process, technology related CAD issues and manufacturing issues, design margin and PVT corners. Reliability issues: Latch-up, electro-migration. Structured design of VLSI circuits: Clocked sequential circuit design: two phase clocking, dynamic shift register. High speed digital circuit design techniques: circuit families, architecture for high speed design, Carry select, carry skip, carry look ahead and tree adders. Wallace tree multiplication. Sequential circuit design: sequencing methods, maximum and minimum delay constrains, clock skew. Design of latches and flip-flops, clock Generation and synchronization, Highspeed clock generation and distribution. Memory elements design: SRAM and DRAM design. System timing consideration, static and dynamic CMOS memory array. Finite State Machine design: Design of Moore Type and Mealy type FSM. Digital system design using Verilog, design of a simple RISC processor. Functional verification of digital system using system Verilog: Flat and layered test benches, verification coverage, random test pattern generation and UVM. ASIC Cell based design, standard cell place and route design, timing directed placement design. Floor planning, power distribution and I/O cell placement.

EEE 468 VLSI Circuits and Design Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 467. In the second part, students will design simple systems using the principles learned in EEE 467.

Power Group

EEE 411 Power System II
3 Credit Hours, 3 Contact Hours per Week

Definition and classification of stability, two axis model of synchronous machine, loading capability, rotor angle stability - swing equation, power-angle equation, synchronizing power coefficients, equal area criterion, multi-machine stability studies, step-by-step solution of the swing curve, factors affecting transient stability. Frequency and voltage stability.

Economic Operation within and among plants, transmission-loss equation, dispatch with losses.

Flexible AC transmission system (FACTS) - **i**ntroduction, **s**hunt compensation (SVC, STATCOM), series compensation (SSSC, TCSC, TCSR, TCPST), series-shunt compensation (UPFC).

Power quality- voltage sag and swell, surges, harmonics, flicker, grounding problems; IEEE/IEC standards, mitigation techniques.

EEE 412 Power System II Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments and do simulations to verify practically the theories and concepts learned in EEE 411. In the second part, students will design simple systems using the principles learned in EEE 411.

EEE 471 Energy Conversion III
3 Credit Hours, 3 Contact Hours per Week

Basic principles of energy conversion: electromagnetic, electrostatic, thermoelectric, electrochemical, and electromechanical.

Acyclic machines: generators, conduction pump and induction pump.

Nonconventional energy conversion: solar-photovoltaic, solar-thermal, wind, geothermal, wave and tidal energy, MHD (Magneto Hydrodynamic) systems.

Motors and drives: series universal motor, permanent magnet DC motor, brushless DC motor (BLDC), stepper motor, reluctance motor, switched reluctance motor, hysteresis motor, repulsion motor, permanent magnet synchronous motor, linear induction motor, electro static motor.

EEE 473 Renewable Energy
3 Credit Hours, 3 Contact Hours per Week

Renewable energy sources: Solar, wind, mini-hydro, geothermal, biomass, wave and tides.

Solar Photovoltaic: Characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, sun tracking systems, Maximum Power Point Tracking (MPPT): chopper, inverter.

Sizing the PV panel and battery pack in stand-alone PV applications. Modern solar energy applications (residential, electric vehicle, naval, and space). Solar power plants connected to grid.

Solar thermal: principles of concentration, solar tower, parabolic dish, receiver, storage, steam turbine and generator.

Wind turbines: Wind turbine types and their comparison, power limitation, Betz's law; Control mechanism: pitch, yaw, speed. Couplings between the turbine and the electric generator, Wind turbine generator - DC, synchronous, self excited induction generator and doubly fed induction generator. Grid interconnection: active and reactive power control.

Biomass and biogas electricity generation.

EEE 475 Power Plant Engineering
3 Credit Hours, 3 Contact Hours per Week

Load forecasting. Load curve: demand factor, diversity factor, load duration curve, energy load curve, load factor, capacity factor, utilization factor. Thermal power station: heat rate, incremental heat rate, efficiency, capacity scheduling, load division. Principles of power plants: steam, gas, diesel, combined cycle, hydro and nuclear. Captive power plant and cogeneration. Power plant auxiliaries and instrumentation. Power evacuation and switchyard. Selection of location: technical, economical and environmental factors. Generation scheduling.

EEE 477 Power System Protection
3 Credit Hours, 3 Contact Hours per Week

Electric arcs, arc extinction mechanism, transient recovery voltage. Circuit Breakers: operating mechanisms, construction and operation of Miniature Circuit Breaker (MCB), Molded Case Circuit Breaker (MCCB), Air Circuit Breaker (ACB), Air Blast Circuit Breaker (ABCB), Vacuum Circuit Breaker (VCB), Oil Circuit Breaker (OCB), Minimum Oil Circuit Breaker (MOCB) and Sulfur Hexafluoride (SF_6) circuit breaker. High Rupturing Capacity (HRC) Fuse, Drop Out Fuse (DOF), Load Break Switches, Contactors. Bus bar layout, isolators, earthing switch; lightning arresters, CT, PT: wound type and CCVT (Capacitor Coupled Voltage Transformer), MOCT (Magneto Optical Current Transducer).

Fundamental of protective relaying. Classical relays (electromagnetic attraction type, induction type); numerical relays. Inverse Definite Minimum Time (IDMT) relays, directional relays, differential and percentage differential relays, distance relays, pilot relays (wire pilot, carrier).

Protection of generators, motors, transformers, transmission lines, HVDC system and feeders.

EEE 478 Power System Protection Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 477. In the second part, students will design simple systems using the principles learned in EEE 477.

EEE 479 Power System Reliability
3 Credit Hours, 3 Contact Hours per Week

Review of probability concepts. Probability distribution: Binomial, Poisson, and Normal. Reliability concepts: Failure rate, outage, mean time to failure, series and parallel systems and redundancy. Markov process. Probabilistic generation and load models. Reliability indices: Loss of load probability and loss of energy probability. Frequency and duration. Reliability evaluation techniques of single area system. Interconnected system: tie line and evaluation of reliability indices.

EEE 481 Power System Operation and Control
3 Credit Hours, 3 Contact Hours per Week

Overview: vertically integrated vs. deregulated power system. Real-time operation: SCADA; EMS (energy management system); various data acquisition devices - RTU, IED, PMU, DFDR, WAMPAC (wide area monitoring, protection and control).
Application functions: state estimation; short term load forecasting; unit commitment (UC); economic dispatch (ED); optimal power flow (OPF). Frequency control: generation and turbine governors, droop, frequency sensitivity of loads, ACE (area control error), AGC (Automatic Generation Control) and coordination with UC and ED; frequency collapse and emergency load shed.
Power system security: static and dynamic; security constrained OPF.
Electricity market operation: GenCos, ISO, DisCos, bidding, spot market, social welfare, market clearing price (MCP), locational marginal price (LMP), bilateral contracts and forward market, hedging.
Demand side control: DMS (distribution management system), DSM (demand side management), smart grid concept.

EEE 483 High Voltage Engineering
3 Credit Hours, 3 Contact Hours per Week

High voltage DC generation: rectifier circuits, ripple minimization, voltage multipliers, Van-de-Graaf and electrostatic generators; applications.
High voltage AC generation: Tesla coils, cascaded transformers and resonance transformers.
Impulse voltage generation: Shapes, mathematical analysis, codes and standards, single and multi-stage impulse generators, tripping and control of impulse generators.
Breakdown in gas, liquid and solid dielectric materials, applications of gas and solid dielectrics in transformer. Corona.
High voltage measurements and testing: IEC and IEEE standards, sphere gap, electrostatic voltmeter, potential divider, Schering bridge, Megaohm meter, HV current and voltage transducers: contact and noncontact.
Over-voltage phenomenon and insulation coordination. Lightning and switching surges, basic insulation level (EV, EHV and UHV systems), surge diverters and arresters.

EEE 484 High Voltage Engineering Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 483. In the second part, students will design simple systems using the principles learned in EEE 483.

EEE 485 Power Transmission and Distribution
3 Credit Hours, 3 Contact Hours per Week

Transmission line parameters: Inductance - inductance due to internal flux, flux linkages between points external to an isolated conductor, flux linkages of one conductor in a group, single-phase two-wire line, composite-conductor lines, three-phase lines with equilateral/ unsymmetrical spacing, double circuits, bundled conductors;

Capacitance - electric field of a long straight conductor, potential difference between points due to a charge, capacitance of a two-wire line, capacitance of three-phase line with equilateral/ unsymmetrical spacing, effect of Earth on transmission line capacitance, bundled conductor, parallel-circuit three-phase lines.

Sag of overhead lines, Types of insulators and electrical stress analysis.

Underground cables: Types and construction; oil filled, gas insulated and XLPE cables; electrical characteristics - electrical stress, capacitance, charging current, insulation resistance, dielectric power factor and dielectric loss, skin effect, proximity effect; identification of fault location.

HVDC transmission: Comparison of AC and DC transmission, HVDC transmission system components, monopolar and bipolar HVDC transmission, power converters: CSC (Current source converter) and VSC (Voltage source converter), operation and control of HVDC transmission link.

Substations: Substation equipment, bus bar arrangements, substation earthing, neutral grounding, substation automation, GIS substation.

Distribution systems: Primary and secondary distribution - radial, ring main, and interconnected system, distribution losses and feeder reconfiguration.

EEE 487 Nuclear Power Engineering
3 Credit Hours, 3 Contact Hours per Week

Basic concepts: nuclear energy, atoms and nuclei, radioactivity, nuclear processes, fission, fusion. Nuclear systems: particle accelerator, isotope separators, neutron chain reaction, reactor types, power generation. Layout of nuclear power plant (NPP). Nuclear power plant reactors : pressurized water reactor, boiling water reactor, CANDU reactor, gas cooled reactor, liquid metal cooled reactor, breeder reactor. Auxiliaries, instrumentation and control. Grid interconnection issues: effects of frequency and voltage changes on NPP operation. Advanced and next generation nuclear plants; very high temperature reactors. Biological effects, reactor safety and security; Three Mile island case; Chernobyl case; Fukushima case. Fuel cycle; radioactive waste disposal.

EEE 489 Smart Grid
3 Credit Hours, 3 Contact Hours per Week

Smart grid: two-way communication; distributed energy resources (DERs) - DG (distributed generation) and ES (energy storage); high power density batteries, EV (electric vehicles) and PHEV (plug-in hybrid electric vehicles); smart sensors, meters and appliances at demand side.
Data communication channels; protocols; TCP/IP; IEEE 802 series wireless LANs: bluetooth, Zigbee, WiMax; wired LANs- Ethernet, PSTN, PLC (Power Line Carrier); cyber security.
Smart meters and AMI (advanced metering infrastructure): construction; standards for information exchange- Modbus, DNP3 and IEC61850; interfacing with HAN, NAN, WAN.
Power electronic interfaces between grid and DERs.

Demand side integration (DSI): DSM; real time pricing; ancillary markets; DR (demand response) for load shaping, frequency and voltage control, energy efficiency.
Microgrids, self-healing and restoration.

16.3 Courses Offered by Other Departments to EEE Students

16.3.1 Computer Science and Engineering

CSE 109 Computer Programming
3 Credit Hours, 3 Contact Hours per Week

Introduction to digital computers. Programming languages, algorithms and flow charts. Structured Programming using C: Variables and constants, operators, expressions, control statements, functions, arrays, pointers, structure unions, user defined data types, input-output and files. Object-oriented Programming using C++: introduction, classes and objects; polyorphism; function and operator overloading; inheritance.

CSE 110 Computer Programming Sessional
1.5 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in CSE 109. In the second part, students will learn program design.

CSE 451 Computer Networks
3 Credit Hours, 3 Contact Hours per Week

Switching and multiplexing; ISO, TCP-IP and ATM reference models. Different Data Communication Services: Physical Layer- wired and wireless transmission media, Cellular Radio: Communication satellites; Data Link Layer: Elementary protocols, sliding window protocols. Error detection and correction, HDLC, DLL of internet, DLL of ATM; Multiple Access protocols, IEEE.802 Protocols for LANs and MANs, Switches, Hubs and Bridges; High speed LAN; Network layer: Routing, Congestion control, Internetworking, Network layer in internet: IP protocol, IP addresses, ARP; NI in ATM transport layer: transmission control protocol. UDP, ATM adaptation layer; Application layer: Network security; Email, Domain Name System; Simple Network Management Protocol; HTTP and World Wide Web.

CSE 452 Computer Networks Sessional
3 Credit Hours, 3 Contact Hours per Week

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in CSE 451. In the second part, students will design systems using the principles learned in CSE 451.

16.3.2 Civil Engineering

CE 106 Engineering Drawing
1.5 Credit Hours, 3 Contact Hours per Week

Introduction- lettering, numbering and heading; instrument and their use; sectional views and isometric views of solid geometrical figures. Plan, elevation and section of multistoried building; building services drawings; detailed drawing of lattice towers.

16.3.3 Mechanical Engineering

ME 267 Mechanical Engineering Fundamentals
3 Credit Hours, 3 Contact Hours per Week

Introduction to sources of energy: Steam generating units with accessories and mountings; steam turbines.
Introduction to internal combustion engines and their cycles, gas turbines.
Refrigeration and air conditioning: applications; refrigerants, different refrigeration methods.

Fluid machinery: impulse and reaction turbines; centrifugal pumps, fans, blowers and compressors.

Basics of conduction and convection: critical thickness of insulation.

ME268 Mechanical Engineering Fundamentals Sessional
1.5 Credit Hours, 3 Contact Hours per Week

Sessional based on ME 267.

16.3.4 Industrial and Production Engineering

IPE 493 Industrial Management
3 Credit Hours, 3 Contact Hours per Week

Management Functions and Organization: Evolution, management function: organization, theory and structure, span of control, authority delegation, manpower planning.
Personal Management: Importance, need hierarchy, motivation, leadership, wage incentives, performance appraisal, participative management.

Operation Management: Production planning and control (PPC) functions, quantitative methods applied in production, quality management, location and layout planning safety and loss management.

Cost and Financial Management: Elements of cost products, cost analysis, investment analysis, benefit cost analysis, risk analysis.

Management Accounting: Cost planning and control, budget and budgetary control.

Marketing Management: Concepts, strategy, sales promotion, patent laws.

Technology Management: Management of innovation and changes, technology life cycle.

Case studies.

16.3.5 Physics

PHY 121 Waves and Oscillations, Optics and Thermal Physics
3 Credit Hours, 3 Contact Hours per Week

Waves and oscillations: Differential equation of simple harmonic oscillator, total energy and average energy, combination of simple harmonic oscillations, spring mass system, torsional pendulum; two body oscillation, reduced mass, damped oscillation, forced oscillation, resonance, progressive wave, power and intensity of wave, stationary wave, group and phase velocities.

Optics: Defects of images: spherical aberration, astigmatism, coma, distortion, curvature, chromatic aberration. Theories of light; Interference of light: Young's double slit experiment, displacement of fringes and its uses, Fresnel bi-prism, interference in thin films, Newton's rings, interferometers; Diffraction: Diffraction by single slit, diffraction from a circular aperture, resolving power of optical instruments, diffraction at double slit and N-slits, diffraction grating; polarization: Production and analysis of polarized light, Brewster's law, Malus law, polarization by double refraction, Nicol prism, optical activity, Polarimeters.

Thermal Physics: Heat and work- the first law of thermodynamics and its applications; Kinetic Theory of gases- Kinetic interpretation of temperature, specific heats of ideal gases, equipartition of energy, mean free path, Maxwell's distribution of molecular speeds, reversible and irreversible processes, Carnot's cycle, second law thermodynamics, Carnot's theorem, entropy, Thermodynamic functions, Maxwell relations, Clausius and Clapeyron equation.

PHY 102 Physics Sessional
1.5 Credit Hours, 3 Contact Hours per Week

Laboratory experiments based on PHY 121.

PHY 165 Electricity and Magnetism, Modern Physics and Mechanics
3 Credit Hours, 3 Contact Hours per Week

Electricity and magnetism: Electric charge and Coulomb's Law, Electric field, Concept of electric flux and the gauss's Law - some applications of gauss's Law, Gauss's Law in vector form, Electric potential, Relation between electric field and electric potential, Capacitance and dielectrics, Gradient, Laplace's and Poisson's equations, Current, Current density, Resistivity, The magnetic field, Ampere's Law, Biot-savart Law and their applications, Laws of electromagnetic induction- Maxwell's equations.

Modern Physics: Galilean relativity and Einstein's special theory of relativity; Lorentz transformation equations, Length contraction, Time dilation and mass-energy relation, Photoelectric effect, Compton effect; de Broglie matter waves and its success in explaining Bohr's theory, Pauli's exclusion principle, Constituent of atomic nucleus, Nuclear binding energy, Different types of radioactivity, Radioactive decay Law; Nuclear reactions, Nuclear fission, Nuclear fusion, Atomic power plant.

Mechanics: Linear momentum of a particle, Linear momentum of a system of particles, Conservation of linear momentum, Some applications of the momentum principle; Angular momentum of a particle, Angular momentum of a system of particles, Kepler's Law of planetary motion, The Law of universal gravitation, The motion of planets and satelites, Introductory quantum mechanics; Wave function, Uncertainity principle, Postulates, Schrodinger time independent equation, Expectation value, Probability, Particle in a zero potential, Calculation of energy.

16.3.6 Chemistry

CHEM 101 Chemistry I
3 Credit Hours, 3 Contact Hours per Week

Atomic Structure, quantum numbers, electronic configuration, periodic table. Properties and uses of noble gases. Different types of chemical bonds and their properties. Molecular structures of compounds. Selective organic reactions.

Different types of solutions and their compositions. Phase rule, phase diagram of monocomponent system. Properties of dilute solutions. Thermochemistry, chemical kinetics, chemical equilibria. Ionization of water and pH concept. Electrical properties of solution.

CHEM 114 Inorganic, Quantitative Analysis Sessional
1.5 Credit Hours, 3 Contact Hours per Week

Volumetric analysis: acid-base titration, oxidation-reduction titrations, determination of Fe, Cu and Ca volumetrically.

16.3.7 Mathematics

MATH 157 Calculus I
3 Credit Hours, 3 Contact Hours per Week

Differential Calculus: Limits, continuity and differentiability. Successive differentiation of various types of functions. Leibnitz’s theorem. Rolle’s theorem, Mean value theorem, Taylor’s and Maclaurin's theorems in finite and infinite forms. Lagrange’s form of remainders. Cauchy’s form of remainders. Expansion of functions, evaluation of indeterminate forms of L’ Hospital’s rule. Partial differentiation. Euler’s theorem. Tangent and normal. Subtangent and subnormal in cartesian and polar co-ordinates. Determination of maximum and minimum values of functions. Curvature. Asymptotes. Curve tracing.

Integral Calculus: Integration by the method of substitution. Standard integrals. Integration by successive reduction. Definite integrals, its properties and use in summing series. Walli’s formulae. Improper integrals. Beta function and Gamma function. Area under a plane curve and area of a region enclosed by two curves in cartesian and polar co-ordinates. Volumes and surface areas of solids of revolution.

MATH 159 Calculus II
3 Credit Hours, 3 Contact Hours per Week

Complex Variable: Complex number system. General functions of a complex variable. Limits and continuity of a function of complex variable and related theorems. Complex differentiation and the Cauchy-Riemann equations. Infinite series. Convergence and uniform convergence. Line integral of a complex function. Cauchy’s integral formula. Liouville’s theorem. Taylor’s and Laurent’s theorem. Singular points. Residue. Cauchy’s residue theorem.

Vector Analysis: Multiple product of vectors. Linear dependence and independence of vectors. Differentiation and integration of vectors together with elementary applications. Line, surface, and volume integrals. Gradient of a scalar function, divergence and curl of a vector function, various formulae. Integral forms of gradient, divergence and curl. Divergence theorem. Stoke’s theorem, Green’s theorem and Gauss’s theorem.

MATH 257 Ordinary and Partial Differential Equations
3 Credit Hours, 3 Contact Hours per Week

Ordinary Differential Equations: Degree and order of ordinary differential equations, formation of differential equations. Solution of first order differential equations by various methods. Solution of general linear equations of second and higher orders with constant coefficients. Solution of homogeneous linear equations. Solution of differential equations of the higher order when the dependent or independent variables are absent. Solution of differential equation by the method based on the factorization of the operators. Frobenius method.

Partial Differential Equations: Introduction. Linear and non-linear first order equations. Standard forms. Linear equations of higher order. Equations of the second order with variable coefficients. Wave equations. Particular solution with boundary and initial conditions.

MATH 259 Linear Algebra
3 Credit Hours, 3 Contact Hours per Week

Introduction to systems of linear equations. Gaussian elimination. Definition of matrices. Algebra of matrices. Transpose of a matrix and inverse of matrix. Factorization. Determinants. Quadratic forms. Matrix polynomials. Euclidean n-space. Linear transformation from IRn to IRm. Properties of linear transformation from IRn to IRm. Real vector spaces and subspaces. Basis and dimension. Rank and nullity. Inner product spaces. Gram-Schmidt process and QR-decomposition. Eigenvalues and eigenvectors. Diagonalization. Linear transformations. Kernel and Range. Application of linear algebra to electric networks.

MATH 357 Probability and Statistics
3 Credit Hours, 3 Contact Hours per Week

Introduction. Sets and probability. Random variable and its probability distributions. Treatment of grouped sampled data. Some discrete probability distributions. Normal distribution. Sampling theory. Estimation theory. Tests of hypotheses. Regression and correlation. Analysis of variance.

16.3.8 Humanities

HUM 127 Sociology
3 Credit Hours, 3 Contact Hours per Week

Introduction: Society, Science and Technology- an overview; Scientific Study of Society; Social Elements, Society, Community, Association and Institution; Mode of Production and Society Industrial Revolution, Development of Capitalism.

Culture and Socialization: Culture; Elements of Culture; Technology and Culture; Cultural Lag; Socialization and Personality; Family; Crime and Deviance; Social Control. Technology, Society and Development; Industrialization and Development; Development and Dependency Theory; Sustainable Development; Development and Foreign Borrowing; Technology Transfer and Globalization, Modernity and Environment; Problem and Prospects.

Pre-industrial, Industrial and Post-industrial Society: Common Features of Industrial Society; Development and Types of Social Inequality in Industrial Society; Poverty, Technology and Society; Social Stratification and Social Mobility; Rural and Urban Life, and their Evaluation.

Population and Society: Society and Population; Fertility. Mortality and Migration; Science, Technology and Human Migration; Theories of Population Growth-Demographic Transition Theory, Malthusian Population Theory; Optimum Population Theory; Population Policy.

HUM 135 English
3 Credit Hours, 3 Contact Hours per Week

General discussion: Introduction, various approaches to learning English.

Grammatical Problems: Construction of sentences, grammatical errors, sentence variety and style, conditionals, vocabulary and diction.

Reading Skill: Discussion readability, scan and skin reading, generating ideas through purposive reading, reading of selected stories.

Writing Skill: Principles of effective writing; Organization, planning and development of writing; Composition, precis writing, amplification.

General strategies for the writing process: Generating ideas, identifying audiences and purposes, construction arguments, stating problems, drafting and finalizing.

Approaches to Communication: Communication today, business communication, different types of business communication.

Listening Skill: The phonemic systems and correct English pronunciation.

Speaking Skill: Practicing dialogue; Story telling; Effective oral presentation.

Report Writing: Defining a report, classification of reports, structure of a report, and writing of reports.

HUM 137 Professional Ethics
3 Credit Hours, 3 Contact Hours per Week

Definition and scopes of Ethics. Different branches of Ethics. Social change and the emergence of new technologies. History and development of Engineering Ethics. Science and Technology- necessity and application. Study of Ethics in Engineering. Applied Ethics in engineering.

Human qualities of an engineer. Obligation of an engineer to the clients. Attitude of an engineer to other engineers. Measures to be taken in order to improve the quality of engineering profession.

Ethical Expectations: Employers and Employees; inter-professional relationship: Professional Organization- maintaining a commitment of Ethical standards. Desired characteristics of a professional code. Institutionalization of Ethical conduct.

HUM 272 Developing English Skills Laboratory
1.5 Credit Hours, 3 Contact Hours per Week

Grammar: Tense, article, preposition, subject-verb agreement, clause, conditional and sentence structure.

Vocabulary building: correct and precise diction, affixes, level of appropriateness. Colloquial and standard, informal and formal.

Developing reading skill: Strategies of reading- skimming, scanning, predicting, inferencing; Analyzing and interpreting variety of texts; Practicing comprehension from literary and nonliterary texts.

Developing writing skill: Sentences, sentence variety, generating sentences; Clarity and correctness of sentences, linking sentences to form paragraphs, writing paragraphs, essays, reports, formal and informal letters.

Listening skill and note taking: Listening to recorded texts and class lectures and learning to take useful notes based on listening.

Developing speaking skill: Oral skills including communicative expressions for personal identification, life at home, giving advice and opinion, instruction and directions, requests, complains, apologies, describing people and places, narrating events.

HUM 277 Fundamentals of Economics
3 Credit Hours, 3 Contact Hours per Week

Introduction to economics. Economics and engineering. Different economic systems. Fundamental economic problems. Basic elements of demand, supply and product market. Theory of utility and preferences, consumer’s surplus. Theory of production and cost. Theory of the firm and market structure. Optimization.

Introducing macroeconomics. National income accounting, the simple Keynesian analysis of national income, employment and inflation. Savings, investment and decision making. Fiscal policy and monetary policy- money and interest rate, income and spending.

Economics of development and planning.

HUM 279 Financial and Managerial Accounting
3 Credit Hours, 3 Contact Hours per Week

Financial Accounting: Objectives and importance of accounting, branches of accounting, accounting as an information system, computerized system and applications in accounting. Recording System: Double entry mechanism, accounts and their classification, accounting equation, accounting cycle journal, ledger, trial balance. Preparation of financial statements considering adjusting and closing entries. Accounting concepts and conventions. Financial statements analysis and interpretation: ration analysis- tests for profitability, liquidity, solvency and overall measure.

Costs and Management Accounting: Cost concept and classification. Segregation and mixed cost. Overhead cost: meaning and classification, allocation of overhead cost, overhead recovery method. Job order costing: preparation of job cost sheet and quotation price. Inventory valuation: absorption costing and variable costing technique. Cost volume profit analysis: meaning, breakeven analysis, contribution margin approach, sensitivity analysis. Short-term investment decisions: Relevant and differential cost analysis; Linear programming. Long-term investment decisions: Capital budgeting, various techniques of evaluation of capital investment, investment appraisal under uncertainty, risk management, capital rationing. Concept of working capital, need for working capital, management of cash, stock debtors.

16.4 Equivalence of Old Courses with New Courses

16.4.1 Equivalence of EEE Courses

Course Number of Previous Course	**Course Number of Present Course**
EEE 101 Electrical Circuits I	EEE 101 Electrical Circuits I
EEE 105 Electrical Circuits II	EEE 105 Electrical Circuits II
EEE 106 Electrical Circuits Laboratory	EEE 102 Electrical Circuits I Laboratory and EEE 106 Electrical Circuits II Laboratory
EEE 110 Electrical Circuits Simulation Laboratory	EEE 102 Electrical Circuits I Laboratory and EEE 106 Electrical Circuits II Laboratory
EEE 201 Electronics I	EEE 201 Electronic Circuits I
EEE 203 Energy Conversion I	EEE 203 Energy Conversion I
EEE 205 Energy Conversion II	EEE 205 Energy Conversion II
EEE 206 Energy Conversion Laboratory	EEE 206 Energy Conversion Laboratory
EEE 207 Electronics II	EEE 207 Electronic Circuits II
EEE 208 Electronics Laboratory	EEE 208 Electronic Circuits II Laboratory
	EEE 202 Electronic Circuits Laboratory
EEE 209 Engineering Electromagnetics	EEE 209 Engineering Electromagnetics
EEE 210 Electronic Circuits Simulation Laboratory	EEE 210 Electronic Circuits Simulation Laboratory
EEE 212 Numerical Technique Laboratory	EEE 212 Numerical Technique Laboratory.
EEE 301 Continuous Signals and Linear Systems	EEE 211 Continuous Signals and Linear Systems
EEE 303 Digital Electronics	EEE 303 Digital Electronics

EEE 304 Digital Electronics Laboratory	EEE 304 Digital Electronics Laboratory
EEE 305 Power System I	EEE 305 Power System I
EEE 306 Power System I Laboratory	EEE 306 Power System I Laboratory
EEE 307 Electrical Properties of Materials	EEE 307 Electrical Properties of Materials
EEE 309 Communication Theory	EEE 309 Communication Systems I
EEE 310 Communication Laboratory	EEE 310 Communication Systems I Laboratory
EEE 311 Digital Signal Processing I	EEE 311 Digital Signal Processing I
EEE 312 Digital Signal Processing I Laboratory	EEE 312 Digital Signal Processing I Laboratory
EEE 314 Electrical Services Design	EEE 414 Electrical Services Design
EEE 315 Microprocessor and Interfacing	EEE 415 Microprocessors and Embedded Systems
EEE 316 Microprocessor and Interfacing Laboratory	EEE 416 Microprocessors and Embedded Systems Laboratory
EEE 400 Project/Thesis	EEE 400 Thesis
EEE 401 Control System I	EEE 317 Control System I
EEE 402 Control System I Laboratory	EEE 318 Control System I Laboratory
EEE 413 Solid State Devices	EEE 313 Solid State Devices

Elective Interdisciplinary Courses and Laboratories

Course Number of Previous Course	**Course Number of Present Course**
EEE 421 Control System II	EEE 421 Control System II
EEE 422 Control System II Laboratory	EEE 422 Control System II Laboratory
EEE 423 Numerical Methods	EEE 423 Numerical Methods
EEE 424 Numerical Methods Laboratory	EEE 424 Numerical Methods Laboratory
EEE 425 Biomedical Instrumentation	EEE 425 Biomedical Signals, Instrumentation and Measurement
EEE 426 Biomedical Instrumentation Laboratory	EEE 426 Biomedical Signals, Instrumentation and Measurement Laboratory
EEE 427 Measurement and Instrumentation	EEE 427 Measurement and Instrumentation
EEE 428 Measurement and Instrumentation Laboratory	EEE 428 Measurement and Instrumentation Laboratory

Elective Communication Courses and Laboratories

Course Number of Previous Course	**Course Number of Present Course**
EEE 331 Random Signals and Processes	EEE 417 Random Signals and Processes
EEE 431 Digital Signal Processing II	EEE 431 Digital Signal Processing II
EEE 433 Microwave Engineering	EEE 433 Microwave Engineering
EEE 434 Microwave Engineering Laboratory	EEE 434 Microwave Engineering Laboratory
EEE 435 Optical Fiber Communication	EEE 435 Optical Fiber Communication
EEE 437 Digital Communication	EEE 439 Communication System II
EEE 438 Digital Communication Laboratory	None
EEE 439 Mobile Cellular Communication	EEE 499 Wireless and Mobile Networks
EEE 441 Telecommunication Engineering	EEE 441 Telecommunication Engineering

Elective Electronics Courses and Laboratories

Course Number of Previous Course	**Course Number of Present Course**
EEE 351 Analog Integrated Circuits	EEE 465 Analog Integrated Circuits and Design

None	EEE 466 Analog Integrated Circuits and Design Laboratory
EEE 431 Solid State Devices	EEE 313 Solid State Devices
EEE 451 Processing and Fabrication Technology	EEE 451 Processing and Fabrication Technology
EEE 453 VLSI I	EEE 467 VLSI Circuits and Design
EEE 454 VLSI I Laboratory	EEE 468 VLSI Circuits and Design Laboratory
EEE 455 Compound Semiconductor and Hetero-Junction Devices	EEE 455 Compound Semiconductor and Hetero-Junction Devices
EEE 457 VLSI II	EEE 467 VLSI Circuits and Design
EEE 458 VLSI II Laboratory	EEE 468 VLSI Circuits and Design Laboratory
EEE 459 Optoelectronics	EEE 459 Optoelectronics
EEE 461 Semiconductor Device Theory	EEE 461 Semiconductor and Nano Device
EEE 463 Introduction to Nanotechnology and Nanoelectronics	EEE 463 Introduction to Nanotechnology and Nanoelectronics
Elective Power courses and Laboratories	
Course Number of Previous Course	**Course Number of Present Course**
EEE 371 Power System II	EEE 411 Power System II
EEE 372 Power System II Laboratory	EEE 412 Power System II Laboratory
EEE 471 Energy Conversion III	EEE 471 Energy Conversion III
EEE 473 Power Electronics	EEE 315 Power Electronics
EEE 474 Power Electronics Laboratory	EEE 316 Power Electronics Laboratory
EEE 475 Power Plant Engineering	EEE 475 Power Plant Engineering
EEE 477 Power System Protection	EEE 477 Power System Protection
EEE 478 Power System Protection Laboratory	EEE 478 Power System Protection Laboratory
EEE 479 Power System Reliability	EEE 479 Power System Reliability.
EEE 481 Power System Operation and Control	EEE 481 Power System Operation and Control
EEE 483 High Voltage Engineering	EEE 483 High Voltage Engineering
EEE 484 High Voltage Engineering Laboratory	EEE 484 High Voltage Engineering Laboratory

16.4.2 Equivalence of Non-EEE Courses

Course Number of Previous Course	**Course Number of Present Course**
Core Courses and laboratories offered By Department of CSE to all EEE Students	
CSE 109 Computer Programming	CSE 109 Computer Programming
CSE 110 Computer Programming Sessional	CSE 110 Computer Programming Sessional
Elective courses and laboratories offered by Department of CSE to EEE students	
CSE 451 Computer Networks	CSE 451 Computer Networks
CSE 452 Computer Networks Laboratory	CSE 452 Computer Network Laboratory
Course offered By the Department of CE to all EEE students	
CE 106 Engineering Drawing	CE 106 Engineering Drawing
Courses and laboratories offered By the Department of ME to all EEE students	
ME 267 Mechanical Engineering Fundamentals	ME 267 Mechanical Engineering Fundamentals
ME 268 Mechanical Engineering Fundamentals Sessional	ME 268 Mechanical Engineering Fundamentals Sessional
Course Offered By the Department of Industrial Production Engineering to all EEE students	
IPE 493 Industrial Management	IPE 493 Industrial Management
Courses and laboratories Offered By the Department of Physics to all EEE students	

PHY 121 Waves and Oscillations, Optics and Thermal Physics	PHY 121 Waves and Oscillations, Optics and Thermal Physics
PHY 102 Physics Sessional	PHY 102 Physics Sessional
PHY 165 Electricity and Magnetism, Modern Physics and Mechanics.	PHY 165 Electricity and Magnetism, Modern Physics and Mechanics
PHY 104 Physics Sessional	PHY 152 (BME) Physics Sessional II
Courses and laboratories offered By the Department of Chemistry to all EEE students	
CHEM 101 Chemistry	CHEM 101 Chemistry
CHEM 114 Inorganic, Quantitative Analysis Sessional	CHEM 114 Inorganic, Quantitative Analysis Sessional
Courses Offered By the Department of Mathematics to all EEE students	
MATH 157 Calculus I	MATH 157 Calculus I
MATH 159 Calculus II	MATH 159 Calculus II
MATH 257 Ordinary and Partial Differential Equations	MATH 257 Ordinary and Partial Differential Equations
MATH 269 Linear Algebra.	MATH 259 Linear Algebra.
MATH 357 Probability and Statistics	MATH 357 Probability and Statistics
Courses and laboratories offered By the Department of Humanities to all EEE students	
HUM 127 Sociology	HUM 127 Sociology
HUM 135 English	HUM 135 English
HUM 137 Professional Ethics	HUM 137 Professional Ethics
HUM 272 Developing English Skills Laboratory	HUM 272 Developing English Skills Laboratory
HUM 277 Fundamentals of Economics	HUM 277 Fundamentals of Economics
Hum 279 Financial and Managerial Accounting	HUM 279 Financial and Managerial Accounting

17. Mapping of POs with Course Outcomes (COs) of All Offered Courses

17.1 Mapping of POs with Course Outcomes (COs) of All Compulsory Courses

Level and Term	Courses	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
Level -1 Term - I	EEE 101	✓	✓										
	EEE 102				✓	✓							
	CSE 109												
	CSE 110												
	CE 106	✓											
	PHY 121	✓											
	MATH 157	✓	✓										
	MATH 159	✓	✓										
Level -1 Term - II	EEE 105	✓	✓										
	EEE 106		✓		✓	✓							
	PHY 165	✓	✓	✓									
	PHY 102	✓											
	CHEM 101	✓	✓	✓									
	CHEM 114	✓	✓		✓					✓			✓
	MATH 257	✓	✓										
	HUM 127							✓	✓	✓	✓	✓	✓
	HUM 277							✓		✓		✓	✓
	HUM 137												
Level -2 Term - I	EEE 201	✓	✓										
	EEE 202				✓	✓				✓			
	EEE 203	✓	✓	✓									
	EEE 211	✓	✓										
	EEE 212		✓		✓	✓							
	MATH 259	✓	✓										
	HUM 135								✓	✓	✓		✓
	HUM 272									✓	✓		
Level -2 Term -II	EEE 205	✓	✓	✓				✓					
	EEE 206	✓		✓	✓								
	EEE 207	✓	✓										
	EEE 208			✓	✓	✓				✓	✓		

Level and Term	Courses	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
	EEE 209	✓	✓										
	ME 267	✓	✓	✓	✓								
	ME 268	✓	✓		✓			✓					✓
	MATH 357	✓		✓									
Level -3 Term -I	EEE 305	✓	✓	✓		✓		✓					✓
	EEE 306	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
	EEE 307	✓	✓	✓									
	EEE 309	✓											
	EEE 310	✓		✓	✓		✓	✓		✓	✓	✓	
	EEE 311	✓	✓	✓									
	EEE 312	✓		✓	✓	✓			✓	✓	✓		✓
	HUM 279							✓	✓	✓	✓	✓	✓
Level -3 Term -II	EEE 303	✓		✓		✓							
	EEE 304	✓		✓		✓			✓	✓	✓		
	EEE 313	✓	✓	✓									
	EEE 315	✓	✓	✓									
	EEE 316	✓	✓	✓		✓	✓	✓		✓	✓	✓	
	EEE 317	✓	✓	✓									
	EEE 318	✓	✓	✓	✓	✓				✓	✓		
	IPE 493		✓	✓						✓			
Level -4 Term -I	EEE 415	✓				✓							✓
	EEE 416			✓		✓	✓	✓		✓	✓	✓	
	EEE 439	✓											
	EEE 400	✓	✓		✓				✓				✓
Level -4 Term -II	EEE 414	✓	✓	✓			✓	✓		✓		✓	✓
	EEE 400	✓	✓		✓				✓		✓		✓

17.2 Mapping of POs with Course Outcomes (COs) of All Optional Courses

Courses	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
Interdisciplinary												
EEE 401	✓	✓	✓	✓								
EEE 402	✓		✓	✓	✓			✓	✓	✓		
EEE 403	✓	✓	✓									
EEE 404	✓		✓	✓	✓			✓	✓	✓		✓
EEE 421	✓	✓	✓	✓								
EEE 422	✓		✓	✓	✓			✓	✓	✓		✓
EEE 425	✓	✓	✓									
EEE 426	✓		✓	✓					✓	✓	✓	✓
EEE 427	✓	✓										
EEE 428			✓	✓	✓				✓	✓		
CSE 451	✓	✓	✓	✓	✓	✓	✓					
CSE 452	✓	✓	✓	✓	✓	✓	✓					
Communication and Signal Processing Group												
EEE 417	✓	✓										
EEE 431	✓	✓	✓	✓								
EEE 433	✓	✓	✓									
EEE 434	✓			✓	✓				✓			
EEE 435	✓	✓	✓									
EEE 437	✓											
EEE 438				✓	✓				✓	✓		
EEE 441	✓	✓	✓									
EEE 443	✓											
EEE 445	✓	✓				✓						
EEE 447	✓	✓	✓									
EEE 449	✓											
EEE 491	✓	✓	✓									
EEE 493	✓	✓	✓									
EEE 495	✓	✓	✓									
EEE 497	✓											
EEE 498	✓			✓	✓				✓			
EEE 499	✓											
Electronics Group												
EEE 451	✓			✓	✓							
EEE 455	✓	✓	✓									
EEE 459	✓	✓	✓							✓		

Courses	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
EEE 460			✓	✓	✓				✓	✓		
EEE 461	✓	✓	✓									
EEE 463	✓			✓	✓							
EEE 465	✓	✓	✓		✓							
EEE 466	✓	✓	✓		✓				✓	✓		
EEE 467	✓	✓	✓	✓	✓							
EEE 468	✓	✓	✓	✓	✓							
Power Group												
EEE 411	✓	✓	✓	✓								
EEE 412	✓	✓	✓	✓	✓							
EEE 471	✓	✓	✓									
EEE 473	✓	✓	✓	✓	✓		✓		✓	✓		✓
EEE 475	✓	✓	✓		✓	✓	✓		✓	✓		✓
EEE 477	✓	✓	✓	✓								
EEE 478	✓	✓			✓				✓			✓
EEE 479	✓	✓	✓	✓								
EEE 481	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EEE 483	✓	✓	✓	✓								
EEE 484			✓	✓	✓				✓	✓		
EEE 485	✓	✓	✓									
EEE 487	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EEE 489	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

PART C: Detailed Description of Courses with Outcome Mapping

(*Changes in PART C can be made through the approval of the respective BUGS. The changes made in this part cannot be conflicting with the content of PART A, PART B and the UG Ordinance of BUET.*)

18. CO-PO Mapping

18.1 CO-PO Mapping of All Compulsory Courses

Level and Term	Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
	EEE 101	CO 1	✓											
		CO 2		✓										
		CO 3	✓											
	EEE 102	CO 1					✓							
		CO 2					✓							
		CO 3				✓								

Level and Term	Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
Level -1 Term -I	CSE 109	CO 1												
		CO 2												
		CO 3												
	CSE 110	CO 1												
		CO 2												
		CO 3												
	CE 106	CO 1	✓											
		CO 2	✓											
		CO 3	✓											
		CO 4	✓											
	PHY 121	CO 1	✓											
		CO 2	✓											
		CO 3	✓											
	MATH 157	CO 1		✓										
		CO 2	✓											
		CO 3		✓										
	MATH 159	CO 1	✓											
		CO 2	✓											
		CO 3		✓										
Level -1 Term -II	EEE 105	CO1	✓											
		CO2		✓										
		CO3		✓										
		CO4		✓										
		CO5	✓											
		CO6		✓										
	EEE 106	CO1					✓							
		CO2		✓										
		CO3				✓								
	PHY 165	CO1	✓											
		CO2		✓										
		CO3			✓									
	PHY 102	CO1	✓											
		CO2	✓											
		CO3	✓											
	CHEM 101	CO1	✓											
		CO2	✓											
		CO3		✓										
		CO4			✓									
	CHEM 114	CO1	✓											
		CO2				✓					✓			
		CO3		✓							✓			
		CO4												✓
	MATH 257	CO1		✓										
		CO2	✓											
		CO3	✓											
		CO4		✓										
	HUM 127	CO1									✓	✓		✓
		CO2								✓				✓
		CO3											✓	✓
		CO4								✓	✓	✓		✓
		CO5											✓	
		CO6							✓				✓	✓
		CO7							✓				✓	
		CO8							✓				✓	
		CO9							✓	✓			✓	✓
		CO1									✓			

Level and Term	Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
	HUM 277	CO2									✓			
		CO3									✓			
		CO4									✓			
		CO5									✓			
		CO6									✓			
		CO7							✓		✓			
		CO8							✓					✓
		CO9							✓		✓		✓	✓
	HUM 137	CO1												
		CO2												
		CO3												
		CO4												
		CO5												
		CO6												
		CO7												
		CO8												
		CO9												
Level -2 Term -I	EEE 201	CO1		✓										
		CO2		✓										
		CO3		✓										
		CO4	✓											
		CO5		✓										
	EEE 202	CO1					✓							
		CO2				✓								
		CO3									✓			
	EEE 203	CO1	✓											
		CO2		✓										
		CO3			✓									
	EEE 211	CO1	✓											
		CO2	✓											
		CO3	✓											
		CO4		✓										
	EEE 212	CO1					✓							
		CO2				✓								
		CO3		✓										
	MATH 259	CO1		✓										
		CO2	✓											
		CO3	✓											
	HUM 135	CO1										✓		
		CO2										✓		
		CO3									✓			
		CO4								✓		✓		
		CO5												✓
	HUM 272	CO1									✓	✓		
		CO2										✓		
		CO3										✓		
		CO4										✓		
		CO5										✓		
	EEE 205	CO1	✓											
		CO2		✓										
		CO3			✓									
		CO4							✓					
	EEE 206	CO1	✓											
		CO2				✓								
		CO3			✓									

Level and Term	Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
Level -2 Term II	EEE 207	CO1	✓											
		CO2		✓										
		CO3	✓											
		CO4	✓											
	EEE 208	CO1					✓							
		CO2				✓								
		CO3			✓									
		CO4										✓		
		CO5									✓			
	EEE 209	CO1	✓											
		CO2	✓											
		CO3		✓										
		CO4		✓										
		CO5		✓										
	ME 267	CO1	✓	✓										
		CO2	✓		✓									
		CO3	✓			✓								
		CO4	✓	✓										
		CO5	✓	✓										
	ME 268	CO1	✓											
		CO2							✓					
		CO3				✓								
		CO4												✓
		CO5		✓										
	MATH 357	CO1	✓											
		CO2			✓									
		CO3	✓											
		CO4			✓									
Level -3 Term -I	EEE 305	CO1	✓		✓									
		CO2		✓			✓							
		CO3	✓						✓					✓
	EEE 306	CO1	✓			✓								
		CO2		✓										
		CO3					✓							
		CO4			✓									
		CO5			✓			✓	✓					
		CO6									✓			
		CO7										✓		
		CO8											✓	
		CO9	✓											
	EEE 307	CO1	✓											
		CO2		✓										
		CO3			✓									
	EEE 309	CO1	✓											
		CO2	✓											
		CO3	✓											
		CO4	✓											
	EEE 310	CO1	✓											
		CO2				✓								
		CO3			✓									
		CO4						✓						
		CO5							✓					
		CO6									✓			
		CO7										✓		
		CO8											✓	
		CO1	✓											

Level and Term	Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
	EEE 311	CO2		✓										
		CO3			✓									
	EEE 312	CO1	✓				✓							
		CO2				✓								
		CO3			✓						✓			
		CO4			✓									✓
		CO5								✓				
		CO6									✓			
		CO7										✓		
	HUM 279	CO1									✓			
		CO2									✓	✓		
		CO3							✓	✓	✓			✓
		CO4											✓	✓
		CO5									✓			
		CO6											✓	✓
		CO7											✓	✓
Level -3 Term -II	EEE 303	CO1	✓											
		CO2					✓							
		CO3			✓									
	EEE 304	CO1	✓											
		CO2					✓							
		CO3			✓									
		CO4								✓				
		CO5									✓			
		CO6										✓		
	EEE 313	CO1	✓											
		CO2	✓											
		CO3	✓											
	EEE 315	CO1	✓											
		CO2	✓											
		CO3		✓										
		CO4		✓										
		CO5			✓									
	EEE 316	CO1	✓											
		CO2	✓				✓							
		CO3		✓										
		CO4			✓									
		CO5							✓					
		CO6								✓				
		CO7									✓	✓	✓	
	EEE 317	CO1	✓											
		CO2		✓										
		CO3			✓									
	EEE 318	CO1					✓							
		CO2				✓								
		CO3		✓										
		CO4	✓											
		CO5					✓							
		CO6			✓									
		CO7										✓		
		CO8									✓			
	IPE 493	CO1									✓			
		CO2			✓									
		CO3		✓										
		CO4		✓										
		CO1	✓											

Level and Term	Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
Level -4 Term -I	EEE 415	CO2					✓							
		CO3												✓
	EEE 416	CO1					✓							
		CO2			✓									
		CO3						✓						
		CO4							✓					
		CO5									✓			
		CO6										✓		
		CO7											✓	
	EEE 439	CO1	✓											
		CO2	✓											
		CO3	✓											
		CO4	✓											
		CO5	✓											
	EEE 400	CO1		✓										
		CO2				✓								
		CO3	✓											
		CO4								✓				
		CO6												✓
Level -4 Term -II	EEE 414	CO1	✓											
		CO2	✓											
		CO3		✓										
		CO4			✓									
		CO5						✓						
		CO6							✓					
		CO7									✓			
		CO8						✓						
		CO9											✓	
		CO10												✓
	EEE 400	CO1		✓										
		CO2				✓								
		CO3	✓											
		CO4								✓				
		CO5										✓		
		CO6												✓

18.2 CO-PO Mapping of All Optional Courses

Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
Interdisciplinary													
EEE 401	CO1	✓	✓										
	CO2				✓								
	CO3		✓										
	CO4				✓								
	CO5			✓									
	CO6		✓										
EEE 402	CO1	✓				✓							
	CO2				✓								
	CO3			✓									
	CO4								✓				
	CO5									✓			
	CO6										✓		

Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
EEE 403	CO1	✓	✓										
	CO2			✓									
	CO3		✓										
	CO4		✓										
	CO5			✓									
EEE 404	CO1	✓				✓							
	CO2				✓	✓							
	CO3			✓									✓
	CO4								✓				
	CO5									✓			
	CO6										✓		
EEE 421	CO1	✓											
	CO2		✓										
	CO3		✓										
	CO4				✓								
	CO5			✓									
	CO6			✓									
EEE 422	CO1	✓				✓							
	CO2				✓	✓							
	CO3			✓									✓
	CO4								✓				
	CO5									✓			
	CO6										✓		
EEE 425	CO1	✓											
	CO2		✓										
	CO3		✓										
	CO4			✓									
EEE 426	CO1	✓											
	CO2				✓								
	CO3			✓						✓			
	CO4									✓	✓	✓	✓
EEE 427	CO1	✓											
	CO2	✓	✓										
	CO3	✓	✓										
	CO4	✓	✓										
	CO5	✓	✓										
EEE 428	CO1					✓							
	CO2				✓								
	CO3			✓									
	CO4										✓		
	CO5									✓			
CSE 451	CO1	✓	✓					✓					
	CO2				✓		✓						
	CO3			✓		✓							
CSE 452	CO1	✓	✓					✓					
	CO2				✓		✓						
	CO3			✓		✓							
Communication and Signal Processing Group													
EEE 417	CO1	✓	✓										
	CO2	✓	✓										
	CO3	✓	✓										
	CO4	✓	✓										
	CO5	✓	✓										
EEE 431	CO1	✓											
	CO2		✓										
	CO3				✓								

Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
	CO4			✓									
	CO5			✓									
EEE 433	CO1	✓											
	CO2		✓										
	CO3	✓											
	CO4			✓									
EEE 434	CO1	✓											
	CO2					✓							
	CO3				✓								
	CO4									✓			
EEE 435	CO1	✓											
	CO2	✓	✓										
	CO3		✓										
	CO4			✓									
EEE 437	CO1	✓											
	CO2	✓											
	CO3	✓											
EEE 438	CO1				✓								
	CO2					✓							
	CO3									✓			
	CO4										✓		
EEE 441	CO1	✓											
	CO2		✓										
	CO3			✓									
EEE 443	CO1	✓											
	CO2	✓											
	CO3	✓											
EEE 445	CO1	✓											
	CO2		✓										
	CO3	✓											
	CO4						✓						
EEE 447	CO1	✓											
	CO2	✓	✓										
	CO3	✓	✓										
	CO4	✓	✓										
	CO5	✓	✓										
	CO6	✓	✓	✓									
EEE 449	CO1	✓											
	CO2	✓											
EEE 491	CO1	✓											
	CO2	✓	✓										
	CO3	✓	✓										
	CO4	✓	✓	✓									
EEE 493	CO1	✓											
	CO2	✓	✓										
	CO3	✓	✓										
	CO4	✓	✓	✓									
EEE 495	CO1	✓											
	CO2		✓										
	CO3			✓									
EEE 497	CO1	✓											
	CO2	✓											
	CO3	✓											
EEE 498	CO1	✓				✓							
	CO2	✓			✓								
	CO3									✓			
EEE 499	CO1	✓											

Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
	CO2	✓											
Electronics Group													
EEE 451	CO1	✓				✓							
	CO2	✓			✓								
EEE 455	CO1	✓											
	CO2		✓										
	CO3			✓									
EEE 459	CO1	✓											
	CO2		✓										
	CO3			✓									
	CO4										✓		
EEE 460	CO1					✓							
	CO2				✓								
	CO3			✓									
	CO4										✓		
	CO5									✓			
EEE 461	CO1	✓											
	CO2		✓										
	CO3			✓									
EEE 463	CO1	✓				✓							
	CO2	✓			✓								
EEE 465	CO1	✓											
	CO2		✓										
	CO3			✓									
	CO4					✓							
EEE 466	CO1	✓											
	CO2		✓										
	CO3			✓									
	CO4					✓							
	CO5									✓			
	CO6										✓		
EEE 467	CO1	✓											
	CO2		✓										
	CO3			✓	✓								
	CO4					✓							
EEE 468	CO1	✓											
	CO2		✓										
	CO3			✓	✓								
	CO4					✓							
Power Group													
EEE 411	CO1	✓											
	CO2		✓										
	CO3			✓									
	CO4				✓								
EEE 412	CO1	✓			✓								
	CO2		✓										
	CO3		✓										
	CO4					✓							
	CO5			✓									
	CO6		✓										
	CO7			✓									
EEE 471	CO1	✓	✓										
	CO2	✓	✓										
	CO3	✓	✓										
	CO4	✓	✓	✓									

Courses	COs	PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)
EEE 473	CO1	✓	✓										
	CO2			✓	✓	✓							
	CO3							✓		✓	✓		✓
EEE 475	CO1	✓	✓				✓	✓					
	CO2			✓		✓		✓					
	CO3		✓	✓									
	CO4									✓	✓		✓
EEE 477	CO1	✓											
	CO2	✓	✓										
	CO3	✓	✓	✓									
	CO4		✓	✓	✓								
EEE 478	CO1	✓											
	CO2		✓										
	CO3					✓							
	CO4												✓
	CO5									✓			
EEE 479	CO1	✓	✓										
	CO2	✓	✓										
	CO3	✓	✓	✓	✓								
	CO4	✓	✓	✓	✓								
EEE 481	CO1	✓	✓										
	CO2	✓	✓		✓								✓
	CO3			✓			✓	✓					
	CO4	✓				✓							
	CO5								✓	✓	✓	✓	✓
	CO6								✓	✓	✓	✓	✓
EEE 483	CO1	✓	✓										
	CO2	✓	✓										
	CO3	✓	✓	✓									
	CO4	✓	✓										
	CO5	✓	✓		✓								
EEE 484	CO1					✓							
	CO2				✓								
	CO3			✓									
	CO4										✓		
	CO5									✓			
EEE 485	CO1	✓	✓										
	CO2	✓	✓	✓									
	CO3	✓											
	CO4	✓											
	CO5	✓		✓									
EEE 487	CO1	✓	✓										
	CO2	✓	✓		✓								
	CO3			✓			✓	✓			✓		✓
	CO4	✓				✓							
	CO5								✓	✓	✓		✓
	CO6								✓	✓		✓	✓
EEE 489	CO1	✓	✓										
	CO2	✓	✓		✓								
	CO3			✓			✓	✓			✓		✓
	CO4	✓				✓							
	CO5								✓	✓	✓		✓
	CO6						✓		✓	✓		✓	✓

19. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

19.1 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities of All Compulsory Courses

Level and Term	Course No.	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
L-1, T-I	EEE 101	✓	✓	✓	✓					✓	✓	✓									
	EEE 102						✓		✓	✓	✓	✓									
	CSE 109		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓					✓
	CSE 110		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓					✓
	CE 106	✓		✓	✓																
	PHY 121																				
	MATH 157																				
	MATH 159																				
L-1 T-II	EEE 105	✓	✓	✓	✓					✓	✓	✓									
	EEE 106	✓	✓	✓	✓		✓		✓	✓	✓	✓									
	PHY 165																				
	CHEM 101																				
	MATH 257																				
	HUM 127																				
	HUM 277																				
	HUM 137																				
L-2 T-I	EEE 201	✓	✓	✓	✓					✓	✓	✓									
	EEE 202						✓		✓	✓	✓	✓									
	EEE 203	✓	✓	✓	✓	✓				✓	✓	✓									
	EEE 211	✓	✓	✓	✓					✓	✓	✓									
	EEE 212		✓	✓	✓		✓		✓	✓	✓	✓									
	MATH 259																				
	HUM 135																				
	HUM 272																				
	EEE 205	✓	✓	✓	✓	✓		✓		✓	✓	✓									

Level and Term	Course No.	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
L-2 T-II	EEE 206	✓	✓	✓	✓	✓			✓	✓	✓	✓									
	EEE 207	✓	✓	✓	✓					✓	✓	✓									
	EEE 208			✓			✓		✓	✓	✓	✓					✓	✓	✓		
	EEE 209	✓	✓	✓	✓					✓	✓	✓									
	ME 267																				
	ME 268																				
	MATH 357																				
L-3 T-I	EEE 305	✓	✓	✓	✓	✓		✓		✓	✓	✓									
	EEE 306	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	
	EEE 307	✓	✓	✓	✓	✓		✓		✓	✓	✓									
	EEE 309	✓	✓	✓	✓					✓	✓	✓									
	EEE 310	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓		✓	✓		✓	
	EEE 311		✓	✓	✓	✓		✓		✓	✓	✓									
	EEE 312		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓		✓	✓
	HUM 279																				
L-3 T-II	EEE 303	✓	✓	✓	✓	✓	✓			✓	✓	✓									
	EEE 304		✓	✓	✓	✓	✓	✓		✓	✓	✓					✓	✓	✓		
	EEE 313	✓	✓	✓	✓	✓		✓		✓	✓	✓									
	EEE 315	✓	✓	✓	✓	✓		✓		✓	✓	✓									
	EEE 316	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓		✓	
	EEE 317	✓	✓	✓	✓	✓		✓		✓	✓	✓									
	EEE 318	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓		✓	
	IPE 493																				
L-4 T-I	EEE 400	✓	✓	✓	✓				✓	✓	✓	✓				✓	✓	✓	✓		✓
	EEE 415	✓	✓	✓	✓		✓			✓	✓	✓									
	EEE 416					✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓	
	EEE 439	✓	✓	✓	✓					✓	✓	✓									
L-4	EEE 400	✓	✓	✓	✓				✓	✓	✓	✓				✓	✓	✓	✓		✓

Level and Term	Course No.	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
T-II	EEE 414	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓

19.2 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities of All Optional Courses

Course No.	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
Interdisciplinary																				
EEE 401																				
EEE 402																				
EEE 403																				
EEE 404																				
EEE 421																				
EEE 422																				
EEE 425																				
EEE 426																				
EEE 427																				
EEE 428					√	√		√	√	√	√					√	√	√		
CSE 451		√	√		√	√	√	√	√	√	√			√	√	√	√	√		√
CSE 452		√	√	√	√	√	√	√	√	√	√			√	√	√	√	√		√
Communication and Signal Processing Group																				
EEE 417																				
EEE 431																				
EEE 433	√	√	√	√	√	√		√	√											
EEE 434																				
EEE 435																				
EEE 437																				
EEE 438		√			√	√		√	√	√	√	√				√	√	√		
EEE 441																				
EEE 443																				
EEE 445																				
EEE 447																				
EEE 449			√	√					√	√	√									
EEE 491																				
EEE 493																				
EEE 495																				
EEE 497																				
EEE 498					√			√	√	√	√					√	√	√		
EEE 499			√	√					√	√	√									

Course No.	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
Electronics Group																				
EEE 451																				
EEE 455					√	√		√	√	√	√					√	√	√		
EEE 459					√	√		√	√	√	√					√	√	√		
EEE 460					√	√		√	√	√	√					√	√	√		
EEE 461																				
EEE 463																				
EEE 465																				
EEE 466																				
EEE 467	√	√	√	√	√	√			√	√	√						√	√		√
EEE 468	√	√	√	√	√	√			√	√	√						√	√		√
Power Group																				
EEE 411																				
EEE 412																				
EEE 471																				
EEE 473																				
EEE 475																				
EEE 477																				
EEE 478									√		√	√	√					√		
EEE 479																				
EEE 481																				
EEE 483																				
EEE 484						√	√		√		√	√	√	√	√	√				
EEE 485																				
EEE 487																				
EEE 489																				

20. Description of All Courses of the Program

20.1 Description of Course EEE 101

Section A: General Information

20.1.1 Course Title	Electrical Circuit 1
20.1.2 Type of Course	Compulsory, Theory
20.1.3 Offered to	EEE
20.1.4 Pre-requisite Course(s)	None

Section B: Course Details

20.1.5 Course Content (As approved by the Academic Council)

Basic Concepts, Charge, Current and Voltage, Power and Energy, Circuit Elements, Applications; Basic Laws, Ohm's Law, Nodes, Branches, and Loops, Kirchhoff's Laws, Series Resistors and Voltage Division, Parallel Resistors and Current Division, Solution of simple circuits with both dependent and independent sources, Wye-Delta Transformations, Applications; Nodal and Mesh Analysis, Applications; Linearity Property, Superposition, Source Transformation, Thevenin's and Norton's Theorem, Maximum Power Transfer Theorem.

Properties of Inductances and capacitances. Series-parallel combinations of inductances and capacitances; Concepts of transient and First-Order Circuits, The Source-Free RL and RC Circuit, Step Response of an RL and RC Circuit, Second-Order Circuits, Finding Initial and Final Values, The Source-Free Series and Parallel RLC Circuit, Step Response of a Series and Parallel RLC Circuit, Duality, Applications of DC transients.

Basic Magnetic Circuits: Magnetic quantities and variables: Field, Flux, Flux Density, Magnetomotive Force, Magnetic Field Strength, permeability and B-H Curve, reluctance, magnetic field strength. Laws in magnetic circuits: Ohm‟s law and Ampere‟s circuital law. Magnetic circuits: Composite series magnetic circuit, parallel and series-parallel circuits. Comparison between electrical and magnetic quantities, Hysteresis and hysteresis loss. Magnetic materials.

20.1.6 Course Objectives

- The main objective of this course is to introduce basic concepts, laws and a variety of analysis techniques to solve and design basic electrical systems
- The course aims to design and analyze circuits using superposition principle, source conversion technique, Thevenin theorem, Norton theorem and maximum power transfer theorem.
- The course aims to give students the necessary background to derive the natural, forced and complete response of simple electrical networks.
- Students will become familiar with the analogy between the analysis of magnetic circuits and that of electrical circuits.

20.1.7 Knowledge required

Basics of physics, equation solver, calculus and differential equation solver.

20.1.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools

1	**Apply the concepts of** circuit elements, circuit, circuit variables, direct current, voltage, dependent and independent sources, circuit laws, analysis methods, theorems to solve various circuits.	PO(a)	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
2	**Analyze** first and second order transient circuits, sequential switching circuits using differential equations to recognize natural, forced and complete response.	PO(b)	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
3	**Solve** series/parallel magnetic circuits based on the understanding of analogy between electrical and magnetic circuits.	PO(a)	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.1.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.1.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)
1-6	1-2	Circuit variables: voltage, current, power and energy, Voltage and current independent and dependent sources, Circuit elements: resistance. Modeling of practical circuits, Ohm‟s law and Kirchhoff‟s laws, Solution of simple circuits with both dependent and independent sources, Series-parallel resistance circuits and their equivalents, Voltage and current divider circuits
7-12	3-4	Delta-Wye equivalent circuits, Techniques of general DC circuit analysis (containing both independent and dependent sources): Node-voltage method, Mesh-current method. Solution of various circuits.
13-18	5-6	Linearity Property, Superposition, Source Transformation, Thevenin's and Norton's Theorem, Maximum Power Transfer Theorem.
19-24	7-8	Properties of Inductances and capacitances. Series-parallel combinations of inductances and capacitances; Concepts of transient

Lectures	Weeks	Topics (According to syllabus)
		and First-Order Circuits, The Source-Free RL and RC Circuit, Step Response of an RL and RC Circuit
25-30	9-10	Second-Order Circuits, Finding Initial and Final Values, The Source-Free Series and Parallel RLC Circuit, Step Response of a Series and Parallel RLC Circuit, Duality, Applications of DC transients.
31-36	11-12	Basic Magnetic Circuits: Magnetic quantities and variables: Field, Flux, Flux Density, Magnetomotive Force, Magnetic Field Strength, permeability and B-H Curve, reluctance, magnetic field strength. Laws in magnetic circuits: Ohm"s law and Ampere"s circuital law. Magnetic circuits: Composite series magnetic circuit, parallel and series-parallel circuits. Comparison between electrical and magnetic quantities, Hysteresis and hysteresis loss. Magnetic materials.
37-42	13-14	Review

20.1.11 Assessment Strategy

- Class participation and attendance will be recorded in every class. Participation and attendance for the students may be considered in case the student could not attend the class due to a valid reason (power failure, internet problem, device problem, health problem, etc.). The student has to inform the teacher over email in case of such occurrences. A maximum of three (03) such missed classes can be considered for this course
- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.1.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.1.13 Textbook/References

- Fundamentals of Electric Circuits (5^{th} Edition)- Charles K. Alexander, Matthew N. O. Sadiku
- Introduction to Electric Circuits- Richard C. Dorf, James A. Svoboda
- Electric Circuits- James William Nilsson
- Basic Electric Circuit Analysis - David E. Johnson, John L. Hilburn
- Basic Engineering Circuit Analysis" - J. David Irwin, R. Mark Nelms
- Introductory Circuit Analysis-(8th Edition)- Robert L Boylestad

20.2 Description of Course EEE 102

Section A: General Information

20.2.1 Course Title	Electrical Circuits I Laboratory
20.2.2 Type of Course	Compulsory, Sessional
20.2.3 Offered to	EEE
20.2.4 Pre-requisite Course(s)	None

Section B: Course Details

20.2.5 Course Content (As approved by the Academic Council)

In this course students will perform simulation study and experiments to verify practically the theories and concepts learned in EEE 101.

20.2.6 Course Objectives

- To deliver hands-on training on simulation study to verify the theories of electrical circuits, and to solve basic electrical systems by utilizing a variety of analysis techniques.
- To provide hands-on training on experiments to validate practically the concepts of electrical circuits and to solve basic electrical systems by applying various analysis techniques.
- To give students the necessary background to examine the natural, forced, and complete response of simple electrical networks.

20.2.7 Knowledge required

Fundamental of physics, equation solver, calculus, and differential equation solver

20.2.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** modern computer aided design tools to model and solve problems related to basic electrical systems	PO(e)	C3, P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests, Lab-quiz
2	**construct** electrical circuits at hardware level to measure and analyse DC and transient characteristics of different circuit networks and circuit elements	PO(e)	C3, P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Reports, Lab-tests, Lab-quiz
3	**compare** theoretical and experimental results of circuit laws, analysis methods, theorems	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Reports, Assignment, Lab-tests

***Program Outcomes (PO):** Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

****Cognitive Domain Taxonomy Levels: C1** – Remember, **C2** – Explain, **C3** – Apply, **C4** – Analyze, **C5** – Evaluate/Compare, **C6** – Create; **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

20.2.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
					✓		✓	✓	✓	✓									

20.2.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1 (S)	Introduction to PSpice
3	1 (H)	Orientation Of Measurement/Recording Instruments, DC-AC Sources/Function Generators and Circuit Elements/Accessories
4	2 (S)	Simulating Circuits with Dependent Sources in PSpice
5	2 (H)	Use of Switches, Series-Parallel Connections and Verification of KVL, KCL, Voltage division between series connected resistances and current division between parallel resistances
6	3 (S)	First Order DC Transients and Steady State AC Circuit Analysis
7	3 (H)	Verification of Network Theorems in Linear Resistive DC Circuits
8	4 (S)	Determination of Equivalent Resistance and Circuit Analysis with Source and Resistance Sweeping
9	4 (H)	Time Responses of R-L and R-C Circuits with DC Excitation (Time Responses of First Order Systems)
10	5(H)	Instantaneous and RMS Values of AC Waveforms; KVL, KCL, Phasor Diagram of Simple Series R-C and R-L Circuits with Sinusoidal Excitation
11	-	Lab-test and Viva (Software)
12	-	Lab-test and Viva (Hardware)
13	-	Lab-Quiz

20.2.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing, viva, and lab quiz.

20.2.12 Distribution of Marks

To be decided by course instructor(s)

20.2.13 Textbook/References

- Fundamentals of Electric Circuits (5th Edition)- Charles K. Alexander, Matthew N. O. Sadiku
- Introduction to Electric Circuits- Richard C. Dorf, James A. Svoboda
- Electric Circuits- James William Nilsson
- Basic Electric Circuit Analysis - David E. Johnson, John L. Hilburn
- Basic Engineering Circuit Analysis” - J. David Irwin, R. Mark Nelms
- Introductory Circuit Analysis-(8th Edition)- Robert L Boylestad
- Lab sheets of the simulation study (Software) and experiments (hardware) will be shared with the class

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.3 Description of Course CSE 109

Section A: General Information

20.3.1 Course Title	Computer Programming
20.3.2 Type of Course	Compulsory, Theory, Non-departmental
20.3.3 Offered to	EEE
20.3.4 Pre-requisite Course(s)	None

Section B: Course Details

20.3.5 Course Content (As approved by the Academic Council)

Introduction to digital computers. Programming languages, algorithms and flow charts. Structured Programming using C: Variables and constants, operators, expressions, control statements, functions, arrays, pointers, structure unions, user defined data types, input-output and files. Object-oriented Programming (OOP) using C++: introduction, classes and objects; polymorphism; function and operator overloading; inheritance;

20.3.6 Course Objectives

The students are expected to:

- Know and comprehend the concepts of structural programming language and object oriented programming language.
- Interpret, analyse and evaluate code written in C/C++.
- Design and construct suitable C/C++ programs, within the boundaries of the ethical and societal obligations of engineers, to solve practical problems.

20.3.7 Knowledge required

Technical

- Introductory knowledge on Computers is required. Knowledge on any high-level programming language such as python may be an added advantage for the learners.

Analytical

- Problem formulation and solving

20.3.8 Course Outcomes

CO No.	**CO Statement** After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Know** and **comprehend** the concepts of structural programming language and object-oriented programming language.	-	C2	Lecture, Demonstration, and hands-on	Class Tests and Assignments, Assignments in CSE 110, and Final Exam
2	**Interpret**, **analyse** and **evaluate** code written in C/C++.	-	C5, A5	Lecture, Demonstration, and hands-on	Class Tests and Assignments, Assignments in CSE 110, and Final Exam
3	**Design** and **construct** suitable C/C++ programs, within the boundaries of the **ethical and societal obligations of engineers**, to **solve** practical problems	-	C6, A5	Lecture, Demonstration, and hands-on	Class Tests and Assignments, Assignments in CSE 110, and Final Exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.3.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√																		
CO2		√	√																	√
CO3		√	√	√	√	√	√	√			√	√	√		√					√

20.3.10 Lecture Plan

Week	Topic
1	Introductory discussion, Motivation behind Programming, hands on demonstration of a very simple Program
2	Data type, variables, operators, expressions, type-casting, Control structure: if-else, switch-case, ternary operator
3	while/do-while/for loops, nested control structure, break and continue;
4	Function: parameter passing, return type;
5	One-dimensional array: searching and sorting with one-dimensional arrays;
6	Character and String: basic string operations, string related library functions;
7	Multi-dimensional array: matrix operations with multi-dimensional arrays; Recursion;
8	Bitwise operations; User-defined data types: structure, union, bitfield, enumeration;
9	Pointers: pointer to string, array, structure, and function
10	Dynamic memory allocation
11	Input/Output I/O): Console I/O, Formatted I/O, File I/O
12	Introduction to OOP, classes and objects, reference
13	Polymorphism, function and operator overloading, static functions
14	Inheritance Continued): function overriding, abstract class

20.3.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 four) Class Tests/Assignments/Projects, out of which the best 3 three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

20.3.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.3.13 Textbook/References

- C/C++ Structured C/C++ Programming by M A H Newton, M. Kaykobad and Md Mostofa Akbar, Voyeger Publications
- Teach yourself C, Herbert Shildt 3rd Edition)
- Teach yourself C++, Herbert Shildt 3rd Edition)
- Programming With C, Schaums Outline Series

20.4 Description of Course CSE 110

Section A: General Information

20.4.1 Course Title	Computer Programming Sessional
20.4.2 Type of Course	Compulsory, Sessional, Non-departmental
20.4.3 Offered to	EEE
20.4.4 Pre-requisite Course(s)	None

Section B: Course Details

20.4.5 Course Content (As approved by the Academic Council)

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in CSE 109. In the second part, students will learn program design.

20.4.6 Course Objectives

The students are expected to:

- Know and comprehend the concepts of structural programming language and object oriented programming language.
- Interpret, analyse and evaluate code written in C/C++.
- Design and construct suitable C/C++ programs, within the boundaries of the ethical and societal obligations of engineers, to solve practical problems.

20.4.7 Knowledge required

Technical

- Introductory knowledge on Computers is required. Knowledge on any high-level programming language such as python may be an added advantage for the learners.

Analytical

- Problem formulation and solving

20.4.8 Course Outcomes

CO No.	**CO Statement** After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Know** and **comprehend** the concepts of structural programming language and object-oriented programming language.	-	C2	Lecture, Demonstration, and hands-on	Lab. and home assignments, participation in hands on sessions

CO No.	**CO Statement** After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
2	**Interpret**, **analyse** and **evaluate** code written in C/C++.	-	C5, A5	Lecture, Demonstration, and hands-on	Lab. and home assignments, participation in hands on sessions
3	**Design** and **construct** suitable C/C++ programs, within the boundaries of the **ethical and societal obligations of engineers**, to **solve** practical problems	-	C6, A5, P7	Lecture, Demonstration, and hands-on	Lab. and home assignments, participation in hands on sessions

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.4.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√																		
CO2		√	√																	√
CO3		√	√	√	√	√	√	√			√	√	√		√					√

20.4.10 Lecture Plan

Week	Topic	Course Outcomes
1	**Type:** Lecture/Demonstration Introduction rules and regulations overview, tools demonstration, writing your first C program!	CO1
2	**Type:** Hands on Data type, variables, operators, expressions, type-casting, Control structure: if-else, switch-case, ternary operator.	CO1, CO2
3	**Type:** Lab. Assignment Data type, variables, operators, expressions, type-casting, Control structure: if-else, switch-case, ternary operator	CO1, CO2

Week	Topic	Course Outcomes
4	**Type:** Lab. Assignment while/do-while/for loops, nested control structure, break and continue;	CO1, CO2
5	**Type:** Lab. Assignment Function: parameter passing, return type;	CO1, CO2, CO3
6	**Type:** Hands on One-dimensional array: searching and sorting with one-dimensional arrays;	CO1, CO2, CO3
7	**Type:** Lab. Assignment Character and String: basic string operations, string related library functions;	CO1, CO2, CO3
8	**Type:** Home Assignment Multi-dimensional array: matrix operations with multi-dimensional arrays; Recursion;	CO1, CO2, CO3
9	**Type:** Lab. Assignment Bitwise operations; User-defined data types: structure, union, bitfield, enumeration;	CO1, CO2, CO3
10	**Type:** Hands on Pointers: pointer to string, array, structure, and function	CO1, CO2, CO3
11	**Type:** Home Assignment Pointers: pointer to string, array, structure, and function , Dynamic memory allocation	CO1, CO2, CO3
12	Quiz	CO1, CO2, CO3
13	**Type:** Hands on Introduction to OOP, classes and objects, reference, Polymorphism, function and operator overloading, static functions	CO1, CO2, CO3
14	**Type:** Home Assignment Polymorphism, function and operator overloading, static functions	CO1, CO2, CO3

20.4.11 Assessment Strategy

- Participation in hands on sessions: Participation in hands on sessions will be recorded.
- Lab. and home assignments: There will be several assignments given. The students will have to solve some of the assignments in the lab. within a short period of time. Other assignments will be take-home.
- Quiz: A comprehensive quiz will be held at the end of the semester.

20.4.12 Distribution of Marks

Participation in hands on sessions:	10 %
Lab. and home assignments:	60%
Quiz:	30%
Total:	100%

20.4.13 Textbook/References

- C/C++ Structured C/C++ Programming by M A H Newton, M. Kaykobad and Md Mostofa Akbar, Voyeger Publications
- Teach yourself C, Herbert Shildt (3rd Edition)
- Teach yourself C++, Herbert Shildt (3rd Edition)
- Programming With C, Schaums Outline Series

20.5 Description of Course CE 106

Section A: General Information

20.5.1 Course Title	Engineering Drawing
20.5.2 Type of Course	Compulsory, Sessional, Non-departmental
20.5.3 Offered to	EEE
20.5.4 Pre-requisite Course(s)	None

Section B: Course Details

20.5.5 Course Content (As approved by the Academic Council)

Lettering, numbering and heading; instrument and their use; sectional and isometric views of solid geometrical figures; plan, elevation and section of multi-storied buildings; drawings of building services; detailed drawing of lattice towers.

20.5.6 Course Objectives

- To introduce basic geometric figures associated with engineering drawing
- To familiarize with different views and projections of any object
- To introduce building drawings with plan and sectional views
- To introduce drawing of lattice towers

20.5.7 Knowledge required

Preliminary knowledge in geometry

20.5.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	***comprehend*** the basics of engineering drawing	PO(a)	C1	Lectures, Assignment	Class assessment, Quiz
2	***interpret*** building drawing plan, elevation & section of buildings	PO(a)	C1, C2	Lectures, Assignment	Class assessment, Quiz
3	***perform*** the task related to tower and circuit drawing	PO(a)	C1, C2	Lectures, Assignment	Class assessment, Quiz
4	***apply*** concepts of different views in engineering drawing	PO(a)	C3	Lectures, Assignment	Class assessment, Quiz

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.5.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO-1	√																			
CO-2			√	√																

CO-3			√	√																
CO-4			√	√																

20.5.10 Lecture Plan

Class No.	Topics	References	Corresponding CO(s)
Lecture 1	Introduction, lettering & Numbering	Handout, Book	CO1
Lecture 2	Drawing of Regular Polygons	Handout, Book	CO1
Lecture 3	Drawing of curved geometric figures and theory of projection	Handout, Book	CO1
Lecture 4	1st and 3rd angle projection and drawing of isometric objects	Handout, Book	CO1
Lecture 5	45° projection method	Handout, Book	CO1
Lecture 6	Review class of geometric drawing	Handout, Book	CO1
Lecture 7	MID QUIZ	Handout, Book	
Lecture 8	Introduction to Building Drawing: Plan, Elevation & Section of one Room Building	Handout, Book	CO1 CO2 CO4
Lecture 9	One storied building drawing: Plan, Elevation and Section	Handout, Book	CO1 CO2 CO4
Lecture 10	Two storied building drawing: Plan, Elevation and Section	Handout, Book	CO1 CO2 CO4
Lecture 11	Zigzag and Inclined section of two storied building	Handout, Book	CO1 CO2 CO4
Lecture 12	Lattice tower drawing	Handout, Book	CO3
Lecture 13	FINAL QUIZ	Handout, Book	

20.5.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment:
    - 2 to 3 Class Assessments will be taken
    - Assessment will be based on either the topic taught on that day or topic taught on the previous day or combination of the two topics.
    - Assignment and/or homework will be provided to ensure the active engagement even outside class hours.
- Quizzes: Two no’s quizzes will be administered.

20.5.12 Distribution of Marks

Attendance	10%
Assignment	30%
Class Assessment	20%
Quiz	40%
Total	100%

20.5.13 Textbook/References

- “Technical Drawing” by Frederick E. Giesecke, Alva Mitcheel, Henry Cecil Spencer, Ivan Leroy Hill, John Thomas Dygdon
- Class Lecture Handout
- “Engineering Drawing” by D.N. Ghose.
- “Civil Engineering Drawing” by D.N. Ghose.
- “Civil Engineering Drawing” by Gurcharan Singh and Subhash Chander Sharma.

20.6 Description of Course PHY 121

Section A: General Information

20.6.1 Course Title	Waves and Oscillations, Optics and Thermal Physics
20.6.2 Type of Course	Compulsory, Theory, Non-departmental
20.6.3 Offered to	EEE
20.6.4 Pre-requisite Course(s)	None

Section B: Course Details

20.6.5 Course Content (As approved by the Academic Council)

Waves and Oscillations: Differential equation of simple harmonic oscillator, Total energy and average energy, Combination of simple harmonic oscillations, Spring mass system, Torsional pendulum; Two body oscillation, Reduced mass, Damped oscillation, Forced oscillation, Resonance; Progressive wave, Power and intensity of wave, Stationary wave, Group and phase velocities.

Optics: Defects of images: Spherical aberration, Astigmatism, Coma, Distortion, Curvature, Chromatic aberration. Theories of light; Interference of light: Young's double slit experiment, Displacements of fringes and its uses, Fresnel bi-prism, Interference in thin films, Newton's rings, Interferometers; Diffraction: Diffraction by single slit, Diffraction from a circular aperture, Resolving power of optical instruments, Diffraction at double slit and N-slits, Diffraction grating; Polarization: Production and analysis of polarized light, Brewster's Law, Malus Law, Polarization by double refraction, Nicol prism, Optical activity, Polarimeters.

Thermal Physics: Heat and work- the first Law of Thermodynamics and its applications; Kinetic theory of gases - kinetic interpretation of temperature, Specific heats of ideal gases, Equipartition of energy, Mean free path, Maxwell's distribution of molecular speeds, Reversible and irreversible processes, Carnot's cycle, Second Law of Thermodynamics, Carnot's theorem, Entropy, Thermodynamic functions, Maxwell relations, Clausius and Clapeyron equation.

20.6.6 Course Objectives

Objective 1: To develop logical and critical thinking with scientific knowledge of waves & oscillation, optics, and thermal physics required for the students of electrical and electronic engineering.

Objective 2: To understand the different laws of physics associated with waves & oscillation, optics, and thermal physics, and apply them to solve the real life problems.

20.6.7 Knowledge required

N/A

20.6.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	At the end of the course, a student should be able to				
CO1	Describe the basic laws of physics related to waves & oscillation, optics, and thermal physics to express different phenomena in the physical world.	PO(a)	C1	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO2	Explain the fundamental concepts and theories of waves & oscillation, optics, and thermal physics applicable for different physical conditions.	PO(a)	C2	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO3	Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences.	PO(a)	C3, C4	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.6.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.6.10 Lecture Plan

wk	Lecture Topics	Corresponding CO(s)
1	• Introductory discussion of this course; definition of wave motion and Simple harmonic motion (SHM), differential equation of SHM. • Defects of images: spherical aberration, astigmatism, coma • Heat and work, state and path functions, internal energy, first law of thermodynamics for close system.	CO1, CO2
2	• Solution of differential equation of SHM, Velocity and acceleration of SHM, Significance of angular frequency, and solving mathematical problems. • Distortion, Curvature, Chromatic aberration • Application of the first law of thermodynamics to steady flow systems (water and gas turbine, spray nozzle, compressors, Boiler, etc.)	CO1, CO2, CO3
3	• Total energy and average energy of SHM, and Solving mathematical problems related to energy of SHM • Solving mathematical problems related to aberration • Kinetic theory of gases, kinetic gas equation, kinetic interpretation of temperature and mathematical problems related to kinetic theory of gas.	CO1, CO2, CO3
4	• Examples of SHM: Spring-mass system, Effect of spring mass in the oscillation (effective mass), Torsional pendulum, and Solving mathematical problems • Theories of light, Interference of light, Young's double slit experiment, displacements of fringes and its uses • Specific heats of ideal gases, equipartition of energy and calculation of specific heat for monoatomic, diatomic, and triatomic molecules, mean free path	CO1, CO2, CO3
5	• Combination of simple harmonic motions (In a same line and right angles), Lissajous figures • Class Test (Optics) • Maxwell’s distribution of molecular speeds, graphical representation of distribution function and molecular speeds different gases, solving mathematical problems related to Maxwell’s distribution.	CO1, CO2, CO3
6	• Damped harmonic oscillation (over-, under- and critical-damping conditions), Quality factor, and logarithmic decrement • Fresnel bi-prism, interference in thin films • Class Test (Thermal Physics)	CO1, CO2, CO3
7	• Forced oscillation, Resonance, Two-body oscillations and Reduced mass • Newton's rings, Interferometers • Average speed, most probable speed, root mean square speeds, and solving mathematical problems related to these speeds	CO1, CO2, CO3
8	• Solving mathematical problems related to damped, forced and two-body oscillations • Solving mathematical problems related to interference of light • Thermodynamic variables, process, equilibrium, reversible and irreversible processes and examples	CO1, CO2, CO3
9	• Class Test (Waves & Oscillations)	CO1, CO2, CO3

	• Diffraction of light, Fresnel and Fraunhofer diffraction, diffraction due to single slit • Caront's heat engine and cycles, efficiency of heat engine, PV diagram, calculation of work done and efficiency from PV diagram	
10	• Various types of waves, progressive wave equation and differential equation of a progressive wave, and solving mathematical problems • Diffraction from a circular aperture, diffraction at double slits • Carnot's theorem and second law of thermodynamics and their uses in solving thermodynamic problem	CO1, CO2, CO3
11	• Energy, power and intensity of wave motion, stationary wave • n-slits- diffraction grating • General notation of entropy, Clausius inequality, physical significance of entropy, entropy in reversible and irreversible cycles, calculation of work done and efficiency from T-S diagram	CO1, CO2, CO3
12	• Analytical treatment of stationary wave, and solving mathematical problems. • Resolving power of optical instruments, solving mathematical problems related to diffraction of light • Thermodynamic functions- internal energy, enthalpy, Helmholtz free energy and Gibb's free energy, uses of these functions in solving thermodynamic problems	CO1, CO2, CO3
13	• Energy of stationary wave, group velocity, phase velocity • Polarization of light, production and analysis of polarized light, Brewster's Law, Malus law • Maxwell's thermodynamic relations and their uses for solving thermodynamic problem	CO1, CO2, CO3
14	• Relation between group velocity and phase velocity, mathematical problems • Polarization by double refraction, Nicol prism, optical activity, polarimeters, polaroid • Clausius-Clapeyron equation, experimental determination of latent heat of vaporization, uses of Clausius-Clapeyron equation in different phase transitions.	CO1, CO2, CO3

20.6.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council

20.6.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.6.13 **Textbook/ Reference**

- Fundamentals of Physics (10^{th} Edition), D. Halliday, R. Resnick, and J. Walker
- Vibrations & Waves; A. P. French
- Fundamentals of Optics (4^{th} Edition); F. A. Jenkins, and H. E. White
- Fundamentals of Thermodynamics (4^{th} edition); C. Borgnakke and R. E. Sonntag
- Physics for Engineers - Part-1; Giasuddin Ahmad
- Waves & Oscillations; N. Subrahmanyum and Brij Lal

20.7 Description of Course MATH 157

Section A: General Information

20.7.1 Course Title	MATH 157
20.7.2 Type of Course	Compulsory, Theory, Non-departmental
20.7.3 Offered to	EEE
20.7.4 Pre-requisite Course(s)	None

Section B: Course Details

20.7.5 Course Content (As approved by the Academic Council)

- **Differential Calculus:** Limits, continuity and differentiability. Successive differentiation of various types of functions. Leibnitz's theorem. Rolle's theorem, Meanvalue theorem, Taylor's and Maclaurin's theorems in finite and infinite forms. Lagrange's form of remainder. Cauchy's form of remainder. Expansion of functions. Evaluation of indeterminate forms by L'Hospital's rule. Partial differentiation, Euler's theorem. Tangent and Normal. Sub tangent and subnormal in Cartesian and polar coordinates. Determination of maximum and minimum values of functions. Curvature. Asymptotes and curve tracing.

- **Integral Calculus:** Integration by the method of substitution. Standard integrals. Integration by successive reduction. Definite integrals, its properties and use in summing series. Walli's formulae. Improper integrals. Beta function and Gamma function. Area under plane curves and area of a region enclosed by two curves in Cartesian and polar coordinates. Volume and surface area of solids of revolution.

20.7.6 Course Objectives

- To provide the appropriate tools of calculus to solve applied problems.
- To provide the standard methods of indefinite and definite integrals with their applications.

20.7.7 Knowledge required

Familiarity with basic properties of set theory and function; fundamental concepts of pre-calculus and preliminary knowledge to solve algebraic and transcendental equations.

20.7.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Explain** the fundamental concepts of limits, derivatives, and expansion of functions.	PO(b)	C2	Lectures, Homework	Written exams, Assignment
2	**Demonstrate** the idea of indefinite and definite integrals to evaluate integrals	PO(a)	C3	Lectures, Homework	Written exams, Assignment
3	**Apply** the idea of accumulation to calculate area, volume and surface area.	PO(b)	C3	Lectures, Homework	Written exams, Assignment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.7.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.7.10 Lecture Plan

Weekly schedule: For Differential Calculus

Weekly plan for course content and mapping with Cos	
Weeks	**Topics**
Week-1 to 2	Limits, Continuity, and differentiability.
Week-3 to 4	Successive differentiation of various types of functions.
Week-5 to 8	Leibnitz's theorem. Rolle's theorem. Mean value theorem. Taylor's and Maclaurin’s theorems in finite and infinite forms. Lagrange's form of remainders. Cauchy's form of remainders.
Week-9 to 10	Expansion of functions. Evaluation of indeterminate forms by L'Hospitals rule. Partial differentiation. Euler's theorem.
Week-11 to 12	Tangent and Normal. Subtangent and subnormal in Cartesian and polar co-ordinates. curvature, Asymptotes.
Week-13 to 14	Determination of Maximum and minimum values of functions with applications.

Weekly schedule: For Integral Calculus

Week	**Topics**
Week-1	Integration by the method of substitution,
Week-2	Standard integrals.
Week-3	Integration by successive reduction.
Week-4	Definite integrals, its properties
Week-5	Use of definite integral in summing series. Walli's formulae.
Week-6	Class test
Week-7	Improper integrals.
Week-8	Beta function and Gamma function.
Week-9	Area under plane curves in Cartesian and polar coordinates
Week-10	Area of a region enclosed by two curves in Cartesian and polar coordinates

Week-11	Volume of solids of revolution.
Week-12	Area of surface of revolution
Week-13	Class Text
Week-14	Review class

20.7.11 Assessment Strategy

- **Class Participation:** Class participation and attendance will be recorded in every class.
- **Continuous Assessment:** Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- **Final Examination:** A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

20.7.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.7.13 Textbook/References

- Calculus by Howard Anton, Irl Bivens and Stephen Davis.
- Differential and Integral Calculus by B. C. Das and B. N. Mukherjee.
- Integral Calculus with applications by A. K. Hazra

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20.8 Description of Course MATH 159

Section A: General Information

20.8.1 Course Title	Calculus-II
20.8.2 Type of Course	Compulsory, Theory, Non-departmental
20.8.3 Offered to	EEE
20.8.4 Pre-requisite Course(s)	None

Section B: Course Details

20.8.5 Course Content (As approved by the Academic Council)

- **Complex Variable:** Complex number system. General functions of a complex variable. Limits and continuity of functions of complex variables and related theorems. Complex differentiation and the Cauchy-Riemann equations. Infinite series. Convergence and uniform convergence. Line integral of complex functions. Cauchy's integral formula. Liouville's theorem. Taylor's and Laurent's theorem. Singular points. Residue, Cauchy's residue theorem.
- **Vector Analysis:** Multiple product of vectors. Linear dependence and independence of vectors. Differentiation and integration of vectors together with elementary applications. Line, surface and volume integrals. Gradient of a scalar function. divergence and curl of a vector function. Various formulae. Integral forms of gradient, divergence and curl. Gauss's divergence theorem, Stokes' theorem and Green's theorem.

20.8.6 Course Objectives

Along with their physical significance.

- To establish sufficient knowledge to deal with different complex and vector function for applying in engineering problems.

➢ To provide fundamental concept of complex and vector analyses

20.8.7 Knowledge required

Fundamental concepts of differential calculus , integral calculus and geometry.

20.8.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Describe** complex number system function of complex variable, vector algebra and vector valued function.	PO(a)	C2	Lectures, Homework	Written exams; assignment
2	**Explain** different operations with complex variables, differentiation and integration of complex and vector function.	PO(a)	C2	Lectures, Homework	Written exams; assignment
3	**Use** the concepts of differentiation and integration of complex and vector function for solving different type of problems	PO(b)	C3	Lectures, Homework	Written exams; assignment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.8.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.8.10 Lecture Plan

Week	**Topics**	**Teacher's Initial/Remarks**
Week-1	Complex number system.	CO1
Week-2	General functions of a complex variable.	CO1
Week-3	Limit and continuity of functions of a complex variable and related theorems.	CO1
Week-4	Complex differentiation and the Cauchy-Riemann equations.	CO2
Week-5	Infinite series, convergence, and uniform convergence.	CO2
Week-6	Line integral of a complex function.	CO2
Week-7	Cauchy's integral formula	CO2
Week-8	**Class Test**	
Week-9	Liouville's theorem, Taylor's theorem.	CO2
Week-10	Laurent's theorem.	CO2
Week-11	Singular points.	CO2
Week-12	Residue.	CO2
Week-13	Cauchy's residue theorem.	CO2
Week-14	**Class Test**	

Weekly schedule: For Vector Analysis

Week	Topics	Teacher's Initial/Remarks
Week-1	Multiple product of vectors.	CO3
Week-2	Linear dependence and Independence of vectors.	CO3
Week-3	Differentiation and integration of vectors.	CO3
Week-4	Solving problems related to differentiation and integration of vector functions.	CO3
Week-5	Gradient of scalar functions, divergence and curl of vector functions.	CO3
Week-6	Integral forms of gradient, divergence and curl.	CO3
Week-7	**Class Test**	
Week-8	Line integrals.	CO4
Week-9	Green's theorem and solving problems related to this theorem.	CO4
Week-10	Surface and volume integrals.	CO4
Week-11	Gauss's theorem and solving problems related to this theorem.	CO4
Week-12	Stokes theorem and solving problems related to this theorem	CO4
Week-13	**Class Test**	
Week-14	Review Class	

20.8.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.8.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.8.13 Textbook/References

- Complex Variables and Application by Ruel V. Churchill/James Ward Brown.
- Schaum's Outline of Theory and Problems of Complex Variables by Murray R. Spiegel.
- Calculus by Howard Anton, Irl Bivens and Stephen Davis.
- Schaum's Outline of Theory and Problems of Vector Analysis *by* Murray R. Spiegel.
- Advanced Engineering Mathematics by Peter V. O' Neil.
- Complex Variables: Harmonic and Analytic Functions by Francis J. Flangian.
- Function Of Complex Variable by M.L. Khanna.
- Vector Analysis by M.D. Raisinghania.
- Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
- Vector Analysis with Applications *by* Md. Ali Ashraf and Md. Abdul Khaleq Hazra.

20.9 Description of Course EEE 105

Section A: General Information

20.9.1 Course Title	Electrical Circuits II
20.9.2 Type of Course	Compulsory, Theory
20.9.3 Offered to	EEE
20.9.4 Pre-requisite Course(s)	None

Section B: Course Details

20.9.5 Course Content (As approved by the Academic Council)

Sinusoids and Phasors, Phasor Relationships for Circuit Elements, Impedance and Admittance, Impedance and Admittance, Kirchhoff's Laws in the Frequency Domain, Impedance Combinations, Applications; Sinusoidal Steady-State Analysis, Nodal and Mesh Analysis, Superposition Theorem, Source Transformation, Thevenin and Norton Equivalent Circuits; AC Power Analysis, Instantaneous and Average Power, Maximum Average Power Transfer, Effective or RMS Value, Apparent Power and Power Factor, Complex Power, Conservation of AC Power, Power Factor Correction, Applications; Transients in AC circuits.

Three-Phase Circuits, Balanced Three-Phase Voltages, Balanced Wye-Wye Connection, Balanced Wye-Delta, Delta-Delta and Delta-Wye Connection, Power in a Balanced System, Unbalanced Three-Phase Systems, Power Factor Correction, Applications; Magnetically Coupled Circuits, Mutual Inductance, Energy in a Coupled Circuit and Ideal Transformers.

Frequency Response, Transfer Function, The Decibel Scale, Bode Plots, Series and Parallel Resonance, Passive Filters; Scaling; Nonsinusoidal Waveforms, Composite Waveforms, Fourier Series, Frequency Spectrum, Total harmonic distortion and its effect, Average Power and RMS Values of a Nonsinusoidal Waveform, Circuit Response to a Nonsinusoidal Waveform, Power factor a non-linear load, RMS and True RMS values.

20.9.6 Course Objectives

- To provide a clear understanding of phasor analysis of AC electrical circuits using basic components in terms of voltage, current and power/energy.
- To develop analytical skills to design and analyze AC circuits using superposition principle, source conversion technique, Thevenin theorem, Norton theorem and maximum power transfer theorem.
- To introduce some basic concepts of 3-phase circuits that are used in power systems.
- To introduce with the mutual inductance and its applications.
- To expose the area of frequency response of AC electrical circuits for designini filters and analyzing transients and nonsinusoidal waveforms.

20.9.7 Knowledge required

Basics of physics, equation solver, calculus and differential equation solver.

20.9.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Derive** the expressions of voltage, current and power/energy of RL, RC and RLC circuits based on the concepts of phasors	PO(a)	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

2	**Employ** circuit laws, analysis methods, theorems to solve various AC circuits.	PO(b)	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
3	**Analyze** the 3-phase circuits with different combination of sources and loads that are used in power systems.	PO(b)	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
	Apply the concepts of mutual inductance in AC circuit analysis	PO(b)	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
4	**Apply** differential equations to solve first and second order transient circuits,.	PO(a)	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
5	Analyze the frequency response curve, nonsinusoidal waveforms	PO(b)	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.9.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.9.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Sinusoids and Phasors, Phasor Relationships for Circuit Elements, Impedance and Admittance, Impedance and Admittance, Kirchhoff's Laws in the Frequency Domain
2	4-6	Impedance Combinations, Applications, Sinusoidal Steady-State Analysis, Nodal and Mesh Analysis, Superposition Theorem
3	7-9	Source Transformation, Thevenin and Norton Equivalent Circuits;
4	10-12	AC Power Analysis, Instantaneous and Average Power, Maximum Average Power Transfer, Effective or RMS Value, Apparent Power and Power Factor,
5	13-15	Complex Power, Conservation of AC Power, Power Factor Correction, Applications
6	16-18	Transients in AC circuits.
7	19-21	Three-Phase Circuits, Balanced Three-Phase Voltages, Balanced Wye-Wye Connection, Balanced Wye-Delta, Delta-Delta and Delta-Wye Connection,

Week	Lectures	Topic
8	22-24	Power in a Balanced System, Unbalanced Three-Phase Systems, Power Factor Correction, Applications
9	25-27	Magnetically Coupled Circuits, Mutual Inductance, Energy in a Coupled Circuit and Ideal Transformers.
10	28-30	Frequency Response, Transfer Function, The Decibel Scale, Bode Plots
11	31-33	Series and Parallel Resonance, Passive Filters; Scaling
12	34-36	Nonsinusoidal Waveforms, Composite Waveforms, Fourier Series, Frequency Spectrum, Total harmonic distortion and its effect, Average Power and RMS Values of a Nonsinusoidal Waveform,
13	37-39	Circuit Response to a Nonsinusoidal Waveform, Power factor a non-linear load, RMS and True RMS values.

20.9.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.9.12 Distribution of Marks

Class Participation	10%
Homework, Assignment and Quizes	20%
Final Examination	70%
Total	100%

20.9.13 Textbook/References

- Fundamentals of Electric Circuits (5^{th} Edition)- Charles K. Alexander, Matthew N. O. Sadiku
- Circuit Analysis: Theory and Practice, Allan H. Robbins Wilhelm C. Miller
- Electric Circuits- James William Nilsson
- Transient Analysis of Electric Power Circuits by the Classical Method in the Examples, A.A.ZELENKOV
- Online resources or supplementary materials will be shared with the class on a need basis

  Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.10 Description of Course EEE 106

Section A: General Information

20.10.1 Course Title	Electrical Circuits II Laboratory
20.10.2 Type of Course	Compulsory, Sessional
20.10.3 Offered to	EEE
20.10.4 Pre-requisite Course(s)	None

Section B: Course Details

20.10.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 105: Electrical Circuits II

20.10.6 Course Objectives

- To provide hands-on training on experiments to validate practically the concepts of RL, RC, RLC electrical circuits, passive filters, series and parallel resonances, three phase power measurement and phase sequences.
- To deliver hands-on training on simulation study to verify the theories of electrical circuits containing RL, RC, RLC, passive filters, series and parallel resonances, three phase power measurement and phase sequences by using a variety of analysis techniques.

20.10.7 Knowledge required

Fundamental of physics, equation solver, calculus, and differential equation solver

20.10.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** circuit simulation software and laboratory equipment to construct and measure RL, RC and RLC circuits and	PO(e)	C3, P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests, Lab-quiz
2	**analyse** passive electrical filters and resonance circuits based on measured or simulated results	PO(b)	C4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Reports, Lab-tests, Lab-quiz
3	**compare** theoretical and experimental results of three phase power measurement and phase sequence methods	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Reports, Assignment, Lab-tests

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.10.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓		✓		✓	✓	✓	✓									

20.10.10 Lecture Plan

Week	Experiment no.	Topic
1	1 (H)	Measurement of Reactance of L and C, Series Parallel RC, RL, RLC Circuits: Waveform Observation, Phasor Diagram Construction, Verification of KVL and KCL in AC Circuits
2	1 (S)	Part-A: Transient Analysis of AC Circuits Part-B: Analysis of Magnetically Coupled AC Circuits
3	2 (H)	Frequency Response of Passive Circuit Elements L and c and A Practical LC Low Pass Filter
4	2 (S)	Steady-State AC Analysis, Frequency Response and Filters
5	3 (H)	Resonance in AC Circuits: Series and Parallel Resonance
6	3 (S)	Series and Parallel Resonance and Power Factor Correction
7	4 (H)	Power Measurement of AC (Single and Three Phase) Circuits and Power Factor Change by Passive Elements (Supplied by Sinusoidal Voltages)
8	4 (S)	Sub-Circuits using Net listing and Schematics and Three Phase Circuits
9	5(H)	Thevenin Theorem, Maximum Power Transfer Condition and Superposition Theorem as Applied in AC Circuits Supplied by Sinusoidal Voltages
10	6(H)	Power Factor Improvement in Single Phase AC Circuits by Passive Elements, Observing B-H Curve of Several Magnetic Materials by Oscilloscope
11	-	Lab-test and Viva (Hardware)
12	-	Lab-test and Viva (Software)
13	-	Lab-Quiz

20.10.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing, viva, and lab quiz.

20.10.12 Distribution of Marks

To be decided by course instructor(s)

20.10.13 Textbook/ References

- Fundamentals of Electric Circuits (5^{th} Edition)- Charles K. Alexander, Matthew N. O. Sadiku
- Electric Circuits- James William Nilsson
- Basic Engineering Circuit Analysis" - J. David Irwin, R. Mark Nelms
- Introductory Circuit Analysis-(8th Edition)- Robert L Boylestad
- Lab sheets of the simulation study (Software) and experiments (hardware) will be shared with the class

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.11 Description of Course PHY 165

Section A: General Information

20.11.1 Course Title	Electricity and Magnetism, Modern Physics and Mechanics
20.11.2 Type of Course	Compulsory, Theory, Non-departmental
20.11.3 Offered to	EEE
20.11.4 Pre-requisite Course(s)	N/A

Section B: Course Details

20.11.5 Course Content (As approved by the Academic Council)

Electricity and magnetism: Electric charge and Coulomb's Law, Electric field, Concept of electric flux and the gauss's Law - some applications of gauss's Law, Gauss's Law in vector form, Electric potential, Relation between electric field and electric potential, Capacitance and dielectrics, Gradient, Laplace's and Poisson's equations, Current, Current density, Resistivity, The magnetic field, Ampere's Law, Biot-savart Law and their applications, Laws of electromagnetic induction- Maxwell's equations.

Modern Physics: Michelson-Morley's experiment, Galilean transformation, Special theory of relativity and its consequences; Quantum theory of radiation; Photo-electric effect, Compton effect, Wave particle duality, Interpretation of Bohr's postulates, Radioactive disintegration, Properties of nucleus, Nuclear reactions, Fission, Fusion, Chain reaction, Nuclear reactor.

Mechanics: Linear momentum of a particle, Linear momentum of a system of particles, Conservation of linear momentum, Some applications of the momentum principle; Angular momentum of a particle, Angular momentum of a system of particles, Kepler's Law of planetary motion, The Law of universal gravitation, The motion of planets and satellites, Introductory quantum mechanics; Wave function, Uncertainty principle, Postulates, Schrodinger time independent equation, Expectation value, Probability, Particle in a zero potential, Calculation of energy.

20.11.6 Course Objectives

- To develop logical and critical thinking with scientific knowledge of electricity & magnetism, modern physics and mechanics required for the students of electrical and electronic engineering.
- To understand the different laws of physics associated with electricity & magnetism, modern physics and mechanics, and apply them to solve the real life problems.

20.11.7 Knowledge required

Insert previous knowledge requirements: N/A

20.11.8 Course Outcomes

CO No.	CO Statement At the end of the course, a student should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Describe the basic laws of physics related to electricity & magnetism, modern physics and mechanics to express different phenomena in the physical world.	PO(a)	C1	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO2	Explain the fundamental concepts and theories of electricity & magnetism, modern physics and mechanics applicable for different physical conditions.	PO(b)	C2	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO3	Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences.	PO(c)	C3, C4	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.11.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.11.10 Lecture Plan

wk	Lecture Topics	Corresponding CO(s)
1	• Electric charge, Coulomb's law, electric field, electric field lines, electric field due to a point charge, electric dipole, line of charge and charged disk, movement of charge in an electric field • Frame of reference, Failure of Newtonian mechanics, Galilean transformation, Concept of ether • Linear momentum of a particle, Linear momentum of a system of particles, Conservation of linear momentum, Some applications of the momentum principle	CO1, CO2
2	• Flux - Gauss' Law - Application of Gauss' Law: Cylindrical, spherical and planar symmetry • Michelson-Morley experiment, consequence of Michelson-Morley experiment • Angular momentum of a particle, Angular momentum of a system of particles, Kepler's Law of planetary motion	CO1, CO2, CO3
3	• Electric potential energy and electric potential, Equipotential surface, Calculating potential from the field • Derivation of Lorentz transformation equations, relativity of length, time and mass • The Law of universal gravitation, The motion of planets and satellites	CO1, CO2, CO3
4	• Potential due to a point charge and a group of point charges, Potential due to continuous charge distribution, Conductors in electrostatic equilibrium • Mass-Energy relation, relativistic addition of velocities, relativity of simultaneity • Introductory quantum mechanics Wave function, Schrodinger equation	CO1, CO2, CO3
5	• Capacitance - Capacitors in series and in parallel - Energy stored in an electric field - Capacitors with dielectric • Class Test (Modern Physics) • Postulates of quantum mechanics, probability density, normalization of wave function, mathematical problem	CO1, CO2, CO3
6	• Class Test (Electricity and Magnetism) • Theory of light, Planck's quantum theory, photo-electric effect, characteristics (laws) of photoelectric emission • Mathematical Problem on Normalization of wave function	CO1, CO2, CO3
7	• Electric current, resistance and Ohm's law - Resistors in series and parallel - Power in electric circuits - Kirchhoff's laws and solving circuits - RC circuits • Failure of wave theory of light to explain photoelectric effect, Einstein photoelectric equation, determination of Planck's constant, light-matter interaction, applications of photo-electric effect • Expectation values, quantum mechanical operator, mathematical problem	CO1, CO2, CO3
8	• Magnetic fields, Hall effect, Biot-savart law, torque on a current loop, magnetic dipole moment • Compton effect, Compton theory, Wave particle duality/de-Broglie hypothesis, Determination of de-Broglie wavelength • Time independent Schrodinger equation, stationary states	CO1, CO2, CO3
9	• Magnetic field due to a current, force between two parallel currents, ampere's law, solenoid • Limitation of Rutherford's atom model, postulates of the Bohr atomic model, limitation of Bohr's atom model, de-Broglie atom model	CO1, CO2, CO3

	• Class Test (Quantum Mechanics)	
10	• Faraday's law of induction, Lenz's law, induction and energy transfer, induced electric field • Properties of nucleus: static nuclear properties and dynamic properties, mass defect, binding energy, binding energy per nucleon, nuclear force • Properties of stationary states and mathematical problem	CO1, CO2, CO3
11	• Inductors and inductance, self-induction, energy stored in a magnetic field, mutual induction, LR circuit • Nuclear chain reactions, Different condition for nuclear chain reactions, Nuclear fission, Nuclear fusion, Little Boy: A gun-type bomb, Fat Man: Implosion-type bomb • Particle in an infinite square well potential: wave function and energy	CO1, CO2, CO3
12	• Magnetic properties of matter, types of magnetic materials, application of magnetic materials • Nuclear power reactor, different parts of nuclear fission reactor, types of fission reactor, nuclear fusion reactor, types of fusion reactor • Mathematical problem on infinite square well potential	CO1, CO2, CO3
13	• Hysteresis curve; electromagnetic oscillation: L-C oscillations and its analogy to simple harmonic motion. • Difficulties against using nuclear fusion, nuclear models, the liquid drop model, semi-empirical mass formula • Particle in a zero potential: wave function and energy	CO1, CO2, CO3
14	• Mathematical problems related to magnetic field and magnetism • The shell model, radioactivity, radioactive transformation, decay law, average life period of a radioelement • Mathematical problems related to zero potential	CO1, CO2, CO3

20.11.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.11.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.11.13 Textbook/ References

- Fundamentals of Physics (10^{th} Edition), D. Halliday, R. Resnick, and J. Walker
- Concepts of Modern Physics (6^{th} edition); A. Beiser.
- Quantum Mechanics, (2^{nd} Edition), David J. Griffith
- Physics for Engineers -Part-2; Giasuddin Ahmad

20.12 Description of Course PHY 102

Section A: General Information

20.12.1 Course Title	Physics Sessional
20.12.2 Type of Course	Compulsory, Sessional, Non-departmental
20.12.3 Offered to	EEE
20.12.4 Pre-requisite Course(s)	None

Section B: Course Details

20.12.5 Course Content (As approved by the Academic Council)

Experiments based on waves & oscillations, heat & thermodynamics, electricity & magnetism, optics, and modern physics.

20.12.6 Course Objectives

Objective 1: To gain practical knowledge about theories of Physics by performing different experiments.
Objective 2: To develop analytical and scientific report writing skills.

20.12.7 Knowledge required

Insert previous knowledge requirements: N/A

20.12.8 Course Outcomes

CO No.	CO Statement At the end of the course, a student should be able to -	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Describe various experimental techniques, and use different instruments to collect, tabulate the data.	PO(a)	C1, C3	Classwork, Q & A Forums	Classwork
CO2	Analyse data, plot graphs, and connect the results for qualitative understanding.	PO(a)	C3, C4	Classwork, Q & A Forums	Classwork
CO3	Interpret the result, draw conclusions and prepare laboratory report.	PO(a)	C3	Classwork, Q & A Forums	Classwork

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.12.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.12.10 Lecture Plan

wk	Lecture	Topics	Corresponding CO(s)
1.	-	Introductory class	
2.	1-W1	Determination of line frequency by Lissajous figures using an oscilloscope and a function generator and verification of the calibration of the calibration of time/div knob at a particular position for different frequencies	CO1, CO2, CO3
3.	2-W3	Determination of the spring constant and the effective mass of a loaded spring	
4.	3-H2	Determination of the pressure-coefficient of air by a constant volume air thermometer	
5.	4-H4	Determination of the thermal conductivity of a bad conductor by Lee's method	
6.	5-O3	Determination of the refractive index of the material of a prism with the help of a spectrometer	
7.	6-O4	Determination of the radius of curvature of a Plano-convex lens by the Newton's ring method	
8.	7-M1	Determination of the threshold frequency for the material of a photo-cathode and hence find the value of the Planck's constant	
9.	8-M2	Determination of the linear absorption coefficient and mass absorption coefficient of Aluminum using a 137Cs radioactive source and verification of the inverse square law of gamma radiation	
10.	9- E3	Verification of Biot-Savart law and Tangent law	
11.	10- E6	Determination of dielectric constant of materials using a parallel plate capacitor	
12.	11-H5	Calibration of a given thermocouple	
13.	12-H6	Determination of the melting point of a solid using the calibration curve obtained in experiment H5	
14.	13- O5	Determination of the specific rotation of sugar solution by a polarimeter	
15.	14-VL-M3	Determination of lattice constant of NaCl crystal using an X-ray diffraction simulator	
16.	15-H7	Determination of the mechanical equivalent of heat by the electrical method	
17.	Sessional Quiz		

20.12.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment will be evaluated based on viva and laboratory report, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Quiz: A comprehensive quiz will be held at the end of the term following the guideline of the Department.

20.12.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	70%
Quiz	20%
Total	100%

20.12.13 Textbook/ References

- Practical Physics for Degree Students; Giasuddin Ahmad and Md. Sahabuddin.
- Advanced Practical Physics for students; B. L. Worsnop and H. T. Flint

20.13 Description of Course CHEM 101

Section A: General Information

20.13.1 Course Title	Chemistry-I
20.13.2 Type of Course	Compulsory, Theory, Non-departmental
20.13.3 Offered to	EEE
20.13.4 Pre-requisite Course(s)	None

Section B: Course Details

20.13.5 Course Content (As approved by the Academic Council)

Modern concept of atomic structure, Modern periodic table with special reference to group chemistry, Dual nature of electron and modern concept of chemical bond, Properties and molecular structure, Modern concept of acids and bases. Selected topics of organic chemistry. Different types of solutions and their compositions, Properties of dilute solution, Phase rule, phase diagram of monocomponent systems, Thermochemistry, Chemical kinetics, Chemical equilibria, Electric properties of solution and electrochemical cells.

20.13.6 Course Objectives

- To provide an in-depth understanding of the fundamentals of building components in atoms, molecules and thus matters, solution system, rate process and energetics of physico-chemical systems.
- To enable students building a foundation on underlying state-of-the-art scientific knowledge, and to develop critical thinking abilities for identifying and resolving the issues they will encounter in their professional career.

20.13.7 Knowledge required

N/A

20.13.8 Course Outcomes

	CO Statement: Upon successful completion of the course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO-1	Identify fundamental concepts of atomic structure, chemical bonding, and periodic properties according to quantum theory	PO(a)	C1	Lectures, Homework	Written exams, class test
CO-2	Illustrate the basic principles associated with properties atom/molecule, solution, chemical equilibria, chemical kinetics, phase diagram and electrochemistry	PO(a)	C2	Lectures, Homework, presentation	Written exams, class test
CO-3	Solve problems associated with physical and chemical changes	PO(b)	C3	Homework, lecture	Written exams, class test
CO-4	Analyze the behavior of materials and chemical systems with the principles of chemistry	PO(c)	C4	Lecture, presentation	Written exams, class test

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.13.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.13.10 Lecture Plan

13	Lecture Plan: Teacher-1

	Lecture Topics	References	Corresponding CO(s)
L1	General Introduction		-
L2	Different types of solutions		CO2, CO4
L3	Dilute solution and Colligative properties, Vapor pressure lowering		CO2, CO4
L4	elevation of boiling point, depression of freezing point, osmotic pressure		CO2, CO4
L5	Electric properties of solution		CO2, CO4
L6	Electrochemical cells		CO2, CO3
L7	Corrosion, energy storage		CO2, CO3
L8	Class Test-1		
L9	Phase rule		CO2, CO3
L10	Phase, component and degrees of freedom, phase rule,		CO2, CO3
L11	Phase diagrams		CO2, CO3
L12	Thermochemistry and laws of thermochemistry		CO2, CO4
L13	Thermochemistry and Energy		CO2, CO4
L14	Hess's law , kirchhoff's law,		CO2, CO4
L15	Scope of chemical kinetics, rate law		CO2, CO3
L16	Integrated rate laws		CO2, CO3
L17	Theories of reaction rate, effect of temperature		CO2, CO3
L18	Dynamic equilibria, equilibrium constant		CO2, CO4
L19	Mathematic problems with Chemical equilibrium		CO3, CO4
L20	Reaction quotient, le chatelier principle,		CO2, CO4
L21	Class Test-2		

13	Lecture Plan: Teacher-2

	Lecture Topics	References	Corresponding CO(s)
L1	General introduction and need of chemistry of engineering students		-
L2	Concepts of atomic structure, subatomic particles, atomic spectra, Bohr's Atomic model of hydrogen		CO1, CO3
L3	Wave- particle duality of matter and energy: blackbody radiation and plank's quantum theory, photoelectric effect, dual nature of light		CO1, CO2
L4	Broglie's matter wave, Dual nature of electron and Heisenberg uncertainty principle		CO3, CO4
L5	Schrodinger wave equation, quantum numbers, Electron configuration of multielectron systems, effect of electronic configuration on atom's size, effective nuclear charge,		CO3, CO2
L6	Electron configuration and chemical periodicity		CO1, CO2
L7	Electron configuration and chemical periodicity		CO1, CO2
L8	Chemical bond and energies involved in chemical bonding		CO1, CO2
L9	Geometry of Molecules		CO1, CO2
L10	Quantum concepts of bonding		CO3, CO4
L11	Class Test 1		
L12	Periodic law and the periodic table		CO1, CO2
L13	Periodic variation of properties		CO1, CO3
L14	Transition metals		CO1, CO2
L15	Properties and theories of metal complex		CO1, CO4
L16	Properties and use of noble gases		CO1, CO4

L17	Acids and bases: concepts		CO1, CO3
L18	Acids and bases: theories		CO1, CO4
L19	Class test 2		
L20	Selected topics of Organic chemistry		CO1
L21	Conducting polymers		CO1

20.13.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment of any of the activities such as quizzes, assignments, presentations, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guidelines of the academic Council.

20.13.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.13.13 Learning Resources

- Chemistry by Raymond Chang, Kenneth A. Goldsby
- General Chemistry by Ebbing, Darrell, Gammon, Steven D.
- Principles of Physical Chemistry by Kindle edition by Maron, S. H., Prutton, C.F.
- Chemistry: The Central Science (MasteringChemistry)by Theodore Brown, H. LeMay, Bruce Bursten, Catherine Murphy, Patrick Woodward, Matthew Stoltzfus

20.14 Description of Course CHEM 114

Section A: General Information

20.14.1 Course Title	Inorganic Quantitative Analysis
20.14.2 Type of Course	Compulsory, Sessional, Non-departmental
20.14.3 Offered to	EEE
20.14.4 Pre-requisite Course(s)	None

Section B: Course Details

20.14.5 Course Content (As approved by the Academic Council)

Volumetric analysis: Acidimetry-Alkalimetry. Titrations involving redox reactions: Determination of Fe, Cu, and Ca volumetrically. Determination of Ca and Mg in water.

20.14.6 Course Objectives

- To develop the basic understanding of a student dealing with chemical reagents, equipment necessary to perform quantitative inorganic analysis along with associated theoretical knowledge on acidimetry-alkalimetry, redox and complexometry
- To provide hands on experience on the techniques of volumetric methods in analyte determination and to prepare students presenting their experimental findings as scientific reports

20.14.7 Knowledge required

N/A

20.14.8 Course Outcomes

	CO Statement Upon successful completion of the course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Describe different parameters and techniques related to inorganic quantitative analysis	PO(a)	C1	Lectures	Quiz, Class performance, viva, Report writing
CO2	Follow the instructions to perform guided enquiry in determining volume of titrants in different kinds of titrations	PO(d), PO(i)	P3	Lectures and Demonstration	Quiz, Class performance, viva, Report writing Final Exam
CO3	Analyze the experimental data for quantitative estimation of an analyte individually or by a group	PO(b), PO(i)	C4	Lectures, Demonstration	Quiz, Class performanc, viva, Report writing Final Exam
CO4	Prepare scientific reports on experiments by organizing experimental findings	PO(l)	C6	Homework	Quiz, Class performanc, viva, Report writing, Final Exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.14.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.14.10 Lecture Plan

	Lecture Topics	References	Corresponding CO(s)
L1	Briefing on lab safety protocol and quiz on it		CO1
L2	Course outline and introductory discussions on chemical analysis		CO1
	Standardization of NaOH solution with standard oxalic acid solution		CO1 - CO4
L4	Standardization of hydrochloric acid with standard NaOH solution		CO1 - CO4
L5	Standardization of HCl with standard Na2CO3 solution		CO1 - CO4
L6	Standardization of sodium thiosulphate solution with a standard potassium dichromate solution		CO1 - CO4
L7	Estimation of copper contained in a supplied solution by iodometric method		CO1 - CO4
L8	Determination of ferrous iron by a standard potassium dichromate solution		CO1 - CO4
L9	Standardization of potassium permanganate solution with standard sodium oxalate solution		CO1 - CO4
L10	Determination of ferrous ion in a solution by standard KMnO4 solution		CO1 - CO4

L11	Determination of calcium in a sample of calcium carbonate		CO1 - CO4
L12	Viva		CO1, CO3
L13	Practical exam		CO2, CO3
L14	Quiz		CO1, CO3

20.14.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment will be accomplished following any of the activities such as quizzes, report writing and viva. The scheme of the continuous assessment for the course will be declared on the first day of classes
- Final Examination: Practical examination will be held individually at the end of the sessional classes.

20.14.12 Distribution of Marks

Attendance and Class Performance	20
Report	30
Quiz	40
Viva	20
Final Examination	40
Total	150

20.14.13 Textbook/ References

Quantitative Inorganic Analysis, By: A. I. Vogel

20.15 Description of Course Math 257

Section A: General Information

20.15.1 Course Title	Ordinary and Partial Differential Equations
20.15.2 Type of Course	Compulsory, Theory, Non-departmental
20.15.3 Offered to	EEE
20.15.4 Pre-requisite Course(s)	None

Section B: Course Details

20.15.5 Course Content (As approved by the Academic Council)

- **Ordinary Differential Equations:** Degree and order of ordinary differential equations. Formation of differential equations. Solution of first order differential equations by various methods. Solution of general linear equations of second and higher order with constant coefficients. Solution of homogeneous linear equations. Solution of differential equations of the higher order when dependent and independent variables are absent. Solution of differential equations by the method based on factorization of operators. Frobenius method.

- **Partial Differential Equations:** Introduction. Solutions of linear and nonlinear partial differential equations of first order. Linear equations of higher order. Equations of the second order with variable coefficients. Wave equations. Particular solutions with boundary and initial conditions.

20.15.6 Course Objectives

- To provide the basic concept of differential equations, their solution along with their physical significance.
- To establish sufficient knowledge to deal with various type of differential equations for solving engineering problems.
- To provide the basic properties of singularities and series solution techniques with engineering applications.

20.15.7 Knowledge required

Fundamental concepts of Pre-Calculus, Differential, and Integral calculus; and preliminary knowledge to solve algebraic, transcendental equation.

20.15.8 Course Outcomes

CO No.	CO Statement **(3-4)**	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Understand** differential equations to solve 1st and higher order linear differential equations.	PO(b)	C2	Lectures, Homework	Written exams; assignment
2	**Apply** the appropriate (different techniques) methods to solve the linear and non-linear differential equations.	PO(a)	C3	Lectures, Homework	Written exams; assignment
3	**Classify** the singular points and able to obtain series solution	PO(a)	C5	Lectures, Homework	Written exams; assignment
4	**Interpret** rigorous knowledge to solve linear and non-linear partial differential equations of Physical Models.	PO(b)	C3	Lectures, Homework	Written exams; assignment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.15.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.15.10 Lecture Plan

Weekly schedule: For Ordinary Differential Equations

Week	**Topics**
Week-1	Degree and order of ordinary differential equations, Formation of differential equations.
Week-2	Formation of differential equations, Solution of first order differential equations by various methods (separable form and reducible to separable form).
Week-3	Solution of first order differential equations by various methods (homogeneous form and reducible to homogeneous form).
Week-4	Solution of first order differential equations by various methods (linear differential equation and Bernoulli’s differential equation).
Week-5	Solution of first order differential equations by various methods (exact differential equation, non-exact differential equation and integrating factor by inspection).

Week-6	**Class Test**
Week-7	Classification of solutions of differential equations, Application of first order differential equations.
Week-8	Solution of general linear equations of second and higher order with constant coefficients (homogeneous and non-homogeneous).
Week-9	Solution of general linear equations of second and higher order with constant coefficients (non-homogeneous).
Week-10	Solution of homogeneous linear equations (Cauchy-Euler equations).
Week-11	Solution of differential equations of the higher order when dependent and independent variables are absent, Solution of differential equations by the method based on factorization of operators.
Week-12	Frobenius method (introduction and solution of type-I problems: roots of indicial equations unequal and not differing by an integer).
Week-13	Frobenius method (solution of type-II problems: roots of indicial equations unequal, differing by an integer and making a coefficient of y indeterminate; solution of type-III problems: roots of indicial equations unequal, differing by an integer and making a coefficient of y infinite; solution of type-IV problems: roots of indicial equations equal).
Week-14	**Class Test**

Weekly schedule: For Partial Differential Equations

Week	**Topics**
Week-1	Introduction to partial differential equations.
Week-2	Introduction to partial differential equations.
Week-3	First order Linear partial differential equations.
Week-4	First order Linear partial differential equations.
Week-5	First order Non-linear partial differential equations.
Week-6	First order Non-linear partial differential equations.
Week-7	Class Test
Week-8	Linear equations of higher order.
Week-9	Linear equations of higher order.
Week-10	Second order PDE with variable coefficient.
Week-11	Wave equations.
Week-12	Particular solutions with boundary and initial conditions.
Week-13	Particular solutions with boundary and initial conditions.
Week-14	Class Test

20.15.11 Assessment Strategy

- **Class Participation:** Class participation and attendance will be recorded in every class.
- **Continuous Assessment:** Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- **Final Examination:** A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

20.15.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.15.13 Textbook/References

- Elementary Differential Equations by Earl D. Rainville and Phillip E. Bedient.
- A First Course in Differential Equations with Modeling Applications by Dennis G. Zill.
- Ordinary and Partial Differential Equations by M.D. Raisinghania

- Elements of Partial Differential Equations by Ian Naismith Sneddon
- Differential Equations with Applications by M. M. K. Chowdhury.
- Advanced Engineering Mathematics by Erwin Kreyszig (Wiley).
- Introduction to Partial Differential Equations and Boundary Value Problems by Rene Dennemeyer

- Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.16 Description of Course HUM 127

Section A: General Information

20.16.1 Course Title	Sociology
20.16.2 Type of Course	Optional, Theory, Non-departmental
20.16.3 Offered to	EEE
20.16.4 Pre-requisite Course(s)	None

Section B: Course Details

20.16.5 Course Content (As approved by the Academic Council)

Introduction: Society, Science and Technology- an overview; Scientific Study of Society; Social Elements, Society, Community, Association and Institution; Mode of Production and Society Industrial Revolution, Development of Capitalism.

Culture and Socialization: Culture; Elements of Culture; Technology and Culture; Cultural Lag; Socialization and Personality; Family; Crime and Deviance; Social Control. Technology, Society and Development; Industrialization and Development; Development and Dependency Theory; Sustainable Development; Development and Foreign Borrowing; Technology Transfer and Globalization, Modernity and Environment; Problem and Prospects.

Pre-industrial, Industrial and Post-industrial Society: Common Features of Industrial Society; Development and Types of Social Inequality in Industrial Society; Poverty, Technology and Society; Social Stratification and Social Mobility; Rural and Urban Life, and their Evaluation.

Population and Society: Society and Population; Fertility. Mortality and Migration; Science, Technology and Human Migration; Theories of Population Growth-Demographic Transition Theory, Malthusian Population Theory; Optimum Population Theory; Population Policy.

20.16.6 Course Objectives

- To provide students basic concepts, nature, and scope of sociology
- To ready students recognize organization, stratification, culture, and inequality
- To qualify students with imperative social skills which will help them in their future careers

20.16.7 Knowledge required

None

20.16.8 Course Outcomes

CO No.	CO Statement *Upon the completion of the course the students should be able to*	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	***define*** sociology, society, and methods of social research	PO(j), PO(i), PO(l)	C1, C2, A1, A2, P1	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
2	***illustrate*** the concept of culture, socialization, stratification, inequality	PO(h), PO (l)	C2, C3, A2, P2, P3	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
3	***interpret*** globalization, poverty, and development	PO(k), PO(l)	C4, A4, P5	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
4	***explain*** electronic communication, deviance, delinquency, and cyber bullying & crime	PO(h), PO(i), PO (j), PO(l)	C3, C5, A4, A5, P5, P7	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
5	***discuss*** demography, migration, and planning	PO(k)	C1, C2, A1, A2, P1	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
6	***evaluate*** climate change and environmental justice	PO(g), PO(k), PO(l)	C6, A5, P7	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
7	***relate*** industrial revolution, and 4th industrial revolution in Bangladesh	PO(g), PO(k)	C2, C3, A2, P2, P3	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
8	***review*** rural, urban, and city development and social interaction	PO(g), PO(k)	C1, C2, A1, A2, P1	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.
9	***correlate*** social change and energy technology	PO(g), PO(h), PO(k), PO(l)	C4, C5, A4, A5, P5, P6	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Exam.

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.16.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.16.10 Lecture Plan

Lectures	Topics	References	Corresponding CO(s)
1–3	Society, science and technology: Definition and uses	Schaefer, R.T. (2018) , Mills, C. W. (2000)	CO1, CO9
4–6	Basic concepts of sociology, Methods of sociology and stages of social research	Schaefer, R.T. (2018)	CO1, CO2

7–9	Culture and civilization: cultural lag	Schaefer, R.T. (2018) , Macionis, J.J. (2008)	CO2
10–12	Socialization and personality development	Schaefer, R.T. (2018)	CO2
13–15	Social stratification and social inequality	Schaefer, R.T. (2018)	CO2
16–18	Globalization, Mass media and technology	Schaefer, R.T. (2018), Giddens, A. (2009)	CO3, CO4, CO9
19–21	Poverty, Development and foreign aid	S. Aminul Islam (2004), Schaefer, R.T. (2018)	CO3
22–24	Crime, Deviance and juvenile delinquency	Schaefer, R.T. (2018)	CO4
25–27	Social planning	Schaefer, R.T. (2018)	CO5
28–30	Family, Society and environment	Schaefer, R.T. (2018), Macionis, J.J. (2008)	CO5, CO6
31–33	Industrial revolution and capitalism	Robert C. Allen (2009), Giddens, A. (2009)	CO7
34–36	Rural and urban sociology, Urbanization and city development	Schaefer, R.T. (2018), Macionis, J.J. (2008)	CO8
37–39	Population and society: concepts and theories	Schaefer, R.T. (2018), Macionis, J.J. (2008)	CO5
40–42	Human migration, social change and technology	Schaefer, R.T. (2018), Giddens, A. (2009)	CO9

20.16.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of Academic Council.

20.16.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.16.13 Textbook/References

- 1. Richard T. Schaefer, (2018). ‘Sociology: A Brief Introduction’, 13th Edition, McGraw-Hill Education, New York, USA.
- Anthony Giddens, ‘Sociology’, 6th Edition, Polity Press, UK (2009).
- Macionis, J.J. (2008). Sociology: A Global Introduction (4th ed.). London: Pearson Education
- Robert C. Allen (2009), The British Industrial Revolution in Global Perspective, Cambridge University Press.
- C. Write Mills (2000), Sociological Imagination, 40th Edition, Oxford University Press
- S. Aminul Islam, ‘Overcoming Poverty in Bangladesh: Search for a New Paradigm’ Bangladesh e-Journal of Sociology’ vol. 1, no. 2, July 2004.

20.17 Description of Course HUM 277

Section A: General Information

20.17.1 Course Title	Fundamentals of Economics
20.17.2 Type of Course	Optional, Theory, Non-departmental
20.17.3 Offered to	EEE
20.17.4 Pre-requisite Course(s)	None

Section B: Course Details

20.17.5 Course Content (As approved by the Academic Council)

Introduction to Economics. Economics and engineering. Different economic systems. Fundamental economic problems. Basic elements of demand, supply and product market. Theory of utility and preferences, consumer's surplus. Theory of production and cost. Theory of the firm and market structure. Optimization. Introducing macroeconomics. National income accounting, the simple Keynesian analysis of national income, employment and inflation. Savings, investment and decision making. Fiscal policy and monetary policy; money and interest rate; income and spending. Economics of development and planning.

20.17.6 Course Objectives

- To give a clear idea about the fundamental economic problems and provide adequate knowledge for understanding basic economic theories and practices, and their implications in an economy.
- To provide students an understanding of how modern economies function in the real world and thereby prepare them to use an economist’s lens for evaluating the overall economy of a country.
- To make students enable to apply their acquired knowledge in different stages of their professional career.

20.17.7 Knowledge required

None

20.17.8 Course Outcomes

CO No.	CO Statement *Upon completion of the course the students should be able to:*	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**understand** the nature of the discipline, economics science, and how it deals with the issues related to scarcity of resources	PO(i)	C2; A1; P1	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO2	**describe** consumers’ behaviour with reference to utility analysis, market mechanism through interactions between demand and supply analysis, and their elasticities	PO(i)	C2; A1; P1	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO3	**explain** firms’ behavior with reference to factors of production, determinants of cost, economies and diseconomies of scale of production, conditions for profit maximization and so on	PO(i)	C2; P4	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment

CO4	**analyse** the performance of firms under different market structures	PO(i)	C2; A3	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO5	**evaluate** important economic events and statistics, and, more importantly, know what determines them	PO(i)	C2; A4	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO6	**understand** the core concepts of macroeconomics, e.g., aggregate demand, aggregate supply, national income accounting, circular flow of income and expenditure, savings and investment, inflation, and money	PO(i)	C2; P1	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO7	**synthesise** the implications of different economic policies like fiscal policy, monetary policy and trade policy with reference to Bangladesh	PO(i), PO(g)	C3, C4, C5; A3; P5	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO8	**illustrate** the nature of an economic theory and the applicability of economic theories to the problems of developing countries	PO(g), PO (l)	C3; A3, A4; P6	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO9	**demonstrate** different issues on planning for growth and development of Bangladesh	PO(g), PO(i), PO(k), PO(l)	C5; A4, A5; P7	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.17.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.17.10 Lecture Plan

Lecture Number	Lecture Topic	References/Textbook	Corresponding CO(s)
1-3	Definition of Economics. Economics and Engineering. Principles of Economics	Hubbard, G. & O'Brien, A. P. (2021a)	**CO1**
4-6	microeconomics: consumer behavior, theory of demand and supply and their elasticity	Hubbard, G. & O'Brien, A. P. (2021a)	**CO2**
7-9	price determination; indifference curve technique	Hubbard, G. & O'Brien, A. P. (2021a)	**CO2**

10-12	factors of production; marginal analysis and optimization	Hubbard, G. & O'Brien, A. P. (2021a)	**CO2**
13-15	theory of production; theory of costs	Hubbard, G. & O'Brien, A. P. (2021a)	**CO3**
16-18	market structure.	Hubbard, G. & O'Brien, A. P. (2021a)	**CO4**
19-21	internal and external economies and diseconomies	Hubbard, G. & O'Brien, A. P. (2021a)	**CO3**
22-24	Macroeconomics: national income analysis	Hubbard, G. & O'Brien, A. P. (2021b)	**CO5**
25-26	aggregate demand and aggregate supply	Hubbard, G. & O'Brien, A. P. (2021b)	**CO6**
27-30	savings and investment; circular flow of income and expenditure; inflation; money	Hubbard, G. & O'Brien, A. P. (2021b)	**CO6**
31-33	fiscal policy and monetary policy	Hubbard, G. & O'Brien, A. P. (2021b)	**CO7**
34-36	money and interest rate; income and spending	Hubbard, G. & O'Brien, A. P. (2021b)	**CO8**
37-39	economics of development and planning.	Todaro, M. P. (2020), Handouts will be supplied by the instructor	**CO9**
40-42	economics of development and planning. and reviews	Todaro, M. P. (2020), Handouts will be supplied by the instructor	**CO9**

20.17.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.17.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.17.13 Textbook/References

- Hubbard, G. & O'Brien, A. P. (2021a). *Microeconomics*. Pearson. 8th Edition, https://www.pearson.com/en-us/subject-catalog/p/microeconomics/P200000005936?view=educator
- Hubbard, G. & O'Brien, A. P. (2021b). *Macroeconomics*. Pearson. 8th Edition, https://www.pearson.com/en-us/subject-catalog/p/macroeconomics/P200000005935/9780136713791.
- Todaro, M. P. (2020). *Economic Development*, 13th Edition, https://www.pearson.com/us/higher-education/program/Todaro-Economic-Development-13th-Edition/PGM100003100761.html.
- Hubbard, G. & O'Brien, A. P. (2021c). *Economics*. Pearson. 8th Edition, https://www.pearson.com/en-us/subject-catalog/p/economics/P200000005930/9780136713951.

- Sloman, J., Garratt, D. and Guest, J. (2018). *Economics*. Pearson.
- Salvatore, D. (2008). *Microeconomics: theory and applications*. McGraw-Hill.
- Koutsoyiannis, A. (1975). *Modern Microeconomics*. Springer.
- Mankiw, N. G. (2007). *Principles of Microeconomics*.
- Mankiw, N.G. (2020). *Principles of Macroeconomics*. Cengage Learning.
- Dornbusch, R., Fischer, S. and Startz, R. (2011). *Macroeconomics*. McGraw-Hill.
- Diulio, E. (1997). *Macroeconomics: theory and problems*. McGraw-Hill.
- Sloman, J., Garratt, D. and Guest, J. (2018). *Economics*. Pearson.

20.18 Description of Course HUM 137

Course Outline Unavailable

20.19 Description of Course EEE 201

Section A: General Information

20.19.1 Course Title	Electronic Circuits I
20.19.2 Type of Course	Compulsory, Theory
20.19.3 Offered Of	EEE
20.19.4 Pre-requisite Course	None

Section B: Course Details

20.19.5 Course Content (As approved by the Academic Council)

- *Semiconductor diodes:* Semiconductor material and properties, pn junction diode, DC analysis and models, AC equivalent circuits, other diode types, single phase rectification and regulators, Zener diode circuits, clipper and clamper circuits, multiple diode circuits, photo diodes and LED circuits, DC power supply.
- *MOS transistors:* Structure of MOSFET, Current-Voltage Characteristics, MOS Device Models, DC circuit analysis, basic MOSFET applications, Biasing, constant current biasing, multistage MOSFET circuits, Junction Field effect transistor (JFET). MOSFET amplifier: Basic transistor amplifier configurations–Common-Source, Common-Gate Stage, Source Follower (common drain); single stage integrated circuit MOSFET amplifiers, multistage amplifiers, basic JFET amplifiers.
- *Bipolar Junction Transistor (BJT):* BJT, DC analysis of BJT circuits, basic transistor applications, biasing, multistage circuits, BJT linear amplifiers-basic configurations, CE amplifiers, AC load lines, CC and CB amplifier, multistage amplifiers, power consideration.
- *Frequency Response:* Amplifier frequency response, system transfer function, frequency response: transistor amplifiers with circuit capacitors, frequency response-BJT, frequency response-FET, high frequency response of transistor circuits.
- *Output stages and power amplifiers:* Power amplifiers, power transistors, classes of amplifiers, Class-A power amplifier, Class-AB push pull complimentary output stage.

20.19.6 Course Objectives

- To provide a clear understanding of the operation and applications of p-n junction diodes, FETs and BJTs which are indispensable for electrical and electronic engineering
- To develop analytical skills for electronic devices and circuits in order to calculate it's performance parameters for practical usage.
- To give students the necessary background of electronics for the design and analysis of electronic circuits and systems in low and high frequency domains.

20.19.7 Knowledge required

Fundamental understanding of concepts of Semiconductors and Electrical Circuits I course

20.19.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**understand** the formation, properties and characteristics of pn junction diode and **explain** diode applications in rectifiers, clampers and clippers. Moreover, Zener diode circuits (voltage regulators), photo diodes and LED circuits are analyzed.	PO(b)	C1, C2, C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
2	**explain** the operation of MOSFETs including it's characteristics and able to **solve** problems associated with DC circuits & small-signal analyses of various MOS amplifiers.	PO(b)	C2, C3, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
3	**describe** the principle of operation of BJTs and **analyze** it's characteristics. Biasing techniques are fully described for BJT amplifiers and switches. Large- and small- signal models are analyzed to **calculate** the parameters of various BJT circuits and amplifiers.	PO(b)	C2, C3, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
4	**describe** and **analyze** the BJT and FET amplifier frequency responses at low, intermediate and high frequencies	PO(a)	C2, C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
5	**describe** the classifications of power amplifiers based on biasing and analyze the circuits	PO(b)	C2, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.19.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.19.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Semiconductor diodes:* Semiconductor material and properties, pn junction diode, DC analysis and models, AC equivalent circuits
2	4-6	*Semiconductor diodes:* Other diode types, single phase rectification and regulators, Zener diode circuits
3	7-9	*Semiconductor diodes:* Clipper and clamper circuits, multiple diode circuits, photo diodes and LED circuits, DC power supply
4	10-12	*MOS transistors:* Structure of MOSFET, Current-Voltage Characteristics, MOS Device Models, DC circuit analysis
5	13-15	*MOS transistors:* Basic MOSFET applications, Biasing, constant current biasing, multistage MOSFET circuits, Junction Field effect transistor (JFET)
6	16-18	*MOS transistors:* Basic MOSFET transistor amplifier configurations–Common-Source, Common-Gate Stage, Source Follower (common drain)
7	19-21	*MOS transistors:* Single stage integrated circuit, MOSFET amplifiers, multistage amplifiers, basic JFET amplifiers
8	22-24	*Bipolar Junction Transistor (BJT):* Structure and operation of BJT, DC analysis of BJT circuits
9	25-27	*Bipolar Junction Transistor (BJT):* Basic transistor applications, biasing, circuits for BJT amplifiers,
10	28-30	*Bipolar Junction Transistor (BJT):* DC and AC load lines, BJT linear amplifiers- CE amplifiers
11	31-33	*Bipolar Junction Transistor (BJT):* BJT linear amplifiers- CC and CB amplifiers, multistage amplifiers, power consideration
12	34-36	*Frequency Response:* Amplifier frequency response, system transfer function, transistor amplifiers with circuit capacitors, frequency response-BJT, Frequency response-FET, high frequency response of transistor circuits
13	37-39	*Output stages and power amplifiers:* Power amplifiers, power transistors, classes of amplifiers, Class-A power amplifier, Class-AB push pull complimentary output stage

20.19.1 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.19.12 Distribution of Marks

Class Participation	10%
Homework, Assignment and Quizes	20%
Final Examination	70%
Total	100%

20.19.13 Textbook/ References

- Microelectronic Circuits by A. S. Sedra and K. C. Smith, Oxford University Press (6th edition)
- Electronic Devices and Circuit Theory by R. L. Boylestad and L. Nashelsky, Prentice Hall of India
- Electronic Devices and Circuits by David A. Bell, Prentice Hall of India
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.20 Description of Course EEE 202

Section A: General Information

20.20.1 Course Title	Electronic Circuits I Laboratory
20.20.2 Type of Course	Compulsory, Sessional
20.20.3 Offered to	EEE
20.20.4 Pre-requisite Course(s)	None

Section B: Course Details

20.20.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 201: Electronic Circuits I. It basically contains two parts**: Hardware(H) and Simulation (S**). In hardware part, student will build circuit and observe the characteristics of electronic circuit by different oscilloscope, mustimeter. In Simulation part, student will use circuit analysis tool such spice, LTspice to observe more detail understanding of the theory.

20.20.6 Course Objectives

- To provide hands-on training on various basic electronic devices, such as diode, BJT, MOSFET
- To make students capable of doing project for real life application using electronic devices

20.20.7 Background Knowledge required

Fundamental understanding of concepts of DC and AC circuits analysis.

20.20.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** equipment to **understand** the practical aspects of various electronic devices	PO(e)	C2, P2	Lectures, Lab demonstrations	Lab-tasks, Lab-tests, Reports, Quiz
2	**compare** theoretical and experimental results of various electronic devices both by experimentally and simulation	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report
3	**demonstrate** effective individual and team-working skills	PO(i)	A3	Lab Group work	Peer and instructor assessment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.20.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
					✓		✓	✓	✓	✓									

20.20.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory Hardware part of the course (H)
2	-	Introductory Simulation part of the course (H)
3	1(H)	Study of Diodes and Its Applications (H)
4	1(S)	Study of Diodes and Its Applications (S)
5	2(H)	Study of BJT Biasing Circuits (H)
6	2(S)	Biasing and DC Characteristics Study of Bipolar Junction Transistor (BJT) With Single and Multistage (Cascaded) Amplifier (S)
7	3(H)	Study of Common Emitter (CE) Amplifier (H)
8	3(S)	DC Characteristics Study and Biasing of Junction Field Effect Transistor (JFET) With Small Signal Amplifier (S)
9	4(H)	DC Characteristics of an Enhancement MOSFET (H)
10	4(S)	DC Characteristics Study and Biasing of Metal Oxide Semiconductor Field Effect Transistor (MOSFET) With Its Application as Inverter (S)
11	-	Viva on Hardware Experiment
12	-	Laboratory Test on Simulation Experiment
13	-	Laboratory Test on hardware
14	-	Lab Final Quiz

S= Simulation

H=Hardware

20.20.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.

20.20.12 Distribution of Marks

Evaluation will be based on following Criteria (weightage distribution will be decided by the by course instructor(s)

Hardware (50% weight) -75 mark	**Simulation (50% weight) -75 mark**
Attendance	Attendance
Lab Report	Lab Report
Class Performance (Group wise)	Class Performance (Group wise)
Viva+ Lab test	Lab Test
Quiz	Quiz

20.20.13 Textbook/ References

- Microelectronic Circuits, 6th edition by Adel S Sedra and Kenneth Carless Smith
- Electronic devices and circuit theory by Robert L Boylestad and Louis Nashelsky

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.21 Description of Course EEE 203

Section A: General Information

20.21.1 Course Title	Energy Conversion I
20.21.2 Type of Course	Compulsory, Theory
20.21.3 Offered to	EEE
20.21.4 Pre-requisite Course(s)	None

Section B: Course Details

20.21.5 Course Content (As approved by the Academic Council)

- *Single-phase Transformer:* principle of operation, construction, no load and excitation current, behavior during loading, effect of leakage flux, ideal transformer, leakage reactance and equivalent circuit of a transformer, equivalent impedance, voltage regulation, per unit quantities, regulation, losses and efficiency, determination of parameters by tests, polarity of transformer windings, vector group, transformer parallel operation. Harmonics in excitation current, transformer inrush current.
- *Poly-phase Transformer:* three phase transformers, connections, harmonic suppression in three phase transformer connection.
- *Autotransformer:* construction, working principle, auto-transformer vs. potential divider, copper saving, advantages/disadvantages, phasor diagrams, equivalent circuits, conversion of a two-winding transformer to an auto-transformer, applications.
- *Instrument transformers:* measurement of high voltages and currents in power system using P.T. and C.T. (respectively). Use of P.T. and C.T. with protective devices.
- *Three-phase Induction Motor:* rotating magnetic field, reversal of rotating magnetic field, synchronous speed, torque in induction motor. Construction - squirrel cage, wound rotor; slip and its effect on rotor frequency and voltage, equivalent circuit of an induction motor, air gap power, mechanical power and developed torque, torque speed characteristic, losses, efficiency & power factor, classification, motor performance as a function of machine parameters, shaping torque speed characteristic and classes of induction motor, per unit values of motor parameters, determination of induction motor parameters by tests, methods of braking, speed control.
- *Induction Generator:* operation, characteristics, voltage build up, applications in wind turbine.

20.21.6 Course Objectives

- To understand the construction and operations of various transformers, 3-phase induction motor and induction generator
- To analyse the characteristics of polyphase induction motors, to calculate various machine parameters based on design data and test results
- To demonstrate the parallel operation of polyphase transformers
- Application of induction generator for harvesting renewable energy e.g., wind turbine

20.21.7 Knowledge required

Fundamental concepts of Electrical Circuits I & II course, and application of Faraday's law

20.21.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Explain** the operations of transformers and 3-ϕ induction motor/generator by **applying** the knowledge of electrical circuits and electromagnetic induction	PO(a)	C2, C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**Analyse** the techniques of parallel operations of transformers (single to single phase, poly to poly phase)	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	At the end of the course the students will be able to **design/develop** three-phase transformer using single-phase transformers	PO(c)	C6	Lectures, Discussions	Assignment, Final exam

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.21.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓				✓	✓	✓									

20.21.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Single-phase Transformer:* principle of operation, construction, no load and excitation current, behaviour during loading, effect of leakage flux.
2	4-6	Ideal transformer, leakage reactance and equivalent circuit of a transformer, equivalent impedance, voltage regulation.
3	7-9	Per unit quantities, regulation, losses and efficiency, determination of parameters by tests.
4	10-12	Polarity of transformer windings, vector group, transformer parallel operation. Harmonics in excitation current, transformer inrush current.
5	13-15	*Poly-phase Transformer:* three phase transformers, connections, harmonic suppression in three phase transformer connection.
6	16-18	*Autotransformer:* construction, working principle, auto-transformer vs. potential divider, copper saving, advantages/disadvantages.
7	19-21	Phasor diagrams, equivalent circuits, conversion of a two-winding transformer to an auto-transformer, applications.

Week	Lectures	Topic
8	20-24	*Instrument transformers:* measurement of high voltages and currents in power system using P.T. and C.T. (respectively). Use of P.T. and C.T. with protective devices.
9	25-27	*Three-phase Induction Motor:* rotating magnetic field, reversal of rotating magnetic field, synchronous speed, torque in induction motor.
10	28-30	Construction - squirrel cage, wound rotor; slip and its effect on rotor frequency and voltage, equivalent circuit of an induction motor, air gap power, mechanical power and developed torque.
11	31-33	Torque speed characteristic, losses, efficiency & power factor, classification, motor performance as a function of machine parameters.
12	34-36	Shaping torque speed characteristic and classes of induction motor, per unit values of motor parameters.
13	37-39	Determination of induction motor parameters by tests, methods of braking, speed control.
14	40-42	*Induction Generator:* operation, characteristics, voltage build up, applications in wind turbine. Summary review.

20.21.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.21.12 Distribution of Marks

Class Participation	10%
Homework, Assignment and Quizzes	20%
Final Examination	70%
Total	100%

20.21.13 Learning Resources

Main Textbook

- Electric Machinery Fundamentals by Stephen J. Chapman, McGraw-Hill, 2012 (5^{th} edition)
- Principles of Electric Machines and Power Electronics by P.C. Sen, 2014 (3^{rd} edition)
- Handbook of Renewable Energy Technology edited by A. F. Zobaa, World Scientific Co., 2011
- Alternating Current Machines by A.F. Puchstein and T.C. Lloyd, 1942 (2^{nd} edition)
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the top

20.22 Description of Course EEE 211

Section A: General Information

20.22.1 Course Title	Continuous Signals and Linear Systems
20.22.2 Type of Course	Compulsory, Theory
20.22.3 Offered to	EEE
20.22.4 Pre-requisite Course(s)	None

Section B: Course Details

20.22.5 Course Content (As approved by the Academic Council)

- Classification of signals and systems: signals - classification, basic operation on signals, elementary signals, representation of signals using impulse function; systems- classification.
- Properties of Linear Time Invariant (LTI) systems: Linearity, causality, time invariance, memory, stability, invertibility.
- Time domain analysis of LTI systems: (i) Differential equations - system representation, order of the system, solution techniques, zero state and zero input response, system properties; (ii) impulse response - convolution integral, determination of system properties; (iii) state variable - basic concept, state equation and time domain solution.
- Frequency domain analysis of LTI systems: (i) Fourier series - properties, harmonic representation, system response, frequency response of LTI systems; (ii) Fourier transformation - properties, system transfer function, system response and distortion-less systems.
- Applications of time and frequency domain analyses: solution of analog electrical and mechanical systems, amplitude modulation and demodulation, time-division and frequency-division multiplexing.
- Laplace transformation: properties, inverse transform, solution of system equations, system transfer function, system stability, frequency response and application.
- Solution of analog electrical and mechanical systems

20.22.6 Course Objectives

- To develop a solid foundation on the continuous time signals and systems, and the essential techniques required for their analysis and synthesis for pursuing further studies in the field of telecommunications and signal processing
- To study the most widely used techniques for transforming and analyzing signals and systems, both in time domain and frequency domain
- To investigate the behavior of linear time invariant (LTI) systems with continuous time signals as input using various techniques, such as convolution, differential equations and state equations.
- To explore the analogy between the electrical systems and mechanical or electromechanical systems, and apply this analogy for problem solving

20.22.7 Knowledge required

Fundamental concepts of mathematics, fundamentals of electrical circuits and mechanical systems.

20.22.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Understand** the properties of different continuous time signals and basic operations on them	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
CO2	**Apply** the fundamental concepts of continuous time signals and basic operations on them to analyze input/output behavior of LTI systems in time-domain.	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
CO3	**Apply** the concept of frequency domain transformation (Fourier series and Fourier transform) of	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam

	continuous time signals to analyze LTI system behaviour				
CO4	**Analyze** input/output behavior of LTI systems using Laplace transform	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.22.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.22.10 Lecture Plan

Week	**Lectures**	**Topic**
1-2	1-6	*Classification of signals and systems:* signals - classification, basic operation on signals, elementary signals, representation of signals using impulse function; systems- classification.
3	7-9	*Properties of Linear Time Invariant (LTI) systems:* Linearity, causality, time invariance, memory, stability, invertibility.
4-6	10-18	*Time domain analysis of LTI systems: (i) Differential equations* - system representation, order of the system, solution techniques, zero state and zero input response, system properties**;** *(ii) impulse response* - convolution integral, determination of system properties; (iii) *state variable* - basic concept, state equation and time domain solution.
7-8	19-24	*Frequency domain analysis of LTI systems: (i) Fourier series* - properties, harmonic representation, system response, frequency response of LTI systems.
9-10	25-30	*Frequency domain analysis of LTI systems: (ii) Fourier transformation* - properties, system transfer function, system response and distortion-less systems.
11	31-33	*Applications of time and frequency domain analyses:* solution of analog electrical and mechanical systems, amplitude modulation and demodulation, time-division and frequency-division multiplexing.
12-13	34-39	*Laplace transformation:* properties, inverse transform, solution of system equations, system transfer function, system stability and frequency response and application.
14	40-42	Solution of analog electrical and mechanical systems.

20.22.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of class tests, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.23.12 Distribution of Marks

Class Participation	10%
Homework, Assignment and Quizzes	20%
Final Examination	70%
Total	100%

20.22.13 Textbook/ References

- Continuous and Discrete Signals and Systems (2nd edition) - Samir S. Soliman and Mandyam D. Srinath
- Signals and Systems (2nd Edition) - Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab
- Analysis of Linear Systems – David K. Chen
- Signals, Systems, and Transforms – Charles L. Phillips, John M. Parr, Eve A. Riskin (4th Ed)
- Signal Processing and Linear Systems – B. P. Lathi (2nd Ed)
- Continuous-Time Signals and Systems – Michael D. Adams

Besides going through relevant topics of the textbooks, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.23 Description of Course EEE 212

Section A: General Information

20.23.1 Course Title	Numerical Technique Laboratory
20.23.2 Type of Course	Compulsory, Sessional
20.23.3 Offered to	EEE
20.23.4 Pre-requisite Course(s)	None

Section B : Course Details

20.23.5 Course Content (As approved by the Academic Council)

Laboratory on numerical techniques using computer solution of differentiation and integration problems, transcendental equations, linear and non-linear differential equations and partial differential equations.

20.23.6 Course Objectives

- To provide hands-on training on how to formulate various engineering and mathematical problems and applications properly for invoking numerical techniques.
- To provide hands-on training on numerical techniques and computer solutions for standard differential equations and relevant problems.

20.23.7 Background Knowledge required

Fundamental understanding of concepts of differentiation and integration problems, linear and non-linear differential equations, and partial differential equations.

20.23.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** modern tools to solve problems relevant to engineering and mathematics	PO(e)	P4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
2	**compare** theoretical and empirical results of standard mathematical problems	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	**analyze** different solution approaches to decide which one is more appropriate for a particular application	PO(b)	C4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.23.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
	✓	✓	✓		✓		✓	✓	✓	✓									

20.23.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	Introduction to MATLAB
3	2	Introduction to MATLAB
4	3	Interpolation
5	4	Curve Fitting
6	5	Solution of Simultaneous Linear Algebraic Equations
7	6	Numerical Differentiation
8	7	Numerical Integration
9	8	Solutions to Non-linear Equations
10	-	Laboratory test 1

Week	Experiment no.	Topic
11	-	Laboratory test 2
12	-	Final project demonstration and presentation
13	-	Final project demonstration and presentation

20.23.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the techniques learned during the semester must be completed by the end of this course. A project report must be submitted, and the project must demonstrated and presented in the class.

20.23.12 Distribution of Marks

To be decided by course instructor(s)

20.23.13 Textbook/ References

- Numerical Methods using MATLAB by John H. Mathews and Kurtis D. Fink
- Engineering problem solving with MATLAB by D. M. Etter

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.24 Description of Course MATH 259

Section A: General Information

20.24.1 Course Title	Linear Algebra
20.24.2 Type of Course	Compulsory, Theory, Non-departmental
20.24.3 Offered to	EEE
20.24.4 Pre-requisite Course(s)	None

Section B: Course Details

20.24.5 Course Content (As approved by the Academic Council)

Definition of matrices. Algebra of matrices. Transpose of a matrix and inverse of a matrix. Factorization. Determinants. Quadratic forms. Matrix polynomials. Eigenvalues and eigenvectors. Diagonalization.
Introduction to systems of linear equations. Gaussian elimination. Euclidean n-space. Linear transformations from IR^n to IR^m. Properties of' linear transformations from IR^n to IR^m. Real vector spaces and subspaces. Basis and Dimension. Row space, column space and null space. Rank and Nullity. Inner products. Angle and orthogonality in inner product spaces. Orthogonal basis: Gram-Schmidt process and QR-Decomposition. Linear transformations: Kernel and Range. Application to Computed Tomography and electric networks.

20.24.6 Course Objectives

- To understand the fundamental properties of matrices including determinants, inverse matrices, matrix factorizations, eigenvalues, eigenvectors along with their application, and linear transformations; understanding the basic concepts of the system of linear equations and apply the matrix calculus to solve linear systems of equations.
- To comprehend the Euclidean n-space, vector spaces, subspaces, linear span, and determine the basis and dimension of vector spaces.

20.24.7 Knowledge required

Familiarity with basic properties of matrix and determinants, fundamental concepts of set theory, real and complex number system, and preliminary knowledge of geometry and precalculus.

20.24.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Understand** the fundamental concepts and methods of Matrix Algebra to solve linear and non-linear system of equations.	PO(b)	**C2**	Lectures, Homework	Written exams; assignment
2	**Apply** the idea of rank, eigen values and eigen vector space and quadratic problem in real- life situations.	PO(a)	**C3**	Lectures, Homework	Written exams; assignment
3	**Explain** vector space, subspace, inner products, their uses and apply to some relevant problems	PO(a)	**C2**	Lectures, Homework	Written exams; assignment

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.24.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.24.10 Lecture Plan

Weekly Schedule for Linear Algebra

Weekly plan for course content and mapping with COs	
Weeks	**Topics**
Week-1 to 2	Types of matrices and algebraic properties, Inverse of a matrix, rank of a matrix, elementary transformations, Factorization Row-reduce a matrix to either row-echelon or reduced row-echelon form.
Week-3 to 4	Introduction to system of linear equations, Gaussian elimination, Quadratic forms, Matrix polynomials. Eigen values and Eigenvectors.
Week- 5 to 8	Euclidean n-space. Linear transformations from IR^n to IR^m. Properties of' linear transformations from IR^n to IR^m. Real vector spaces and subspaces. Basis and Dimension. Rank and Nullity.

Week-9 to 10	Inner product spaces. Angle and orthogonality in inner product spaces. Linear transformations: Kernel and Range.
Week-11 to 12	Orthogonal basis: Gram-Schmidt process and QR-Decomposition.
Week-13	Application of linear algebra related to Engineering disciplines.
Week-14	Class Test

20.24.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment in any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.24.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.24.13 Textbook/References

- Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
- Elementary Linear Algebra: Applications Version by Howard Anton and Chris Rorres.
- Introduction to linear Algebra by Gilbert Strang.
- Theory and Problems of Linear Algebra (Schaum's Outline Series) by Seymour Lipschutz.
- Advanced Engineering Mathematics, S. Chand Publishing, H. K. Dass.
- Elementary Linear Algebra with Applications by Bernard Kolman.

20.25 Description of Course HUM 135

Section A: General Information

20.25.1 Course Title	English
20.25.2 Type of Course	Compulsory, Theory, Non-departmental
20.25.3 Offered to	EEE
20.25.4 Pre-requisite Course(s)	None

Section B: Course Details

20.25.5 Course Content (As approved by the Academic Council)

General Discussion: Introduction, Various Approaches to Learning English.
Grammatical Problems: Construction of Sentences, Grammatical Errors, Sentence Variety and Style, Conditionals, Vocabulary and Diction.
Reading Skill: Discussing Readability, Scan and Skim Reading, Generating Ideas Through Purposive Reading, Reading of Selected Stories.
Writing Skill: Principles of Effective Writing; Organization, Planning and Development of Writing; Composition, Précis Writing, Amplification.
General Strategies For The Writing Process: Generating Ideas, Identifying Audiences and Purposes, Constructing Arguments, Stating Problems, Drafting and Finalizing.

Approaches to Communication: Communication Today, Business Communication, Different Types of Business Communication.
Listening Skill: The Phonemic Systems and Correct English Pronunciation.
Speaking Skill: Practicing Dialogue; Story telling; Effective Oral Presentation.
Report Writing: Defining a Report, Classification of Reports, Structure of a Report, Writing Report on Different Topics.

20.25.6 Course Objectives

- To address the specific needs of the students in strengthening their English language skills in reading, writing, speaking and listening
- To enhance their ability to understand and apply the principles of effective writing
- To prepare students to analyse literary texts critically

20.25.7 Knowledge required

None

20.25.8 Course Outcomes

CO No.	CO Statement Upon completion of the course students will be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**identify** the required communication skills in English for smooth navigation in the academic world and beyond	PO (j)	C1,C3	Lectures, PPT Presentation	Assignment, Class Test and Term Final Exam
2	**acquire** necessary skills for successful communication in English	PO(j)	C1; A1, A4	Lectures, PPT Presentation	Assignment, Class Test and Term Final Exam
3	**gain** confidence in listening, reading, speaking and writing English, functioning effectively as an individual and as a member of a team	PO(i)	C3,C5; A1, A4	Lectures, PPT Presentation	Assignment, Class Test and Term Final Exam
4	**analyse and evaluate** literary texts using appropriate critical methods, aiming at improvement of communication	PO(j), PO(h)	C4,C6; P1,P3	Lectures, PPT Presentation	Assignment, Class Test and Term Final Exam
5	**Demonstrate** competence in effective communication in English	PO(l)	C3; A4, A5; P6, P7	Lectures, PPT Presentation	Assignment, Class Test and Term Final Exam

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.25.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.25.10 Lecture Plan

Lec#	Lecture Topics	Textbooks/ References	Corresponding CO(s)
1-3	English Phonetics: Ways of correct English pronunciation,the speech sounds of English Language,differences and similarities between the speech sound of English and Bengali, the vowels, consonants and diphthongs, Phonetic transcription of some words	Baker (2008), Handout, Hornby (2020)	CO3, CO5
4-6	Construction of sentences: Different types of sentences and their structure	Raymond (2001), Thomson & Martinet (2001), Handout	CO1, CO2
7-8	Paragraph Writing: What is a paragraph? Topic sentence, connectives, order and unity in a paragraph	Imhoof & Herman (2000), Handout	CO5
9	Evaluation (Class Test 1)		
10-12	Grammatical Problems: Errors which usually occur in sentences, problems with different parts of speech with special reference to verbs, some problems in usage	Berry (2000), Fitikides (2002)	CO1, CO2, CO3, CO5
13-14	Dialogue writing: What is a dialogue? Points that we need to keep in mind while writing dialogue on a given topic	Handout	CO1, CO2, CO3, CO5
15	Concept of effective oral presentation	Sharma & Mohan (2000)	CO1, CO2, CO3, CO5
16-18	Report Writing: Structure and Layout of a report, Different types of reports, Book Report	Sharma & Mohan (2000),	CO1, CO2, CO3, CO5
19	Evaluation (Class Test 2)		
20	Composition: Thesis sentence, organization, linking expressions, writing guided compositions following some hints, writing compositions on current affairs	Imhoof & Herman (2000)	CO1, CO2, CO3

21-22	Comprehension: Reading imaginative and practical passages, meanings, styles, facts in given passages; points which we should keep in mind while doing exercise on comprehension, practicing reading comprehension	Simon & Swan (2001), Mosback, & Mosback (1999)	CO1, CO3, CO4, CO5
23	Vocabulary: How can we enrich our collection of words? Getting meanings of unfamiliar words from their contexts, acquiring common words we need in our everyday life	McCarthy& O'Dell (2002), Handout	CO1, CO3, CO4, CO5
24-25	Amplification: Points relating to expansion of ideas, how can we expand a proverb? Exercise on Amplification	Handout	CO2, CO3, CO4,CO5
26-28	Précis Writing: What is a précis? Which points we need to keep in mind while writing précis of a given passage? Writing précis of given passages	Sharma & Mohan (2000)	CO2, CO3, CO4,CO5
29-30	'Shooting an Elephant' by George Orwell; a critical analysis of the story'	Choudhury & Haq (1982)	CO1,CO2, CO3,CO4,CO5
31-32	'Fire on the Mountain' by William Golding, a general discussion of the story, a critical analysis of the story, important characters, themes, symbols	Choudhury & Haq (1982)	CO1,CO2, CO3, CO4,CO5
33	Evaluation (Class Test 3)		
34-36	Commercial Correspondence: Defining Context, Feedback ,. different parts of a letter,Sales, Claim and Adjustment letters Assignment (equivalent to One Class Test)	Sharma & Mohan (2000)	CO1,CO2, CO3, CO5
37-38	Business letter; Public letter; Job application letter. Commercial letters: Tender-notice and Pre-qualification notice, different types of tender notices	Sharma & Mohan (2000)	CO1,CO2, CO3,CO5
39-40	The Rocking-Horse Winner' by D. H. Lawrence, a general discussion on the story	Ed. Faculty, Department of English, DU	CO1,CO2, CO3, CO4, CO5
41	'An Astrologer's Day' Written by R.K. Narayan, a general discussion on the story, a critical analysis of the story; a comparative and critical analysis of the fourn stories	Narayan (1943)	CO1,CO2, CO3, CO4,CO5
42	Feedback Session: A general discussion on the topics already covered		CO5

20.25.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment of any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of Academic Council.

20.25.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.25.13 Textbook/References

- Imhoof, M., & Herman, H. *From Paragraph to Essay.* Harlow: Longman, 2000
- Berry, T.E. *Most Common Mistakes in English Usage.* New Delhi: McGraw-Hill, 2000.

- Fitikides, T.J. *Common Mistakes in English.* London: Longman, 2002.
- Sharma, R C., & Mohan, Krishna. *Commercial Correspondence and Report Writing.* New Delhi: Tata McGraw-Hill, 2000
- G, Simon., & Swan, M. *Effective Reading.* Cambridge: CUP, 2001
- Mosback, G., & Mosback, V. *Practicing Faster Reading.* Cambridge: CUP, 1999
- Choudhury, Serajul Islam and Haq, Ahsanul. Ed. *Prose of Our Time*.Dhaka: Nawroze Kitabistan, 1982
- Ed. Faculty, Department of English, DU. Poems, Essays, Short Stories. University of Dacca,1975
- Narayan, R.K.*Malgudi Day* .Mysore:Indian Thought Publications , 1943
- Raymond, Murphy. *Intermediate English Grammar.* Cambridge: CUP
- *Essential Grammar in Use.* Cambridge: CUP, 2001
- Thomson, A. J., & Martinet, A.V. *A Practical English Grammar.* New Delhi: OUP, 2001
  McCarthy , Michael & O'Dell, Felicity.*English Vocabulary in Use*. Cambridge: CUP, 2002

20.26 Description of Course HUM 272

Section A: General Information

20.26.1 Course Title	Developing English Skills (Sessional)
20.26.2 Type of Course	Compulsory, Sessional, Non-departmental
20.26.3 Offered to	EEE
20.26.4 Pre-requisite Course(s)	None

Section B: Course Details

20.26.5 Course Content (As approved by the Academic Council)

Grammar: Tense, article, preposition, subject-verb agreement, clause, conditional and sentence structure.

Vocabulary Building: Correct and precise diction, affixes, level of appropriateness; Colloquial and standard, informal and formal.

Developing Reading Skill: Strategies of reading–skimming, scanning, predicting, inferencing; Analysis and interpreting variety of texts; Practicing comprehensionfrom literary and non-literarytexts.

Developing Writing Skill: Sentences, sentence variety, generating sentences; Clarity and correctness of sentences; Linking sentences to form paragraphs, writing paragraphs, essays, reports, formal and informal letters.

Listening Skill and Note Taking: Listening to recorded texts and class lectures, learning to take useful notes based on listening.

Developing Speaking Skill: Oral skills including communicative expressions forpersonal identification, life at home, giving advice and opinion, instructions and directions, requests, complaints, apologies, describing people and places, narrating events.

20.26.6 Course Objectives

- To enable learners to communicate effectively in academic and professional settings by developing their four core communication skills in English: listening, speaking, reading, and writing

- To develop an appreciation for English literary texts among learners to improve their English language skills

20.26.7 Knowledge required

None

20.26.8 Course Outcomes

CO No.	CO Statement *Upon successful completion of this course, learners will be able to*	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**express** ideas and opinions fluently in English in social and professional settings	PO(i); PO(j)	C2	Lectures; Extempore speech; Q & A Forums	Viva voce; Presentation; Debate
CO2	**follow** speech, lectures, and arguments in common English accent	PO(j)	A1, A3, P3	Lectures; Listening practice; Q & A Forums	Viva voce; Presentation; Debate, Phonetics test
CO3	**understand** and **analyse** English literary texts and articles with ease	PO(j)	C4, C2	Lectures; Group discussion on short stories and essay; Q & A Forums	Written exams; Viva voce; Debate
CO4	**organize** and **synthesize** ideas in a clear, detailed, and well-structured text	PO(j)	C5, A4	Lectures; Writing practice in peer groups; Corrective feedback on writing; Q & A Forums	Written exams; Assignment on presentation synopsis, Report
CO5	**compose** paragraphs, reports, and essays on complex subjects	PO(j)	C6, P7	Lectures; Writing paragraphs, essays, and reports in peer group, Q & A Forums	Written exams; Report

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.26.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.26.10 Lecture Plan

Lec#	Lecture Topics	References	Corresponding CO(s)
1	Introduction to General English Listening Practice	Sharma & Mohan (2000),	CO1, CO2

Lec#	Lecture Topics	References	Corresponding CO(s)
	Extempore Speech	Baker (2008)	
2	Listening Practice Picture Description	Handout, Baker (2008)	CO1, CO2
3	Listening Practice Dialogue: Practice in Pair Work	Sharma & Mohan (2000), Baker (2008)	CO1, CO2
4	Introduction to Paragraph Writing Paragraph in Peer Group	Imhoof & Herman (2000), Hefferman (2001)	CO4, CO5
5	Report: Types & Layout Assignment on Report Selection of the Report Topic	Sharma & Mohan (2000)	CO4, CO5
6	English Phonetics: A Gateway to Correct English Pronunciation Phonetic Symbols &Their Applications, Phonetic Transcriptions Listening Practice Discussion on Short Stories Instruction for Selecting Topic of Presentation	Baker (2008), Handout Sharma & Mohan (2000)	CO2, CO3
7	Test on Phonetics Listening Practice Submission of Topic for Mock & Final Presentation Discussion on Short Stories	Baker (2008), Handout	CO2, CO3
8	Debate Based on Short Stories	-	CO1
9	Mock Presentation	-	CO1
10 & 11	Final Test on Presentation Submission of the Presentation Synopsis	-	CO1, CO4
12	Final Test on Reading & Writing Skills	-	CO3, CO4, CO5
13 & 14	Final Test on Speaking Skill	-	CO1, CO2

20.26.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive reading and writing skill test will be held following the guideline of the Academic Council.

20.26.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.26.13 Textbook/References

- Sharma, R C., & Mohan Krishna (2000), *Commercial Correspondence and Report Writing*. New Delhi: Tata McGraw-Hill.
- Baker, Ann. (2008), *Ship or Sheep?* New Delhi: Cambridge University Press.
- G, Simon., & Swan M. (2001), *Effective Reading.* Cambridge: CUP
- Mosback, G., & Mosback (1999), V. *Practicing Faster Reading.* Cambridge: CUP.
- Imhoof, M., & Herman H. (2000), *From Paragraph to Essay.* Harlow: Longman.
- Thomson, A. J., & Martinet, A.V (2001), *A Practical English Grammar.* New Delhi: OUP.
- Hefferman, AW James (2001), *Writing: A College Handbook*. London: Norton.
- Fitikides, T.J. (2002), *Common Mistakes in English.* London: Longman.

20.27 Description of Course EEE 205

Section A: General Information

20.27.1 Course Title	Energy Conversion II
20.27.2 Type of Course	Compulsory, Theory
20.27.3 Offered to	EEE
20.27.4 Pre-requisite Course(s)	None

Section B: Course Details

20.27.5 Course Content (As approved by the Academic Council)

- Synchronous Generator: construction, armature (stator) and rotating field (exciter), excitation system with brushes and brushless excitation system, cooling, generated voltage equation of distributed short pitched armature winding, armature winding connections and harmonic cancellation in distributed short pitched winding, equivalent circuit, synchronous impedance, generated voltage and terminal voltage, phasor diagram, voltage regulation with different power factor type loads, determination of synchronous impedance by tests, phasor diagram, salient pole generator d-q axes parameters, equivalent circuit, generator equations, determination of d-q axes parameters by tests, equation of developed power and torque of synchronous machines (salient and non-salient pole motor and generator).
- Parallel Operation of Generators: requirement of parallel operation, conditions, synchronizing, effect of synchronizing current, hunting and oscillation, synchroscope, phase sequence indicator, load distribution of alternators in parallel, droop setting, frequency control, voltage control, house diagrams.
- Synchronous Motors: construction, operation, starting, effect of variation of load at normal excitation, effect of variation of excitations, V curves, inverted V curves and compounding curves, power factor adjustment, synchronous capacitor and power factor correction.
- DC Motors: principle of operation, constructional features, back emf and torque equations, armature reaction and its effect on motor performance, compensating winding, problems of commutation and their mitigations, types of dc motors and their torque speed characteristics, starting and speed control of dc motors, applications of different types of dc motor.
- Single Phase Induction Motor: operation, quadrature field theory, double revolving field theory, split phasing, starting methods, equivalent circuit, torque-speed characteristic and performance calculation.
- Renewable Energy: Introduction to photovoltaic systems.

20.27.6 Course Objectives

- To understand the construction and operations of synchronous generator (alternator), synchronous motor, DC motor, single phase induction motor and photovoltaic system
- To analyse the characteristics of salient and non-salient pole generators and motors, to calculate various machine parameters based on design data and test results
- To demonstrate the parallel operation of generators/infinite bus system
- To be familiar with the application of renewable energy technology such as photovoltaic systems

20.27.7 Knowledge required

Fundamental concepts of Electrical Circuits I & II course, application of Faraday’s law, and Energy Conversion I course

20.27.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Explain** the operations of synchronous and other (1-ϕ, DC) electrical machines by **applying** the knowledge of electrical circuits and electromagnetic induction	PO(a)	C2, C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**Analyse** the techniques of parallel operation of alternator (to another alternator and to infinite bus system)	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**Design** solar home system satisfying necessary requirements	PO(c)	C6	Lectures, Discussions	Assignment, Final exam
4	**Compare** renewable energy technology with conventional energy generation technology	PO(g)	C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.27.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓		✓	✓	✓									

20.27.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Synchronous Generator: construction, armature (stator) and rotating field (exciter), excitation system with brushes and brushless excitation system.
2	4-6	Cooling of generator. Generated voltage equation of distributed short pitched armature winding, armature winding connections and harmonic cancellation in distributed short pitched winding.
3	7-9	Equivalent circuit, synchronous impedance, generated voltage and terminal voltage, phasor diagram, voltage regulation with different power factor type loads.

Week	Lectures	Topic
4	10-12	Determination of synchronous impedance by tests, phasor diagram, salient pole generator d-q axes parameters, equivalent circuit, generator equations.
5	13-15	Determination of d-q axes parameters by tests, equation of developed power and torque of synchronous machines (salient and non-salient pole motor and generator).
6	16-18	*Parallel Operation of Generators:* requirement of parallel operation, conditions, synchronizing, effect of synchronizing current, hunting and oscillation.
7	19-21	Synchroscope, phase sequence indicator, load distribution of alternators in parallel, droop setting, frequency control, voltage control, house diagrams.
8	20-24	*Synchronous Motors:* construction, operation, starting, effect of variation of load at normal excitation, effect of variation of excitations.
9	25-27	V-curves, inverted-V curves and compounding curves, power factor adjustment, synchronous capacitor and power factor correction.
10	28-30	*DC Motors:* principle of operation, constructional features, back emf and torque equations, armature reaction and its effect on motor performance, compensating winding, problems of commutation and their mitigations.
11	31-33	Types of dc motors and their torque speed characteristics, starting and speed control of dc motors, applications of different types of dc motor.
12	34-36	*Single Phase Induction Motor:* operation, quadrature field theory, double revolving field theory, split phasing.
13	37-39	Starting methods, equivalent circuit, torque-speed characteristic and performance calculation.
14	40-42	*Renewable Energy:* Introduction to photovoltaic systems. Summary review.

20.27.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.27.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.27.13 Textbook/References

- Electric Machines Theory, Operation, Applications, Adjustment, and Control by Charles I. Hubert, 2002 (2nd edition)
- Principles of Electric Machines and Power Electronics by P.C. Sen, 2014 (3rd edition)
- Handbook of Renewable Energy Technology edited by A. F. Zobaa, World Scientific Co., 2011
- Alternating Current Machines by A.F. Puchstein and T.C. Lloyd, 1942 (2nd edition)
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.28 Description of Course EEE 206

Section A: General Information

20.27.1. Course Title	Energy Conversion Laboratory
20.28.2 Type of Course	Compulsory, Sessional
20.28.3 Offered to	EEE
20.28.4 Pre-requisite Course(s)	None

Section B: Course Details

20.28.5 Course Content (As approved by the Academic Council)

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in Energy Conversion I and Energy Conversion II courses. In the second part, students will design simple systems using the principles learned in Energy Conversion I and Energy Conversion II courses.

20.28.6 Course Objectives

- To provide hands-on experience on the theories and concepts of induction motors, transformers, synchronous machines and DC motors.
- To design simple systems using the principles of induction motors, transformers, synchronous machines and DC machines.

20.28.7 Knowledge required

Fundamental concepts of Electrical Circuits I & II course, application of Faraday's law, and Energy Conversion I course

20.28.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** the concepts of, transformer, induction motors, synchronous and other (1-ϕ, DC) electrical machines	PO(a)	P4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
2	**compare** theoretical and empirical results	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	**design** simple systems using the principles of induction motors, transformers, synchronous machines and DC machines.	PO(c)	C3	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.28.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓			✓	✓	✓	✓									

20.28.10 Lecture Plan

Week	**Experiment no.**	**Topic**
1	-	Introductory class and overview of the course
2	1	The Single-Phase Transformer
3	2	Transformer Regulation; Determination of the Equivalent Circuit Parameters of a Transformer and Calculation of Efficiency and Regulation using Equivalent Circuit
4	3	The Capacitor-Start Motor
5	4	The Wound-Rotor Induction Motor
6	5	The Three-Phase Alternator
7	6	Alternator Synchronization
8	7	The Synchronous Motor
9	8	The Direct Current Motor
10	9	The DC Compound Motor
11	-	Laboratory test
12	-	Final project demonstration and presentation
13	-	Final quiz

20.28.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the techniques learned during the semester must be completed by the end of this course. A project report must be submitted, and the project must be demonstrated and presented in the class.

20.28.12 Distribution of Marks

To be decided by course instructor(s)

20.28.13 Textbook/References

- Electric Machinery Fundamentals by Stephen J. Chapman, McGraw-Hill, 2012 (5th edition)
- Principles of Electric Machines and Power Electronics by P.C. Sen, 2014 (3rd edition)
- Handbook of Renewable Energy Technology edited by A. F. Zobaa, World Scientific Co., 2011

- Alternating Current Machines by A.F. Puchstein and T.C. Lloyd, 1942 (2nd edition)

  Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.29 Description of Course EEE 207

Section A: General Information

20.29.1 Course Title:	Electron Circuits II
20.29.2 Type of Course	Compulsory, Theory
20.29.3 Offered to	EEE
20.29.4 Pre-requisite Course(s)	None

Section B: Course Details

20.29.5 Course Content (As approved by the Academic Council)

Ideal operational amplifier and op-amp circuits; Op-amp applications: inverting amplifier, non-inverting amplifier, summing amplifier, differential amplifier, logarithmic amplifier, operational transconductance amplifiers exponential amplifier, differentiator, integrator, voltage to current converter, voltage follower, and other applications. Non-ideality of op-amp: Non-ideal op-amp characteristics and its effects. Integrated circuit biasing and active loads: BJT current sources, FET current sources, small signal analysis of active loads, design applications: an NMOS current source; differential and multistage amplifiers: BJT differential amplifier, FET differential amplifier, differential amplifier with active load, BiCMOS circuits, gain stage and simple output stage, BJT operational amplifier circuit; Frequency response of amplifiers: Poles, zeros and Bode plots, amplifier transfer function, techniques of determining 3 dB frequencies of amplifier circuits, frequency response of single stage and cascade amplifiers, frequency response of differential amplifiers; Feedback and stability: Basic feedback concept, feedback topologies: voltage(series-shunt) amplifiers, current (shunt-series) amplifiers, transconductance (serie-series) amplifiers, transresistance (shunt-shunt) amplifiers, loop gain, stability of feedback circuit, frequency compensation; Applications and Design of Integrated Circuits: Active filter, Oscillators, Schmitt trigger Circuits, Nonsinusoidal oscillators and timing circuits, integrated power amplifier, voltage regulator, Design application: An active Band-pass filter. 555 Timer IC and its Applications; Introduction to power amplifier classes: class A, class B, class AB, class C operation.

20.29.6 Course Objectives

- The main objective of this course is to explain the model of operational amplifier and analyze op-amp circuits to perform different operations such as integration, differentiation and filtering on electronic signals
- The course aims to understand how negative feedback is used to stabilize the gain of an op-amp based amplifier and how positive feedback can be used to design an oscillator
- The objective of this course is to perform analysis on different classes of power amplifiers, calculations of power and efficiency, and distortion
- Thus, the course aims to give students the necessary background to design and perform analysis of electronic amplifier circuits

20.29.7 Knowledge required

Fundamental understanding of concepts of Electrical Circuits I, Electrical Circuits II and Electronic Circuits

I

20.29.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Explain the operation of opamp and its applications in mathematical and filtering circuits.	PO(a)	C1	Lecture, Discussion, Class Participation	Assignment, Class test, Final exam
CO2	Explain and calculate different performance parameters of feedback circuits, oscillators, pulse circuits, waveform generator and multi-vibrators	PO(b)	C2	Lecture, Discussion, Class Participation	Assignment, Class test, Final exam
CO3	Determine output power, efficiency and frequency response of power amplifiers	PO(a)	C3	Lecture, Discussion, Class Participation	Assignment, Class test, Final exam
CO4	Describe the applications of electronic devices and circuits and Explain their functions in larger electronic systems	PO(a)	C2	Lecture, Discussion, Class Participation	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.29.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.29.10 Lecture Plan

Week	Lectures	Topic	COs
1	1-3	Properties of Ideal Op-Amps, Non-inverting and inverting amplifiers, differential amplifier, and its applications in mathematical circuits like inverting integrator, differentiator, weighted summer	**CO1**
2	4-6	Other applications of Op-Amp circuits (ZCD, VLD, Smoke Detector, etc.), effects of finite open loop gain and bandwidth on circuit performance, logic signal operation of Op-Amp	**CO1**
3-4	7-12	Non-ideal op-amp characteristics and its effects: DC imperfections. General purpose Op-Amp: DC analysis, AC imperfections: small signal analysis of different stages, gain and frequency response of 741 Op-Amp	**CO1**
5	13-15	**Active Filters**: Different types of filters and specifications, transfer functions, realization of first and second order low, high and band pass filters using Op-Amps	**CO1**
6-8	16-24	**Negative Feedback:** Properties, basic topologies, feedback amplifiers with different topologies (voltage-series, voltage-shunt, current-shunt and current-series), stability and frequency compensation.	**CO2**
9 - 10	25-30	**Signal Generators:** Basic principle of sinusoidal oscillation, BJT and Op-Amp RC oscillator, LC , Wien- bridge and crystal oscillators, multi-vibrators	**CO2**

11-13	31-39	**Power Amplifiers:** Classification of amplifiers, Class A, Class B and Class AB amplifiers; **Frequency Response of Amplifiers:** Poles, zeros and Bode plots, amplifier transfer functions, frequency response of single-stage and multi-stage amplifiers, frequency response of differential amplifier	**CO3**
14	40-42	The applications of electronic devices and circuits and Explain their functions in larger electronic systems and review	**CO4**

20.29.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.29.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.29.13 Textbook/ References

- R.F. Coughlin and F.F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits"
- J. Millman and C.C. Halkias, "Integrated Electronics: Analog and Digital Circuits and Systems"
- Sedra and Smith, "Microelectronic Circuits"
- Savant, Roden and Carpenter, "Electronic Design: Circuits and Systems
- R. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory"

20.30 Description of Course EEE 208

Section A: General Information

20.30.1 Course Title	Electronic Circuits II Laboratory
20.30.2 Type of Course	Compulsory, Sessional
20.30.3 Offered to	EEE
20.30.4 Pre-requisite Course(s)	None

Section B: Course Details

20.30.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 207: Electronic Circuits II. It basically contains two parts**: Hardware (H) and Simulation (S**). In hardware part, student will build circuit and observe the characteristics of electronic circuits by different oscilloscope, multimeter, etc. In Simulation part, student will use circuit analysis tool such spice, LT spice to observe more detail understanding of the theory.

20.30.6 Course Objectives

- To provide hands-on training on various electronic devices and circuits with applications
- To make students capable of doing small projects using Op-amp and other electronic devices

20.30.7 Background Knowledge required

Fundamental understanding of concepts of electronic devices and circuits analysis

20.30.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	use modern tools to solve problems relevant to electronic circuits	PO(e)	C3, P4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests, Viva, Quiz
CO2	compare theoretical and experimental results of electronic devices and circuits	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests, Viva, Quiz
CO3	design electronic circuits/systems so that specific performance characteristics are attained	PO(c)	C6	Lectures, interactive discussions	Project demonstration
CO4	Demonstrate/present designed electronic circuits/systems	PO(j)	A3	Interactive discussions	Project demonstration and Presentation
CO5	demonstrate effective individual and team-working skills	PO(i)	A3	Interactive discussions	Peer and instructor assessment

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.30.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
		✓			✓		✓	✓	✓	✓					✓	✓	✓		

20.30.10 Lecture Plan

Week	**Experiment no.**	**Topic**
1	-	Introductory Hardware part of the course (H)
2	-	Introductory Simulation part of the course (S)
3	1(S)	Study of the Characteristics and Application of Operational Amplifier (Part A)

Week	Experiment no.	Topic
4	1(H)	Study of Feedback Amplifier Circuits
5	2(S)	Study of the Characteristics and Application of Operational Amplifier (Part B)
6	2(H)	Linear Application of Operational Amplifier
7	3(S)	Study of Class B Complementary Power Amplifier
8	3(H)	Study of Class B Complementary Power Amplifier
9	4(S)	Study of the Wien Bridge Oscillator
10	4(H)	Study of Wien Bridge Oscillator
11	-	Viva on Hardware Experiments
12	-	Laboratory Test on Simulation Experiments
13	-	Laboratory Test on hardware
14	-	Project Presentation and Lab Final Quiz

20.30.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing, viva and quiz.
- A group projects using Op-amp and other electronic (i.e. diode, BJT, MOSFET) and electrical (i.e. resistor, capacitor) components has to be completed by the end of term. The project has to be demonstrated and presented in the class.

20.30.12 Distribution of Marks

To be decided by course teacher(s)

20.30.13 Textbook/References

- Operational Amplifiers and Linear Integrated Circuits by R.F. Coughlin and F.F. Driscoll
- Electronic Design: Circuits and Systems by Savant, Roden and Carpenter
- Microelectronic Circuits by Adel S Sedra and Kenneth Carless Smith
- Electronic devices and circuit theory by Robert L Boylestad and Louis Nashelsky

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.31 Description of Course EEE 209

Section A: General Information

20.31.1 Course Title	Engineering Electromagnetics
20.31.2 Type of Course	Compulsory, Theory
20.31.3 Offered to	EEE
20.31.4 Pre-requisite Course(s)	None

Section B: Course Details

20.31.5 Course Content (As approved by the Academic Council)

Electromagnetics, Why EM, Applications, Fields, EM Source, Electrical quantities; **Electrostatics**: Fundamental postulates of static Electric field, Coulomb's law, Gauss law and applications, Electric potentials, material media in Electric field, Electric flux density, dielectric strength, boundary conditions for Electrostatics, Electric dipole, Capacitances, Electrostatics energy, Boundary value problem, Poisson's and Laplace equation, Image theory; **Steady Electric currents**: Current density and ohm's law, equation of continuity, Power dissipation and Joules law, Governing equations for steady current and boundary conditions; **Magnetostatics**: Fundamental postulates of magnetostatics, Vector magnetic potentials, Biot-savart law, magnetic dipole, magnetic field intensity and permeability, magnetic materials, boundary conditions, Inductances, magnetic stored energy, magnetic force and torque; **Time varying Fields and Maxwell's equation**: Faraday's law of EM induction, Maxwell's equations (differential, integral and phasor form), Potentials functions, Time harmonics fields, Helmholtz's wave equations; **Plane electromagnetic waves**: Plane waves in lossless media, Doppler effect, TEM wave, Polarization of plane waves, plane wave in lossy media, lowloss dielectric, good conductors, Phase velocity and group velocity, EM power flow and Poynting vector, Instantaneous EM power in a good conductor and lossy dielectric, Normal incidence of plane wave at plane boundaries

20.31.6 Course Objectives

- The main objective of this course is to introduce basic concepts of electromagnetics and establish the foundation of understanding various electromagnetic theories, which are indispensable for many modern electrical and electronic devices of power and energy systems, telecommunications, computing, and other technologies.
- The course aims to develop vector calculus, phasor, and differential equation based mathematical skills for solving electromagnetic field and wave related problems of practical usage.
- Students will become familiar with electromagnetic applications that are used in the designs and implementations of electrical and electronic systems and modern wireless communications systems.
- Thus, the course aims to give students the necessary background for the design and analysis of both low frequency electrical devices and high frequency electronic components.

20.31.7 Knowledge required

Basics of vector calculus and coordinate geometry.

20.31.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
CO1	**Understand** the fundamental laws of vector fields and scalar fields and **explain** the nature of static and time varying electric and magnetic fields.	PO(a)	C1, C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO2	**Employ** vector algebra, coordinate systems, and vector calculus to **solve** static and time varying field problems.	PO(a)	C1, C2, C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO3	**Interpret** and **apply** Maxwell's equations to time-harmonic fields in different media and **solve** for	PO(b)	C1, C2, C3, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

	wave equations using boundary conditions.				
CO4	**Describe** and **analyze** the properties of plane waves and understand the concepts of wavelength, phase velocity, phase and attenuation constants, power flow, and the polarization in unbounded space, and at media interfaces.	PO(b)	C1, C2, C3, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO5	**Identify** electromagnetic phenomena relevant to real-life applications and **describe** the engineering uses of electromagnetic waves.	PO(b)	C1, C2, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.31.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.31.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-3	1	Introduction: Electromagnetics, Why EM, Applications, Fields, EM Source, Electrical quantities	CO1
4-12	2-4	Electrostatics: Fundamental postulates of static Electric field, Coulomb's law, Gauss law and applications, Electric potentials, material media in Electric field, Electric flux density, dielectric strength, boundary conditions for Electrostatics, Electric dipole, Capacitances, Electrostatics energy, Boundary value problem, Poisson's and Laplace equation, Image theory	CO1 CO2
13-15	5	Steady Electric currents: Current density and ohm's law, equation of continuity, Power dissipation and Joules law, Governing equations for steady current and boundary conditions	CO1 CO2

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
16-21	6-7	Magnetostatics: Fundamental postulates of magnetostatics, Vector magnetic potentials, Biot-savart law, magnetic dipole, magnetic field intensity and permeability, magnetic materials, boundary conditions, Inductances, magnetic stored energy, magnetic force and torque	CO1 CO2
22-27	8-9	Time varying Fields and Maxwell's equation: Faraday's law of EM induction, Maxwell's equations (differential, integral and phasor form), Potentials functions, Time harmonics fields, Helmholtz's wave equations	CO3 CO5
28-36	10-12	Plane electromagnetic waves: Plane waves in lossless media, Doppler effect, TEM wave, Polarization of plane waves, plane wave in lossy media, lowloss dielectric, good conductors, Phase velocity and group velocity, EM power flow and Poynting vector, Instantaneous EM power in a good conductor and lossy dielectric, Normal incidence of plane wave at plane boundaries	CO4 CO5
37-39		Review	CO5

20.31.11 Assessment Strategy

- Class participation and attendance will be recorded in every class. Participation and attendance for the students may be considered in case the student could not attend the class due to a valid reason (power failure, internet problem, device problem, health problem, etc.). The student has to inform the teacher over email in case of such occurrences. A maximum of three (03) such missed classes can be considered for this course
- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.
-

20.31.12 Distribution of Marks

Class Participation	10%
Homework Assignment and Quizzes (continuous assessment)	20%
Final Examination (3 hours)	70%
Total	100%

20.31.13 Textbook/ References

- M. N. O. Sadiku, "Principles of Electromagnetics", Sixth Edition, Oxford University Press, 2015
- F. T. Ulaby, E. Michielssen, and U. Ravaioli, "Fundamentals of Applied Electromagnetics," Sixth Edition, Pearson Education Limited, 2016
- David K. Cheng, "Fundamentals of Engineering Electromagnetics," Addison-Wesley Publishing Company, 1993
- W. H. Hayt, "Engineering Electromagnetics," 8th edition, McGraw-Hill, 2012
- Other Resources (Online Resources or Others, if any):
- Operational Amplifiers and Linear Integrated Circuits by R.F. Coughlin and F.F. Driscoll
- Electronic Design: Circuits and Systems by Savant, Roden and Carpenter
- Microelectronic Circuits by Adel S Sedra and Kenneth Carless Smith
- Electronic devices and circuit theory by Robert L Boylestad and Louis Nashelsky

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.32 Description of Course ME 267

Section A: General Information

20.32.1 Course Title	Mechanical Engineering Fundamentals
20.32.2 Type of Course	Compulsory, Theory, Non-departmental
20.32.3 Offered to	EEE
20.32.4 Pre-requisite Course(s)	None

Section B: Course Details

20.32.5 Course Content (As approved by the Academic Council)

Introduction to sources of energy. Steam generating units with accessories and mountings; Steam turbines,condensers, vapor cycles.

Internal combustion engines: Introduction to internal combustion engines and their cycles; gas turbines.

Refrigeration and air conditioning: applications; refrigerants, different refrigeration methods.

Fluid Machinery: Fluid flow, measurements of flow, friction in flow, centrifugal pumps, fans, blowers and compressor.

Fundamental of conduction, convection and radiation: one dimensional steady state conduction in plated pipes; critical thickness of insulation.

20.32.6 Course Objectives

- To prepare the students to use thermodynamics in engineering practice
- To study and gather knowledge about the working principles of IC engines and their cycles
- To provide students an understanding of fluid flow and fluid machinery and the modes of heat transfer and its applications.

20.32.7 Knowledge required

None

20.32.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Illustrate** the use of laws of thermodynamics for practical systems	PO (a) PO (b)	C2, C3	Lectures, Homework	Assignment, Class test, Final exam
2	**Explain** the major components of energy generation and conversion and corresponding thermodynamic cycles	PO (a), PO (c)	C1, C3, C4	Lectures, Homework	Assignment, Class test, Final exam
3	**Evaluate** the performance of IC Engines and refrigeration & air-conditioning.	PO (a), PO (d)	C1, C2	Lectures, Homework	Assignment, Class test, Final exam
4	**Analyse** fluid flow and fluid machinery	PO (a), PO (b)	C1, C2, C4	Lectures, Homework	Assignment, Class test, Final exam
5	**Examine** mechanisms of heat transfer involved in conduction, convection, and radiation	PO (a), PO (b)	C1, C2	Lectures, Homework	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.32.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.32.10 Lecture Plan

Lec#	Lecture Topics	References	Corresponding CO(s)
1-2	Sources of Energy		CO 1
3-6	Thermodynamics Basics, Laws of Thermodynamics		CO 1
7-9	Vapor Cycles		CO 1
10-12	Steam turbines, Gas turbines, Condensers,		CO 1, CO 2
13-14	Steam generating units with accessories and mountings;		CO 1, CO 2
15-16	Introduction to internal combustion engines		CO 1, CO 3
17-19	IC Engine Operations and subsystems		CO 1, CO 3
20-22	Air Standard Cycles		CO 1, CO 3
23-25	Fundamentals of Refrigeration and Air Conditioning		CO 1, CO 3
26-27	Refrigerants, different refrigeration methods		CO 1, CO 3
28-30	Fluid flow		CO 4
31-33	Measurements of flow, friction in flow		CO 4
34-36	Centrifugal pumps, fans, blowers, and compressor		CO 4
37-39	Fundamental of conduction, convection, and radiation		CO 5
40-42	One dimensional steady state conduction in plated pipes, Critical thickness of insulation		CO 5

20.32.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.32.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.32.13 Textbook/References

- Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles
- Fundamentals of Engineering Thermodynamics by Moran, M.J. & Saprio, H.N.
- Heat Transfer: A Practical Approach-Yunus A. Cengel
- Refrigeration and Air Conditioning- Ahmadul Ameen

20.33 Description of Course ME 268

Section A: General Infromation

20.33.1 Course Title	Mechanical Engineering Fundamentals Sessional
20.33.2 Type of Course	Compulsory, Sessional, Non-departmental
20.33.3 Offered to	EEE
20.33.4 Pre-requisite Course(s)	ME 267

Section B: Course Details

20.33.5 Course Content (As approved by the Academic Council)

Experiment

Experiment No.01:

Determination of Heating Value of Gaseous Fuel by Gas Calorimeter

Experiment No.2:

(a)Determination of Carbon Residue of a given oil

(b)Determination of Flash point and Fire Point of given oil

Experiment No.3:

Study and calibration of Thermocouple

Experiment No.4:

(a)Determination of Viscosity of an oil by Saybolt Viscosimeter

(b)Calibration of Pressure Gauge by Dead Weight Tester

Sessional Lecture (Model Lab Classes)

(a) Internal Combustion Engine

(b) Pumps and Turbines

(c) Boilers and Steam Turbines

(d) Refrigeration and Air Conditioning

20.33.6 Course Objectives

- To learn the fundamental concepts relevant to thermodynamics.
- To understand basic operations of Mechanical Engineering equipment practically in
- relation with theory (mainly Thermodynamics course)
- To learn to determine certain aspects of a fuel such as heating value, carbon residue, fire point, flash point, and viscosity of fuels.
- To study how to applythefirst and secondlawsofthermodynamics in various systems.
- To be acknowledged the calibration methods of pressure gauge and thermocouples.
- To know about basic mechanical machinery and equipment.

20.33.7 Knowledge required

ME 267: Mechanical Engineering Fundamentals

20.33.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**
1	**Explore** knowledge of applied thermodynamics in the investigation of mechanical and thermal properties of fuels	PO(a)	C1
2	**Discuss** the environmental effects of control volume devices such as IC engine, refrigeration unit, pumps, compressors, turbines, and heat exchangers.	PO (g)	C2
3	**Analyse** different thermodynamic systems with respect to theoretical knowledge	PO (d)	C4
4	**Apply** the experience which can be applied in their practical job field in manufacturing and processing industries.	PO (l)	C3
5	**Explain** the basic operating principle of IC engine, air conditioning and refrigeration cycles etc theoretically.	PO (b)	C1

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.33.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.33.10 Lecture Plan

Lectures	**Topics**	**Reference**	**COs**
1-3	Experiment No. 1: Determination of Heating Value of Gaseous Fuel by Gas Calorimeter Model Lab Class: Internal Combustion Engine	Lab Sheet	CO1, CO2, CO3, CO5
4-6	Experiment No. 2: (a) Determination of Carbon Residue of a given oil (b) Determination of Flash point and Fire Point of given oil Model Lab Class: Pumps and Turbines	Lab Sheet	CO1, CO2
7-9	Experiment No. 3: Study and calibration of Thermocouple Model Lab Class: Boilers and Steam Turbines	Lab Sheet	CO1, CO2, CO3, CO4

Lectures	Topics	Reference	COs
10-12	Experiment No. 4: (a) Determination of Viscosity of an oil by Saybolt Viscosimeter (b)Calibration of Pressure Gauge by Dead Weight Tester Model Lab Class: Refrigeration and Air Conditioning	Lab Sheet	CO1,CO4, CO5
13-14	Viva, Quiz		

20.33.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Lab reports and Vivas are taken as part of continuous assessment. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive final quiz examination will be held at the end of all sessional classes for ME 268.

20.33.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	50%
Final Examination	40%
Total	100%

20.33.13 Textbook/References

- Mechanical Engineering Laboratory-J. S. Doolittle, McGrow Hill
- Thermodynamics: An Engineering Approach by YunusCengeland Michael Boles.
- Heywood (2018), "Internal Combustion Engine Fundamentals." McGraw-Hill

20.34 Description of Course MATH 357

Section A: General Information

20.34.1 Course Title	Probability and Statistics
20.34.2 Type of Course	Compulsory, Theory, Non-departmental
20.34.3 Offered to	EEE
20.34.4 Pre-requisite Course(s)	None

Section B: Course Details

20.34.5 Course Content (As approved by the Academic Council)

Introduction. Sets and probability. Random variables. Properties describing distributions. Treatment of grouped sample data. Some discrete probability distributions. Normal distribution. Sampling theory. Estimation theory. Tests of hypotheses. Regression and correlation. Analysis of variance.

20.34.6 Course Objectives

- To understand fundamental concepts in probability and statistics.
- To apply rules and algorithm of probability and statistics in various logical problems.
- To enable students maneuver mathematical probabilistic models for different problems, to analyze them and to interpret the results.

20.34.7 Knowledge required

Familiarity with basic properties of set, real number system and function, fundamental concepts of calculus and preliminary knowledge to solve algebraic equations.

20.34.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Demonstrate** the idea of frequency distribution, mean, median, mode and other measures of central tendency.	PO(a)	C3	Lectures, Homework	Written exams; assignment
2	**Develop** the preliminary concept of standard deviation, moments, skewness, kurtosis, and other measures of dispersion for statistical data.	PO(c)	C6	Lectures, Homework	Written exams; assignment
3	**Apply** the probability theory including discrete probability distribution and continuous probability distributions in real life problem.	PO(a)	C3	Lectures, Homework	Written exams; assignment
4	**Illustrate** the basic idea of sampling theory including estimation, hypothesis testing, regression analysis and correlation coefficients.	PO(c)	C3	Lectures, Homework	Written exams; assignment voce; presentation; assignment

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.34.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.34.10 Lecture Plan

Weekly schedule: For Probability and Statistics

Week	Topics	Teacher's Initial/Remarks
Week-1	Course introduction, grading policies etc. Concepts of statistics and probability, sample space, population, Experiments, Events, Sure, Impossible, Complementary, and mutually exclusive events, Frequency distribution.	
Week-2	Treatment of Grouped sample data, Descriptive Statistics, Measures of central tendency.	
Week-3	Computing AM, GM, HM, median and mode for group and ungrouped data, Measures of Dispersion and related topics including CV.	
Week-4	Shape characteristics, moments, skewness and kurtosis, Probability theory.	
Week-5	Conditional probability, partitions, total probability, Bayes' theorem.	
Week-6	Random Variables and related probability distribution, Discrete random variables, Mathematical expectation, variance, standard deviation; binomial distribution, use of statistical tables.	
Week-7	Poisson distribution, Multinomial distribution, Continuous random variables, probability density function, cumulative distribution function, expected values.	

Week-8	**Class Test**	
Week-9	Normal distribution, normal approximation to binomial, Exponential distribution, Uniform distribution, Gamma distribution.	
Week-10	Functions of random variables, expected value, variance, standard deviation, Two dimensional random vectors.	
Week-11	Joint-distribution functions, Marginal distributions, Conditional distributions.	
Week-12	Covariance, correlation, conditional expectation, central limit theorem.	
Week-13	Special mathematical expectations, properties of variances, Sampling theory, sampling distribution, sampling with and without replacement.	
Week-14	**Class Test**	

20.34.11 Assessment Strategy

- **Class Participation:** Class participation and attendance will be recorded in every class.
- **Continuous Assessment:** Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.

- **Final Examination:** A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

20.34.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.34.13 Textbook/References

- Probability and Statistics for Engineers and Scientists by Walpole, Myers, Myers, and Ye, Pearson Education, Inc., Ninth Edition, 2012.
- Elements of Probability and Statistics by Frank L. Wolf.
- Probability and Statistics with Applications by Y. Leon Maksoudian.
- Probability and Statistics for Engineers by Erwin Miller and John E. Freund.

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.35 Description of Course EEE 305

Section A: General Information

20.35.1 Course Title	Power System I
20.35.2 Type of Course	Compulsory, Theory
20.35.3 Offered to	EEE
20.35.4 Pre-requisite Course(s)	None

Section B: Course Details

20.35.5 Course Content (As approved by the Academic Council)

Network representation: Single line and reactance diagram of power system and per unit system.
Line representation: equivalent circuit of short, medium and long lines, reactive compensation of lines,

Introduction to DC transmission.

Load flow: Gauss-Siedel and Newton-Raphson methods. Power flow control.

Synchronous machine transient and subtransient reactance and short circuit currents.
Symmetrical fault calculation methods.
Symmetrical components: power, unsymmetrical series impedances and sequence networks.

Different types of unsymmetrical faults: solid faults and faults through impedance.

Protection: fault level calculation, selection of circuit breakers, introduction to relays and circuit breakers. Typical layout of a substation.

Power plants: types, general layout of a thermal power plant and major components of gas turbine, steam turbine and combined cycle power plants.

20.35.6 Course Objectives

- To provide understanding of the techniques of power system modelling and analysis under normal and faulted conditions which are required for planning and design of a new power system, the best operation of an existing power system, and for the future expansion of an existing power system.
- To provide basic knowledge of high voltage DC (HVDC) transmission of power and its integration in an AC power system
- To provide introduction to the typical substation layout and basic relays and breakers used for the protection of a power system
- To provide foundation knowledge of different types of thermal power plants

20.35.7 Knowledge required

Fundamental concepts of Electrical Circuits, and Energy Conversion I and II.

20.35.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the knowledge of basic mathematics and electrical circuit equations to model these components based on the understanding of how to represent power system components using single line diagram and per unit	PO(a), PO(c)	C2, C3	Lectures, Discussions	Class test, Final exam
2	**apply** the models and tools to analyse power system load flow, and balanced and unbalanced fault analysis	PO(b), PO(e)	C3,C4	Lectures, Discussions	Class test, Final exam
3	**explain the** structure and operation of HVDC transmission system, power system protection equipment and their operation, and the basic knowledge about different types of thermal power plants	PO(a), PO(g), PO(l)	C2, C3	Lectures, Discussions	Class test, Final exam

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.35.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓		✓	✓	✓									

20.35.10 Lecture Plan

Sl#	Week	Topic
1	1-2	**Overview of Power System;** **Network representation**: Single line and reactance diagram of power system; per unit system.
2	3-4	**Line representation:** Equivalent circuit of short, medium and long lines, reactive power compensation of long lines. **Introduction to DC transmission.**
3	5-7	**Load/Power flow Study:** Formulation, Gauss- Seidel method, Basic Newton Raphson, decoupled, fast decoupled and DC load flow methods **Power flow control:** Tap changing transformer, phase shifting and regulating transformer, shunt capacitor.
4	8-11	**Fault analysis:** Short circuit current and reactance of a synchronous machine; Symmetrical fault analysis methods; bus impedance matrix; solid fault and fault through impedance; Symmetrical components, sequence networks and unsymmetrical faults analysis.
5	12-13	**Protection:** Introduction to relays; overcurrent, differential protection and distance protection; fault level calculation; introduction to circuit breakers, selection of circuit breakers. **Typical layout of a substation**
6	14	**Power plants:** types, general layout of a thermal power plant and major components of gas turbine, steam turbine and combined cycle power plants

20.35.11 Assessment Strategy

- Continuous assessment will be done in the form of class tests.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.35.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.35.13 Textbook/References

- John J. Grainger and William D. Stevenson, Jr. "Power System Analysis", McGraw-Hill, Latest reprint
- J. Duncan Glover, Mulukutla S. Sarma, and Thomas J. Overbye, "Power System Analysis and Design", 5th Ed.
- Leslie Hewitson, Mark Brown, and Ramesh Balakrishnan, "Practical Power System Protection", Newnes (Elsevier), 2004.
- K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Interactions", 1st Ed., Reprint 2005
- Supplied handout for HVDC transmission of power
- Any other contemporary books and URLs may be used

- *It is strongly advised that the students will follow the class lectures and discussions regularly for a thorough understanding of the topics*

20.36 Description of Course EEE 306

Section A: General Information

20.36.1 Course Title	Power System I Laboratory
20.36.2 Type of Course	Compulsory, Sessional
20.36.3 Offered to	EEE
20.36.4 Pre-requisite Course(s)	EEE 305 (may be taught simultaneously)

Section B: Course Details

20.36.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 305. In the second part of the course, the students will perform design projects related to EEE 305 course contents to achieve specific program outcomes.

20.36.6 Course Objectives

- To perform experiments in relevance with the theoretical concepts of the course EEE 305: Power System I
- To conduct design projects in order to achieve specific program outcomes described in the Course Outline

20.36.7 Knowledge required

Fundamental concepts of Electrical Machines I, Electrical Machines II and Power System I

20.36.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**investigate** the behavior of a real PFI plant upon load changes based on the understanding of its construction and operation	PO(a), PO(d)	C4	Lectures, Laboratory Experiments	Lab Performance Report Writing Viva Voce Final Quiz
CO2	**Apply** the knowledge of equivalent circuits to simulate a transmission line and **analyse** its behavior for different lengths, e.g., short, medium and long lines	PO(b)	C3, C4	Lectures, Laboratory Experiments	Lab Performance Report Writing Viva Voce Final Quiz
CO3	**Use power system analysis tools** like PSAF for power flow and fault study	PO(e)	C4, P4	Hands on experience simulation tools, Discussions	Assignment, Lab Test
CO4	**Use necessary tools to investigate** the impact on power system while some part of it is modified, and **design** necessary system upgradation	PO(c)	C4, C6	Hands on work using simulation tools, Discussions	Assignment, Lab Test
CO5	**design** a power system element with appropriate considerations to safety, cultural, societal, and environmental considerations	PO(c), PO(f), PO(g)	C6	--	Project Demonstration
CO6	**Demonstrate** membership and leadership in designing power system element related problem solving	PO(i)	P7	--	Project logbook , Peer assessment, Viva, Presentation
CO7	**Communicate** effectively on power system element design	PO(j)	A2	--	Video Presentation,

	with presentation and detailed report				Design Report
CO8	**Demonstrate** project management and cost analysis for power element design project	PO(k)	A3	--	Project Report and Presentation
CO9	**Understand** the layout and operation of a small power plant and small substations	PO(a)	C2	Visiting a small power plant and substations	Report Writing, Power Point Presentation, Viva Voce

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.36.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	

20.36.10 Lecture Plan

Week	Mode	Topic	COs (POs)
1	Introduction	Introductory discussions and overview of the experiments and projects; formation of Teams for design project and lab works	-
2	Experiment 01	Study of Microprocessor Controlled PFI Plant	CO1 (PO1, PO4)
3	Experiment 02	Study of the Transmission Line Models	CO2 (PO2)
4	Experiment 03	Load flow Study of a Power System	CO3 (PO5), CO4(PO3)
5	Experiment 04	Short Circuit Study for a Test Network	CO3 (PO5)
6	Project Proposal Presentation	Describe specific technical requirements to be attained during the project	
7	Visit	Study of BUET Power Plant and Sub-stations	CO9 (PO1)
8	Presentation on Power plant and Substations visit	Study of BUET Power Plant and Sub-stations	CO9 (PO1, PO10)
9	Project Design Presentation	• Describe specific technical requirements to be attained during the project • Describe **<u>sustainability and impact of the work</u>** in societal and environmental contexts • Describe **<u>contextual knowledge to assess</u>** societal, health, safety, legal and cultural issues relevant to the project	CO5 (PO6, PO7)
11	Project Demonstration/ Presentation	• Present/demonstrate the technical progress of the project • Describe **<u>any necessary modification proposed to address</u>** public health and safety, cultural, societal, and environmental considerations related to the project	CO5 (PO3) CO5 (PO6)
12	Project Demonstration/ Presentation	• Present/demonstrate the technical progress of the project • Describe multidisciplinary aspects of the project	CO5 (PO9)

		• Describe how each team member has been effectively working (individually and as a member or leader) to attain the goals	CO5 (PO11)
12	Project Demonstration	• **<u>Practical demonstration of the project</u>**: show evidence that specific technical requirements have been attained by the project	CO5 (PO3)
13	Final Presentation	• Describe how **<u>engineering management principles and economic decision-making applied to the project</u>** • Use multimedia and necessary documentation (user manual, video demonstration and project report) to **<u>clearly communicate the project</u>**	CO6 (PO9) CO7 (PO10) CO8 (PO11)

20.36.11 Assessment Strategy

As per distribution in the next section

20.36.12 Distribution of Marks

Class Performance	10%
Lab Reports	10%
Lab test/Viva/Quiz	30%
*Final Project	<u>50% (marks distribution of the project will be declared at the beginning of the semester)</u>
Total	100%

*Assessment will be performed by internal and external evaluators with industry experience

20.36.13 Textbook/References

- John J. Grainger and William D. Stevenson, Jr. "Power System Analysis", McGraw-Hill, 1994
- J. Duncan Glover, Mulukutla S. Sarma, and Thomas J. Overbye, "Power System Analysis and Design", 5th Ed.
- William D. Stevension, Jr., "Elements of Power System Analysis", 4th Ed.
- Supplied Labsheets
- Any other contemporary books and URLs may be used
- *It is strongly advised that the students will follow the class lectures and discussions regularly for a thorough understanding of the topics.*

20.37 Description of Course EEE 307

Section A: General Information

20.37.1 Course Title	Electrical Properties of Materials
20.37.2 Type of Course	Compulsory, Theory
20.37.3 Offered to	EEE
20.37.4 Pre-requisite Course(s)	None

Section B: Course Details

20.37.5 Course Content (As approved by the Academic Council)

- *Crystal structures:* Types of crystals, lattice and basis, Bravais lattice and Miller indices.
- *Classical theory of electrical and thermal conduction:* Scattering, mobility and resistivity, temperature dependence of metal resistivity, Mathiessen's rule, Hall effect and thermal conductivity.
- *Introduction to quantum mechanics*: Wave nature of electrons, Schrodinger's equation, one-dimensional quantum problems- infinite quantum well, potential step and potential barrier; Heisenbergs's uncertainty principle and quantum box, Electron in a 3D box. Hydrogen Atom.
- *Band theory of solids*: Band theory from molecular orbital, Bloch theorem, Kronig-Penny model, Brillouin zone, effective mass, density-of-states. Carrier statistics: Maxwell-Boltzmann and Fermi-Dirac

distributions, Fermi energy. Modern theory of metals: Determination of Fermi energy and average energy of electrons, classical and quantum mechanical calculation of specific heat.

- *Dielectric properties of materials*: Dielectric constant, polarization- electronic, ionic, orientational and interfacial; internal field, Clausius-Mosotti equation, spontaneous polarization, frequency dependence of dielectric constant, dielectric loss, piezoelectricity, ferroelectricity, pyroelectricity.
- *Magnetic properties of materials*: Magnetic moment, magnetization and relative permitivity, different types of magnetic materials, origin of ferromagnetism and magnetic domains.
- *Introduction to superconductivity*: Zero resistance and Meissner effect, Type I and Type II superconductors and critical current density. BCS theory. Magnetic recording materials, Josephson theory.
- Introduction to meta-materials.

20.37.6 Course Objectives

- To provide a physics-based understanding of the electrical, thermal, dielectric and magnetic properties of the materials.
- To establish the theoretical foundation required for designing electrical and electronic devices so that those can be applied for practical applications

20.37.7 Knowledge required

Fundamental understanding of concepts of atomic and molecular physics.

20.37.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the physics-based knowledge to solve problems relevant to the electrical, thermal, dielectric and magnetic properties of materials	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse** the properties of materials based on the underlying physics	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**design** electrical and electronic devices such that specified performance characteristics are attained	PO(c)	C6	Lectures, Discussions	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.37.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓		✓	✓	✓									

20.37.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Crystal structures:* Types of crystals, lattice and basis, Bravais lattice and Miller indices
2	4-6	*Classical theory of electrical and thermal conduction:* Scattering, mobility and resistivity, temperature dependence of metal resistivity
3	7-9	*Classical theory of electrical and thermal conduction:* Mathiessen's rule, Hall effect and thermal conductivity
4	10-12	*Introduction to quantum mechanics:* Wave nature of electrons, Schrodinger's equation, one-dimensional quantum problems- infinite quantum well
5	13-15	*Introduction to quantum mechanics:* potential step and potential barrier; Heisenbergs's uncertainty principle and quantum box, Electron in a 3D box. Hydrogen Atom
6	16-18	*Band theory of solids:* Band theory from molecular orbital, Bloch theorem, Kronig-Penny model.
7	19-21	*Band theory of solids:* Brillouin zone, effective mass, density-of-states. Carrier statistics: Maxwell-Boltzmann and Fermi-Dirac distributions, Fermi energy.
8	20-24	*Modern theory of metals*: Determination of Fermi energy and average energy of electrons, classical and quantum mechanical calculation of specific heat.
9	25-27	*Dielectric properties of materials:* Dielectric constant, polarization-electronic, ionic, orientational and interfacial; internal field, Clausius-Mosotti equation, spontaneous polarization.
10	28-30	*Dielectric properties of material:* frequency dependence of dielectric constant, dielectric loss, piezoelectricity, ferroelectricity, pyroelectricity
11	31-33	*Magnetic properties of materials:* Magnetic moment, magnetization and relative permitivity, different types of magnetic materials, origin of ferromagnetism and magnetic domains.
12	34-36	*Introduction to superconductivity:* Zero resistance and Meissner effect, Type I and Type II superconductors and critical current density. BCS theory. Magnetic recording materials, Josephson theory.
13	37-39	Introduction to meta-materials

20.37.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of Academic Council

20.37.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.37.13 Textbook/References

- Principles of Electronic Materials and Devices by S. O. Kasap (3rd edition)
- Semiconductor Physics and Devices: Basic Principles by Donald A. Neaman (4^{th} edition)
- Semiconductor Device Fundamentals by Rober F. Pierret
- Online resources or supplementary materials will be shared with the class on a need basis
- Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.38 Description of Course EEE 309

Section A: General Information

20.38.1 Course Title	Communication System-I
20.38.2 Type of Course	Compulsory, Theory
20.38.3 Offered to	EEE
20.38.4 Pre-requisite Course(s)	None

Section B: Course Details

20.38.5 Course Content (As approved by the Academic Council)

- Overview of communication systems: Basic principles, fundamental elements, system limitations, message source, bandwidth requirements, transmission media types, bandwidth and transmission capacity
- Noise: Sources of noise, characteristics of various types of noise and signal to noise ratio.
- Communication systems: Analog and digital
- Continuous wave modulation: Transmission types- base-band transmission, carrier transmission; amplitude modulation- introduction, double side band, single side band, vestigial side band, quadrature; spectral analysis of each type, envelope and synchronous detection; angle modulation instantaneous frequency, frequency modulation (FM) and phase modulation (PM), spectral analysis, demodulation of FM and PM.
- Sampling- sampling theorem, Nyquist criterion, aliasing, instantaneous and natural sampling, flat-topped sampling; pulse amplitude modulation- principle, bandwidth requirements; pulse code modulation (PCM)- quantization principle, quantization noise, non-uniform quantization, signal to quantization error ratio, differential PCM, demodulation of PCM; delta modulation (DM)- principle, adaptive DM; line coding- formats and bandwidths.
- Digital modulation and demodulation: Amplitude-shift keying principle, ON-OFF keying, bandwidth requirements, detection, noise performance; phase-shift keying (PSK)- principle, bandwidth requirements, detection, differential PSK, quadrature PSK, noise performance; frequency-shift keying (FSK)- principle, continuous and discontinuous phase FSK, minimum-shift keying, bandwidth requirements, detection of FSK, Multilevel signaling
- Multiplexing: Time-division multiplexing (TDM)- principle, receiver synchronization, frame synchronization, TDM of multiple bit rate systems; frequency-division multiplexing (FDM)- principle, demultiplexing. PDH, SONET/SDH.
- Multiple-access techniques: Time-division multiple-access (TDMA), frequency-division multiple access (FDMA); code-division multiple access (CDMA) - spread spectrum multiplexing, coding techniques and constraints of CDMA.

20.38.6 Course Objectives

- To provide knowledge on the fundamental theories and concepts of communication so that these knowledges help students for (i) understanding the communication courses in the following semesters and post-graduate studies, (ii) pursuing research in communications, and (iii) working in communication industries
- To provide theoretical foundation required for designing the building blocks of analog and digital communication systems so that those can be applied for practical system design

- To build capacity of the students for signal level analysing of communication systems

20.38.7 Knowledge required

Fundamental understanding of concepts of Electric and Electronic Circuits, and Linear Signal and Systems

20.38.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Explain** the elements, environments, and impairments of communication systems	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
CO2	**Apply** the knowledge of mathematics and **analyse** the transmitted and received signals of various transmission schemes in time domain as well as in frequency domain	PO(a)	C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
CO3	**Explain** the essential concepts of various channel sharing multiplexing techniques for communication systems	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
CO4	**Design** the parameters of communication systems so that certain requirements are satisfied	PO(a)	C6	Lectures, Discussions	Assignment, Class test, Final exam

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.38.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.38.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Overview of communication systems*: Basic principles, fundamental elements, system limitations, message source, bandwidth requirements, transmission media types, bandwidth and transmission capacity

Week	Lectures	Topic
2	4-6	*Noise:* Sources of noise, characteristics of various types of noise and signal to noise ratio.
3-4	7-12	*Communication systems*: Analog and digital. *Continuous wave modulation:* double side band, single side band, vestigial side band, quadrature; spectral analysis of each type, envelope and synchronous detection
5-6	13-18	*Continuous wave modulation:* angle modulation, frequency modulation (FM) and phase modulation (PM), spectral analysis, demodulation of FM and PM.
7-9	19-27	*Sampling*- sampling theorem, Nyquist criterion, aliasing, instantaneous and natural sampling, flat-topped sampling; pulse amplitude modulation- principle, bandwidth requirements; pulse code modulation (PCM)- quantization principle, quantization noise, non-uniform quantization, signal to quantization error ratio, differential PCM, demodulation of PCM; delta modulation (DM)- principle, adaptive DM; line coding- formats and bandwidths.
10-11	28-33	*Digital modulation and demodulation:* Amplitude-shift keying principle, ON-OFF keying, bandwidth requirements, detection, noise performance; phase-shift keying (PSK)- principle, bandwidth requirements, detection, differential PSK, quadrature PSK, noise performance; frequency-shift keying (FSK)- principle, continuous and discontinuous phase FSK, minimum-shift keying, bandwidth requirements, detection of FSK, Multilevel signaling.
12	34-36	*Multiplexing:* Time-division multiplexing (TDM) - principle, receiver synchronization, frame synchronization, TDM of multiple bit rate systems; frequency-division multiplexing (FDM) - principle, demultiplexing. PDH, SONET/SDH.
13	37-39	*Multiple-access techniques:* Time-division multiple-access (TDMA), frequency-division multiple access (FDMA); code-division multiple access (CDMA) - spread spectrum multiplexing, coding techniques and constraints of CDMA.

20.38.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of class tests, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.38.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.38.13 Textbook/References

- Modern Analog and Digital Communications, 4th edition by B P Lathi and Zhi Ding
- Communication systems, 5th edition by S. Haykin and M. Moher
- Digital and Analog Communication Systems – Leon W. Couch
- Fundamental of Communication System – M. Fitz
- Communication Systems and Techniques - M. Schwartz, W. R. Bennett, and S. Stein
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbooks, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.39 Description of Course EEE 310

Section A: General Information

20.39.1 Course Title	Communication System I Laboratory
20.39.2 Type of Course	Compulsory, Theory
20.39.3 Offered to	EEE
20.39.4 Pre-requisite Course(s)	None

Section B: Course Details

20.39.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 309 course. In the second part of the course, the students will perform design projects related to EEE 309 course contents to achieve specific program outcomes.

20.39.6 Course Objectives

- To provide hands-on training on various analog and digital transmission schemes by hardware modules
- To make capable in doing project for real life application by applying communication technologies

20.39.7 Knowledge required

Fundamental understanding of concepts of the physics of solid-state devices and engineering electromagnetics

20.39.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**use** modules/equipment to **be able to explain** the practical aspects of various communication schemes	PO(a)	C2, P2	Lectures, Lab demonstrations	Lab-tasks, Lab-tests, Reports, Viva, Quiz
CO2	**compare** theoretical and experimental results of various communication schemes	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Viva, Quiz
CO3	**design** project for real life application by applying communication related technologies with appropriate considerations to safety, cultural, societal, and environmental considerations	PO(c)	C6	Lectures, interactive discussions	Project Report and Hardware demonstration
CO4	**Assess** impact of communication system project design on Societal, Health, Safety, Legal and Cultural Issues	PO(f)	C5	interactive discussions	Presentation and Report

CO5	**Evaluate** Sustainability and Impact of the Designed communication system Project in the Societal and Environmental Contexts	PO(g)	C5	Interactive discussions	Presentation and Report
CO6	**Demonstrate** participation and leadership in designing communication system related problem solving	PO(i)	P7	Interactive discussions	Project logbook , Peer assessment, Viva, Presentation
CO7	**Communicate** effectively on communication system design with presentation and detailed report	PO(j)	A2	Interactive discussions	Project demonstration and Presentation
CO8	**Demonstrate** project management and cost analysis for communication system project	PO(k)	A3	Interactive discussions	Project Report and instructor assessment

***Program Outcomes (PO): PO1** Engineering Knowledge, **PO2** Problem Analysis, **PO3** Design/development Solution, **PO4** Investigation, **PO5** Modern tool usage, **PO6** The Engineer and Society, **PO7** Environment and sustainability, **PO8** Ethics, **PO9** Individual work and team work, **PO10**. Communication, **PO11** Project management and finance, **PO12** Life-long Learning

****Cognitive Domain Taxonomy Levels: C1** – Remember, **C2** – Explain/understand, **C3** – Apply, **C4** – Analyze, **C5** – Evaluate/Compare, **C6** – Create; **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

20.39.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓		✓	✓		✓	

20.39.10 Lecture Plan

Week	Topic
1	Introductory class and overview of the course
2	Experiment 1: Amplitude modulation and demodulation
3	Experiment 2: Frequency modulation and demodulation
4	Experiment 3: Frequency division multiplexing (FDM) and Quadrature amplitude modulation (QAM)
5	Experiment 4: Sampling and reconstruction of message signal
6	• Evaluation on the previous experiments • Submission of the design project proposal • Describe specific technical requirements to be attained during the project • Describe **<u>sustainability and impact of the work</u>** in societal and environmental contexts
7	Experiment 5: Delta modulation and demodulation
8	Experiment 6: Digital modulations and demodulations

Week	Topic
9	Experiment 7: Pulse code modulation and demodulation, uniform and non-uniform quantization & • Present/demonstrate the technical progress of the project • Describe **contextual knowledge to assess** societal, health, safety, legal and cultural issues relevant to the project
10	Experiment 8: Optical fiber characteristics and optical communication & • Present/demonstrate the technical progress of the project • Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project
11	• Evaluation on the experiments and learning • Present/demonstrate the technical progress of the project • Describe multidisciplinary aspects of the project • Describe how each team member has been effectively working (individually and as a member or leader) to attain the goals
12	**Practical demonstration of the project**: show evidence that specific technical requirements have been attained by the project
13	• Describe how **engineering management principles and economic decision-making applied to the project** • Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project**

20.39.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design and implementation of real life application by applying communication technologies has to be completed by the end of term. A project report has to be submitted and the project has to demonstrated and presented in the class.

20.39.12 Distribution of Marks

Class Participation	10%
Lab Reports	10%
Lab test/Viva/Quiz	30%
*Final Project	50% (marks distribution of the project will be declared at the beginning of the semester)
Total	100%

*Assessment will be performed by internal and external evaluators with industry experience

20.39.13 Textbook/References

- Modern Analog and Digital Communications, 4th edition by B P Lathi and Zhi Ding
- Communication systems, 4th edition by Simon Haykin
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.40 Description of Course EEE 311

Section A: General Information

20.40.1 Course Title	Digital Signal Processing
20.40.2 Type of Course	Compulsory, Theory
20.40.3 Offered to	EEE
20.40.4 Pre-requisite Course(s)	None

Section B: Course Details

20.1.5 Course Content (As approved by the Academic Council)

- Introduction to digital signal processing. Sampling, quantization and signal reconstruction.
- Analysis of discrete-time system in the time domain: impulse response model, difference equation model. Correlation: power signal, energy signal, applications.
- Z-transform and analysis of LTI systems. Minimum phase, maximum phase and all pass systems.
- Frequency analysis of discrete-time signals: discrete Fourier series and discrete-time Fourier transform (DTFT). Frequency analysis of LTI systems. Calculation of spectrum of discrete-time signals.
- Discrete Fourier transform (DFT) and fast Fourier transform (FFT).
- Digital filter design- linear phase filters, specifications, design using window, optimal methods; IIR filters- specifications, design using impulse invariant, bi-linear z- transformation, least-square methods.

20.40.6 Course Objectives

- To demonstrate fundamental concepts, algorithms, and applications of digital signal processing.
- To enable students to apply digital signal processing theories to their own field of interests and to provide a basis for the study of more advanced topics and applications.

20.40.7 Knowledge required

Fundamental understanding of concepts of Continuous Signals and Linear Systems course and Mathematics courses.

20.40.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the digital signal processing principles to solve problems relevant to the time and frequency domain operations	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse** the signal processing techniques applied to real-life applications based on the underlying principles	PO(b)	C4	Lectures, Discussions	Assignment, Presentation, Class test, Final exam
3	**design** digital filters and systems such that specified performance characteristics are attained	PO(c)	C5, C6	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.40.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
	✓	✓	✓	✓		✓		✓	✓	✓									

20.40.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Introduction to digital signal processing and its applications. Sampling: discrete time signal generation, aliasing
2	4-6	Quantization, coding, digital signal Signal reconstruction.
3	7-9	Analysis of discrete-time system in the time domain: convolution, impulse response model,
4	10-12	Analysis of discrete-time system in the time domain: difference equation model.
5	13-15	Correlation: power signal, energy signal, applications.
6	16-18	Z-transform, ROC, analysis of LTI systems in Z domain, Inverse Z-transform.
7	19-21	Minimum phase, maximum phase and all pass systems. Stability and causality.
8	20-24	Frequency analysis of discrete-time signals: discrete Fourier series and discrete-time Fourier transform (DTFT).
9	25-27	Frequency analysis of LTI systems. Calculation of spectrum of discrete-time signals.
10	28-30	Discrete Fourier transform (DFT) Fast Fourier transform (FFT).
11	31-33	Digital filter design- linear phase filters, specifications, FIR filter design using window method
12	34-36	FIR filter design using window method, optimal methods; IIR filters- specifications, design using impulse invariant,
13	37-39	IIR filter design using bi-linear z- transformation, least-square methods. Applications

20.40.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.40.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.40.13 Textbook/References

- Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck, Discrete-Time Signal Processing, Prentice Hall, Pearson, 3rd Ed., 2009 (required).
- J.G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, Prentice-Hall, 5th Ed., 2022 (required).

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.41 Description of Course EEE 312

Section A: General Information

20.41.1 Course Title	Digital Signal Processing I Laboratory
20.41.2 Type of Course	Compulsory, Sessional
20.41.3 Offered to	EEE
20.41.4 Pre-requisite Course(s)	None

Section B: Course Details

20.41.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 311. In the second part of the course, the students will perform design projects related to EEE 311 course contents to achieve specific program outcomes.

20.41.6 Course Objectives

- To perform experiments in relevance with the theoretical concepts of the course EEE 311: Digital Signal Processing I
- To conduct design projects in order achieve specific program outcomes described in the Course Outline

20.41.7 Knowledge required

Fundamental understanding of concepts of Continuous Signals and Linear Systems course and Mathematics courses.

20.41.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**understand** different digital signal processing algorithms and **use** programming software to implement them	PO(a), PO(e)	P1, P4	Lectures, Lab work, Lab test	Lab Performance Lab Report Lab Test Quiz
CO2	**compare** theoretical and experimental results of digital signal processing algorithms	PO(d)	C5	Lectures, Lab work Lab test	Lab Performance Lab Report Lab Test Quiz

CO3	**design** digital filters and systems such that specified performance characteristics are attained and demonstrate effective individual and team working skills	PO(c), PO(i)	C6, A3	Lectures, Lab work Lab test	Lab Performance Lab Report Lab Test Quiz Project Report
CO4	**design** a digital system to solve a relevant problem with due considerations to public health and safety, societal, cultural and environmental consideration	PO(c), PO(l)	P7	--	Project Demonstration, Project Report
CO5	**demonstrate** application of ethical principles and practices in the project, and **evaluate** peer team members ethically	P(h)	A3	--	Peer evaluation, Report
CO6	**work** effectively as an individual and as a team member towards the successful completion of the project	PO(i)	P4	--	Viva, Peer evaluation
CO7	**report** effectively on the design done for CO4 with presentation, user-manual and detailed report	PO(j)	A3	--	Video Presentation Project Report

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.41.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓		✓	✓

20.41.10 Lecture Plan

Week	**Delivery**	**Topic**
1	Introduction and Expt.-1 (A)	Introduction to digital signal processing and its major applications Overview on lab experiments, projects, policies, grading; group formation Matlab basics, generating discrete time signal.
2	Expt. 1 (B, C)	Study of sampling, quantization and encoding Project topic discussion
3	Expt.- 2	Time domain analysis of discrete time signals and systems
4	Project Proposal Presentation	Project proposal, discussion on overall outcome of the project, technical requirement, task distribution among the group members
5	Expt.- 3	Z-transform and its Application
6	Expt.- 4(I)	Frequency domain analysis of DT signals and systems: DTFS, DTFT
7	Project Design Presentation	• Present/demonstrate the technical progress of the project • Literature review, data collection, algorithm development, discussion on preliminary findings • Describe **contextual knowledge to assess** societal, health, safety, legal and cultural issues relevant to the project

8	Expt.- 4(II)	Frequency domain analysis of DT signals and systems: DFT, Application
9	Expt.- 5	Filter Design and Analysis and Application
10	Project Progress Presentation	• Present/demonstrate the technical progress of the project • Describe **<u>any necessary modification proposed to address</u>** public health and safety, cultural, societal, and environmental considerations related to the project • Evaluate the **<u>limitations of the technology</u>** used in the project • Present the draft project report and draft presentation
11	Quiz and Lab Test	• Quiz and Lab Test based on Experiment 1-5
12	Peer Assessment and Vivat	• Present/demonstrate the technical progress, **<u>team and individual contribution</u>** and **<u>ethical principles</u>** applied to the design and implementation of the project • Answer Technical Questions related to the project **<u>Individually</u>** and **<u>ethical principles</u>** applied to the design and implementation of the project • Complete the Peer Assessment Survey to **<u>ethically</u>** evaluate the contribution to the project **<u>individually</u>** and as a **<u>team</u>**
13	Project Demonstration	• Use multimedia and necessary documentation (user manual, video demonstration and project report) to **<u>clearly communicate the project</u>** • Participate in the project showcase and **<u>communicate</u>** the design to industry stakeholders

20.41.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design of a digital system performing a specific task with the help of various signal processing operations has to be completed by the end of this course following the detailed guideline. A project report has to be submitted as per the instructions and the project has to demonstrated and presented in the class for evaluation.

<u>Instructions on Lab Project</u>

Students are to demonstrate the culmination of Course Outcomes through a small project, that can be implemented in roughly 4-5 weeks. A Project Proposal needs to be prepared by the student group.

<u>Project Requirements:</u>

- Must have conflicting / wide range solution (say improving speed of a circuit might also increase power consumption) (P(a))
- Must be an open-ended real-life problem with no obvious solution (P(b)) (Complex Engineering problem)
- Project should address community needs, public health and safety, cultural, societal, and environmental considerations [CO3 (PO(c))]
- Project must involve real-life data and its necessary processing using software. Understand the limits of the used technology. [CO2(PO(e))]

<u>Evaluation</u>

- 10 Minutes recorded video presentation [with PPT slides] [CO6(P(j))]
- Peer Evaluation of Group Members [CO4(PO(h))], [CO5(PO(i))]
- Report in prescribed format with:
  a. Literature survey on concerned technology [CO4(PO(l))]
  b. Technical Details of the Solution [CO6(PO(j))]
  c. Teamwork and Individual Performance Report [CO5(PO(i))]
  d. Technological Limit Evaluation [CO2(PO(e))]
  e. Public health and safety, cultural, societal, and environmental considerations [CO3(PO(c))]
  f. Ethics declaration statement [CO4(PO(h))]

20.41.12 Distribution of Marks

Class Participation	10%
Lab Reports and Lab Performance	10%
Lab test/Viva/Quiz	40%
*Final Project	40%
Total	100%

*Assessment will be performed by internal and external evaluators with industry experience
* marks distribution of the project will be declared at the beginning of the semester

20.41.13 Textbook/References

- Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck, Discrete-Time Signal Processing, Prentice Hall, Pearson, 3rd Ed., 2009 (required).
- J.G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, Prentice-Hall, 5th Ed., 2022 (required).

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.42 Description of Course HUM 279

Section A: General Information

20.42.1 Course Title	Financial and Managerial Accounting
20.42.2 Type of Course	Compulsory, Theory, Non-departmental
20.42.3 Offered to	EEE
20.42.4 Pre-requisite Course(s)	None

Section B: Course Details

20.42.5 Course Content (As approved by the Academic Council)

Financial Accounting: Objectives and importance of accounting, Branches Accounting, Accounting as an information system, Computerized system & applications in accounting. Recording system: Double entry mechanism, Accounts and their classification, Accounting equation, Accounting cycle – Journal, Ledger, Trail balance. Preparation of Financial statements considering adjusting and closing entries. Accounting concepts & conventions. Financial statements analysis and interpretation: ratio analysis – Tests for profitability, liquidity, solvency and overall measure.
Cost and Management Accounting: Cost concepts & classification. Segregation of mixed cost. Overhead Cost: meaning & classification, allocation of overhead cost, Overhead recovery method. Job order costing: preparation of job cost sheet and quotation price. Inventory valuation: absorption costing & variable costing technique. Cost Volume-Profit analysis: meaning, breakeven analysis, contribution margin approach, sensitivity analysis. Short-term investment decisions: Relevant & differential cost analysis; Linear programming. Long-term investment decisions: Capital budgeting, various techniques of evaluation of capital investment, investment appraisal under uncertainty, risk management, capital rationing. Concept of working capital, need for working capital, management of cash, stock, debtors.

20.42.6 Course Objectives

- To make students conversant about the basic concepts of financial, cost and managerial accounting
- To demonstrate students different accounting methodologies, procedures, tools, and techniques
- To enable students preparing, analysing, and interpreting financial, cost and managerial information and taking appropriate decisions

20.42.7 Knowledge required

None

20.42.8 Course Outcomes

CO No.	CO Statement Upon successful completion of the course the students should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(ies)	Assessment Tool(s)
CO1	express the basic concepts of financial, cost and managerial accounting	PO(i)	C2; A1; P1, P2	Lectures, Power point presentation	Class tests; Assignments; Quiz; Final Exam
CO2	identify and classify different cost, managerial and financial information of any organization	PO (i), PO(j)	C1, C4; A2; P3	Lectures, Power point presentation	Class tests; Assignments; Quiz; Final Exam
CO3	illustrate financial information and analyse financial performance and position of an entity	PO(g), PO(h), PO(i), PO(l)	C3, C4; A3, A4; P4	Lectures, Power point presentation	Class tests; Assignments; Quiz; Final Exam
CO4	facilitate and justify different financial and investment decisions	PO(k), PO(l)	C5, C6; A4, A5	Lectures, Power point presentation	Class tests; Assignments; Quiz; Final Exam
CO5	demonstrate different costing and managerial methods and techniques	PO(i)	C3; A1, A2; P1, P2	Lectures, Power point presentation	Class tests; Assignments; Quiz; Final Exam
CO6	plan effective costing tools and techniques for cost benefit analysis	PO(k), PO(l)	C5; A3; P3, P4	Lectures, Power point presentation	Class tests; Assignments; Quiz; Final Exam
CO7	evaluate projects for benefit maximization.	PO(k), PO(l)	C6; A4; P5	Lectures, Power point presentation	Class tests; Assignments; Quiz; Final Exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.42.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.42.10 Lecture Plan

Lectures	Topics	Textbook	Corresponding CO(s)
1-3	Introduction to Financial Accounting; Introduction to Cost Accounting	Kieso(2015) , Garrison (2011)	CO1
4-6	Assumptions and Principles; Cost Concepts and Classification	Kieso (2015) , Garrison (2011)	CO1, CO2
7-9	Accounting as an information system, accounting cycle, accounting Equation; Cost Concepts and Classification, Overhead Costing	Kieso(2015) , Garrison (2011)	CO1, CO2

10-12	Transaction Analysis; Cost Sheet: Cost of Goods Manufactured, Cost of Goods Sold and Income Statement;	Kieso(2015) , Garrison (2011)	CO2, CO5
13-15	Recording Process; Job order costing	Kieso(2015) , Garrison (2011)	CO2, CO5
16-18	Recording Process; Job order costing	Kieso(2015) , Garrison (2011)	CO2, CO5
19-21	Adjusting the Accounts; Cost Volume Profit Analysis	Kieso(2015) , Garrison (2011)	CO2, CO5, CO6
22-24	Adjusting the Accounts; Inventory valuation: absorption costing and variable costing	Kieso(2015) , Garrison (2011)	CO2, CO5, CO6
25-27	Preparation of Financial Statements or Reports; Relevant costing	Kieso(2015) , Garrison (2011)	CO3, CO5
28-30	Preparation of Financial Statements or Reports; Relevant costing	Kieso(2015) , Garrison (2011)	CO3, CO5, CO6
31-33	Preparation of Financial Statements or Reports; Liner Programming	Kieso(2015) , Garrison (2011)	CO3, CO5, CO6
34-36	Financial Statements/ Report analyse and Interpretation; Concept of Working capital, management of cash, stock, debtors	Kieso(2015) , Garrison (2011)	CO3, CO4, CO5,
37-39	Financial Statements/ Report analyse and Interpretation; Concept of Working capital, management of cash, stock, debtors	Kieso(2015) , Garrison (2011)	CO3, CO4, CO5,
40-42	Long run planning and control, Capital Budgeting	Kieso(2015) , Garrison (2011)	CO6, CO7

20.42.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.42.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.42.13 Textbook/References

- Weygandt J. J., Kimmel D. P. & Kieso E.D. (2015), Accounting Principles, New Jersey, John Wiley & Sons.
- Garrison R., Moreen E., & Brewer P. (2011), Managerial Accounting , New York, McGraw-Hill/Irwin.
- Horngren C. T., Foster G., & Datar S. M. (2017), Cost Accounting: A Managerial Emphasis , New York, Pearson.
- https://open.umn.edu/opentextbooks/subjects/accounting
- https://www.e-booksdirectory.com/listing.php?category=376

20.43 Description of Course EEE 303

Section A: General Information

20.43.1 Course Title	Digital Electronics
20.43.2 Type of Course	Compulsory, Theory
20.43.3 Offered to	EEE
20.43.4 Pre-requisite Course(s)	None

Section B: Course Details

20.43.5 Course Content (As approved by the Academic Council)

Introduction to number systems and codes. Analysis and synthesis of digital logic circuits: Basic logic functions, Boolean algebra, combinational logic design, minimization of combinational logic. Introduction to Verilog Hardware Description Language programming and structural and behavioral design of digital systems using VerilogHDL, Verilog Timing analysis and test bench, MOSFET Digital circuits: NMOS inverter, CMOS inverter, CMOS logic circuits, Clocked CMOS logic circuits, transmission gates, sequential logic circuits, BJT digital circuits: ECL, TTL, STTL, BiCMOS, Memories: classification and architecture, RAM memory cells, Read only memory, data converters, Modular combinational circuit design: pass transistor, pass gates, multiplexer, demultiplexer and their implementation in CMOS, decoder, encoder, comparators, binary arithmetic elements and ALU design. Sequential circuits: latches, flip-flops timing analysis and power optimization of sequential circuits. Modular sequential logic circuit design: shift registers, counters and their applications. Asynchronous and synchronous sequential circuits. Dual Inline Packaged and Surface Mount Device (SMD) Integrated Circuits, Introduction to System Integration and Printed Circuit Board design, Design of a Simple-As-Possible (SAP) computer: SAP-1, selected concepts from SAP-2 (jump, call, return).

20.43.6 Course Objectives

- Introduce students concepts of number systems and digital electronics
- Enable students to analyze and design combinational and sequential logic circuits
- Give students a foundation on hardware description language based design (Verilog)

20.43.7 Knowledge required

Fundamental understanding of concepts of Electronics I and Electronics II

20.43.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Analyze** the structure and behaviour of different types of combinational and sequential digital logic circuits	PO(a)	C4	Lectures, Homework	Class test, Final exam
CO2	**identify** the requirements of physically implementing digital electronic circuits, different logic technologies and memory circuits using Verilog, FPGA and PCB design tools	PO(e)	C2	Lectures, Homework	Class test, Final exam
CO3	**design** combinational and sequential logic circuits with practical constraints using Verilog	PO(c)	C6	Lectures, Tutorials, Homework	Assignment Class test, Final exam

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.43.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓	✓			✓	✓	✓									

20.43.10 Lecture Plan

Week	**Topic**	
1	Introduction to Number Systems and codes. Introduction to Boolean algebra, Introduction to VerilogHDL	Harris 1.4, 5.3, 1.5
2-3	Analysis and synthesis of digital logic circuits: Basic logic function, combinational logic design, Universal logic gates, Minimization of combinational logic, k-map	Harris 2.1-2.9
4	Programming and structural and behavioral design of digital systems using VerilogHDL, Verilog Timing analysis and test bench. Verilog synthesis with combinational logic	Harris 4
5	ALU design (Adder, Subtractor, Comparator)	Harris 5.2- Floyd 6.1-6.3
	Winter Vacation	
6	Decoder, encoder, Multiplexer, demultiplexer	Floyd 6.4-6.9
7	MOSFET Digital circuits: NMOS inverter, CMOS inverter, CMOS logic circuits, Clocked CMOS logic circuits, transmission gates, Modular combinational circuit design: pass transistor, pass gates, and their implementation in CMOS	Harris 1.7-1.8
8	Sequential circuits: different types of latches, flip-flops	Harris 3.1-3.2 Floyd 7.1-7.3
9	Modular sequential logic circuit design: shift registers, counters, and application	Floyd 8.1-8.3, 9.2-9.7
10-11	Asynchronous and synchronous sequential circuits., Introducing State Machine Design, State Minimization, Mille and Moore type state machine, design of simple FSM using Verilog	Harris 3.4
12-13	Design of a Simple-As-Possible (SAP) computer: SAP-1, selected concepts from SAP-2 (jump, call, return)	Malvino Ch10,11 (partially)
13	Dual Inline Packaged and Surface Mount Device (SMD) Integrated Circuits, Introduction to System Integration and Printed Circuit Board design, Memories: classification and architecture, RAM memory cells, Read only memory	Lecture Slides Harris 5.5

20.43.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.43.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.43.13 Textbook/References

- [Harris] Digital Design and Computer Architecture ARM Edition
- [Floyd] Thomas L. Floyd, "Digital Fundamentals" 11th Edition, Pearson (2015)
- [Malvino] Albert P. Malvino, Jerald A. Brown - Digital Computer Electronics-McGraw-Hill (1993)
- [Brown] Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design" 3rd Edition, McGraw Hill (2014)
- [Mano] Morris Mano and Michael Ciletti, "Digital Design with an Introduction to VerilogHDL" 5th Edition, Pearson (2013)

20.44 Description of Course EEE 304

Section A: General Information

20.44.1 Course Title	Digital Electronics Laboratory
20.44.2 Type of Course	Compulsory, Sessional
20.44.3 Offered to	EEE
20.44.4 Pre-requisite Course(s)	None

Section B: Course Details

20.44.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 303. In the second part of the course, the students will perform design projects related to EEE 303 course contents to achieve specific program outcomes.

20.44.6 Course Objectives

- To perform experiments in relevance with the theoretical concepts of the course EEE 303: Digital Electronics
- To conduct design projects in order to achieve specific program outcomes described in the Course Outline

20.44.7 Knowledge required

Fundamental understanding of concepts of Electronics I and Electronics II

20.44.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Build** digital electronic circuits using 74 series gates in breadboards	PO(a)	P3	Labwork Labtest	Lab Performance Lab Report Lab Test Quiz
CO2	**Construct** Verilog programs and logic circuits for solving problems related to digital electronics, understanding the practical limitations	PO(e)	P5	Labwork Labtest	Lab Performance Lab Report Lab Test Quiz Project Report

CO3	**design** a digital system to solve a relevant problem with due considerations to public health and safety, societal, cultural and environmental consideration	PO(c)	P7	--	Project Demonstration, Project Report
CO4	**demonstrate** application of ethical principles and practices in the project, and **evaluate** peer team members ethically	PO(h)	A3	--	Peer evaluation, Report
CO5	**work** effectively as an individual and as a team member towards the successful completion of the project	PO(i)	P4	--	Viva, Peer evaluation
CO6	**report** effectively on the design done for CO3 with presentation, user-manual and detailed report	PO(j)	A3	--	Video Presentation Project Report

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.44.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
	✓	✓	✓	✓	✓	✓		✓	✓	✓					✓	✓	✓		

20.44.10 Lecture Plan

Week	Delivery	Topic
1	Lecture	Introduction to overview of the experiments and projects, Lab Policies, Grading; formation of Teams for design project and lab works
2	Experiment 01	Introduction To Basic Gates and Logic Simplification Techniques with discrete logic and Schematic Capture.
3	Experiment 02	Design, Simulation, and Implementation of Arithmatic Circuits using 74 series ICs and VerilogHDL
4	Project Proposal Presentation	Describe specific technical requirements to be attained during the project
5	Experiment 03	Design, Simulation, and Implementation of Combinational Circuits Decoder/Encoder/Multiplexer Circuit using 74 series ICs and VerilogHDL
	Experiment 04	Design, Simulation and Test of Sequential Circuits Using Verilog And Implementation In FPGA.
6	Project Design Presentation	• Present/demonstrate the technical progress of the project Describe **contextual knowledge to assess** societal, health, safety, legal and cultural issues relevant to the project
7	Experiment 05	Design, Simulation and Test of Finite State Machines Using Verilog And Implementation In FPGA.
8	Experiment 06	Design, Simulation and Test of an SAP computer Machines Using Verilog And Implementation In FPGA.
9	Project Progress Presentation	• Present/demonstrate the technical progress of the project

		Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project
10	Lab Test	Lab Test performed on Experiment 1-6
11	Project Progress Presentation	• Present/demonstrate the technical progress of the project • Evaluate the **limitations of the technology** used in the project Present the draft project report and draft presentation
12	Peer Assessment and Vivat	• Present/demonstrate the technical progress, **team and individual contribution** and **ethical principles** applied to the design and implementation of the project • Answer Technical Questions related to the project **Individually** and **ethical principles** applied to the design and implementation of the project Complete the Peer Assessment Survey to **ethically** evaluate the contribution to the project **individually** and as a **team**
13	Project Demonstration	• Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project** Participate in the project showcase and **communicate** the design to industry stakeholders

20.44.11 Assessment Strategy

Lab Project

Students are to demonstrate the culmination of Course Outcomes through a small project, that can be implemented in roughly 4 weeks. A Project Proposal needs to be prepared by the student group.

Project Requirements:

- Must have conflicting / wide range solution (say improving speed of a circuit might also increase power consumption) (P(a))
- Must be an open-ended problem with no obvious solution (P(b)) (Complex Engineering problem)
- Project should address public health and safety, cultural, societal, and environmental considerations [CO3 (PO(c))]
- Must be done with a **CPLD, FPGA or 74 series IC**s. Arduino or Microcontrollers are NOT allowed. Understand the limits of the used technology. [CO2(PO(e))]

Evaluation

- 10 Minutes recorded video presentation [with PPT slides] [CO6(P(j))]
- Peer Evaluation of Group Members [CO4(PO(h))], [CO5(PO(i))]
- Report in prescribed format with:
  - g. Technical Details of the Solution [CO6(PO(j))]
  - h. Teamwork and Individual Performance Report [CO5(PO(i))]
  - i. Technological Limit Evaluation [CO2(PO(e))]
  - j. public health and safety, cultural, societal, and environmental considerations [CO3(PO(c))]
  - k. ethics declaration statement [CO4(PO(h))]

20.44.12 Distribution of Marks

Class Participation	10%
Lab Reports and Lab Performance	10%
Lab test/Viva/Quiz	30%
*Final Project	50%
Total	100%

* Assessment will be performed by internal and external evaluators with industry experience

* marks distribution of the project will be declared at the beginning of the semester

20.44.13 Textbook/References

No Textbooks are required. Lab Manual will be provided by instructors

20.45 Description of Course EEE 313

Section A: General Information

20.45.1 Course Title	Solid State Devices
20.45.2 Type of Course	Compulsory, Theory
20.45.3 Offered to	EEE
20.45.4 Pre-requisite Course(s)	None

Section B: Course Details

20.45.5 Course Content (As approved by the Academic Council)

- *Semiconductors in equilibrium:* Energy bands, intrinsic and extrinsic semiconductors, Fermi levels, electron and hole concentrations, temperature dependence of carrier concentrations and invariance of Fermi level.
- *Carrier transport processes and excess carriers:* Drift and diffusion, generation and recombination of excess carriers, built-in-field, recombination-generation SRH formula, surface recombination, Einstein relations, continuity and diffusion equations for holes and electrons and quasi-Fermi level.
- *PN junction:* Basic structure, equilibrium conditions, contact potential, equilibrium Fermi level, space charge, non-equilibrium condition, forward and reverse bias, carrier injection, minority and majority carrier currents, transient and AC conditions, time variation of stored charge, reverse recovery transient and capacitance.
- *Bipolar Junction Transistor:* Basic principle of pnp and npn transistors, emitter efficiency, base transport factor and current gain, diffusion equation in the base, terminal currents, coupled-diode model and charge control analysis, Ebers-Moll model and circuit synthesis. BJT non-ideal effects; Hetero-junction transistors.
- *Metal-semiconductor junction:* Energy band diagram of metal semiconductor junctions, rectifying and ohmic contacts.
- *MOS structure:* MOS capacitor, energy band diagrams and flat band voltage, threshold voltage and control of threshold voltage, static CV characteristics, qualitative theory of MOSFET operation, body effect and current-voltage relationship of a MOSFET. Non-ideal characteristics of MOSFET: channel-length modulation and shortchannel effects in MOSFETs. MOS scaling
- *Introduction to Multigate FET architecture*: Double gate MOSFET, FinFET, Surrounding gate FET, high-K dielectric FETs.

20.45.6 Course Objectives

- To provide a physics-based understanding of the operation principle of some of the most commonly used solid-state electronic devices, such as p-n junction diodes, metal-semiconductor devices, bipolar-junction transistors (BJTs), metal oxide semiconductor field effect transistors (MOSFETs) and capacitors.
- To establish the theoretical foundation required for designing solid-state devices so that those can be applied for practical electronic applications

20.45.7 Knowledge required

Fundamental understanding of concepts of Electronic Circuits I course and Electrical Properties of Materials courses

20.45.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the physics-based knowledge to solve problems relevant the operation of solid-state devices	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam

2	**analyse** the operation of solid-state devices based on the underlying physics	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**design** solid-state electronic devices such that specified performance characteristics are attained	PO(c)	C6	Lectures, Discussions	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.45.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓		✓	✓	✓									

20.45.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Semiconductors in equilibrium:* Energy bands, intrinsic and extrinsic semiconductors, Fermi levels
2	4-6	*Semiconductors in equilibrium:* Electron and hole concentrations, temperature dependence of carrier concentrations and invariance of Fermi level.
3	7-9	*Carrier transport processes and excess carriers:* Drift and diffusion, generation and recombination of excess carriers, built-in-field, recombination-generation SRH formula
4	10-12	*Carrier transport processes and excess carriers:* Surface recombination, Einstein relations, continuity and diffusion equations for holes and electrons and quasi-Fermi level.
5	13-15	*p-n junction:* Basic structure, equilibrium conditions, contact potential, equilibrium Fermi level, space charge, non-equilibrium condition, forward and reverse bias
6	16-18	*p-n junction:* Carrier injection, minority and majority carrier currents, transient and AC conditions, time variation of stored charge, reverse recovery transient and capacitance.
7	19-21	*Bipolar Junction Transistor:* Basic principle of pnp and npn transistors, emitter efficiency, base transport factor and current gain, diffusion equation in the base, terminal currents,
8	20-24	*Bipolar Junction Transistor:* Coupled-diode model and charge control analysis, Ebers-Moll model and circuit synthesis. BJT non-ideal effects; Hetero-junction transistors.

Week	Lectures	Topic
9	25-27	*Metal-semiconductor junction:* Energy band diagram of metal semiconductor junctions, rectifying and ohmic contacts.
10	28-30	*MOS structure:* MOS capacitor, energy band diagrams and flat band voltage, threshold voltage and control of threshold voltage
11	31-33	*MOS structure:* Static CV characteristics, qualitative theory of MOSFET operation, body effect and current-voltage relationship of a MOSFET.
12	34-36	*MOS structure:* Non-ideal characteristics of MOSFET: channel-length modulation and shortchannel effects in MOSFETs. MOS scaling
13	37-39	*Introduction to Multigate FET architecture:* Double gate MOSFET, FinFET, Surrounding gate FET, high-K dielectric FETs.

20.45.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.45.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.45.13 Textbook/References

- Semiconductor Physics and Devices: Basic Principles by Donald A. Neaman (4th edition)
- Solid State Electronic Devices by Ben G. Streetman and Sanjay Kumar Banerjee
- Semiconductor Device Fundamentals by Rober F. Pierret
- Online resources or supplementary materials will be shared with the class on a need basis
  Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.46 Description of Course EEE 315

Section A: General Information

20.46.1 Course Title	Power Electronics
20.46.2 Type of Course	Compulsory, Theory
20.46.3 Offered to	EEE
20.46.4 Pre-requisite Course(s)	None

Section B: Course Details

20.46.5 Course Content (As approved by the Academic Council)

- Fundamental of power electronics, characteristics of static power semiconductor devices (BJT, MOSFET, IGBT, Thyristors).
- AC/DC power converters: uncontrolled rectifiers (single phase and three phase), controlled rectifiers (single phase and three phase), dual converter.
- AC/AC power converters: phase-controlled converters (single phase and three phase), AC switch, cycloconverter.

- DC/DC converters: choppers (step down and step up), switching regulators (buck, boost, buck-boost).
- DC/AC converters: types, single phase and three phase inverters.
- Various applications of converters.

20.46.6 Course Objectives

- To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics
- To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications
- To provide foundation for further study of power electronic circuits and systems

20.46.7 Knowledge required

Fundamental concepts of Electrical Circuits I and & II courses and Electronics I

20.46.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Relate** the components of power electronics and learn their key characteristics.	PO(a)	C1	Lectures, Discussions	Assignment, Class test, Final exam
2	**Describe** the basic operation, losses and efficiency of the power electronics converters.	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
3	**Explain** the operational issues and limitations of practical converters in industrial applications.	PO(b)	C2	Lectures, Discussions	Assignment, Class test, Final exam
4	**Apply** various methods to **analyse** power electronics circuits.	PO(b)	C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
5	**Appraise** the requirements of converters for specific applications.	PO(c)	C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.46.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓		✓	✓	✓									

20.46.10 Lecture Plan

Week	Lectures	Topic
1	1-3	**Introduction:** Fundamental of Power Electronics
2-3	4-9	Characteristics of static power semiconductor devices (Power Diode, BJT, Thyristors, MOSFET, IGBT)
4-5	10-15	**AC/DC Power Converters (Rectifier):** uncontrolled rectifiers (single phase and three phase), controlled rectifiers (single phase and three phase), dual converter.
6-7	16-21	**DC/DC Converters (Choppers):** Step down and step up, switching regulators (buck, boost, buck-boost)
8-9	22-27	**DC/AC Converters (Inverters):** Types, single phase and three phase inverters.
10	28-30	**AC/AC Power Converters:** Phase-controlled converters (single phase and three phase), AC switch, cycloconverter.
11-12	31-36	Various applications of converters: (FACTS, UPS, Power Supplies, DC/AC Drives, Renewable Energy, etc.)
13	37-39	Summary review.

20.46.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.46.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.46.13 Textbook/References

- Power Electronics Handbook, edited by M. H. Rashid, Butterworth-Heinemann, 2018 (4^{th} edition)
- Power Electronics Devices, Circuits and Applications, by M. H. Rashid, Pearson, 2014 (4^{th} edition)

  Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.47 Description of Course EEE 316

Section A: General Information

20.47.1 Course Title	Power Electronics Laboratory
20.47.2 Type of Course	Compulsory, Sessional
20.47.3 Offered to	EEE
20.47.4 Pre-requisite Course(s)	EEE 201 Electronic Circuits I, EEE 207 Electronic Circuits II

Section B: Course Details

20.47.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 315. In the second part of the course, the students will perform design projects related to EEE 315 course contents to achieve specific program outcomes.

20.47.6 Course Objectives

- Familiarization with power semiconductor switches, such as BJT, MOSFET, IGBT, SCR, and TRIAC.
- Getting acquainted with operating switching regulator IC (IC 3524) and learning its application for Switch Mode Power Supply (SMPS), such as controlling converters and inverters.
- Studying the operation of chopper-type DC-DC converters, such as Buck, Boost, Buck-boost, Ćuk, Sepic and Zeta converters, and observing their input-output relationships.
- Familiarization with single-phase inverter circuits, such as square wave-push-pull and half-bridge voltage source inverter.
- Designing stepper motor control circuit for full-stepping and half-stepping configurations.
- Operating single and three-phase uncontrolled rectifiers.
- Investigating modern power electronics problems and designing the solution to a specific problem via project.

20.47.7 Knowledge required

Basic Electronic Circuits and semiconductor devices.

20.47.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Understand** the principles of operation of semiconductor switches, switching regulator ICs and switch mode power supply.	PO(a)	C1, C2	Lectures, Laboratory Experiments	Report Writing, Viva Voce, Quiz
CO2	**Apply** switches and ICs to design and reproduce converters, inverters, rectifiers, and control circuits of stepper motors.	PO(a), PO(e)	C3, P3	Lectures, Laboratory Experiments	Sessional Performance
CO3	**Review** the scopes of improvement related to the power electronics field.	PO(b)	C4	Lectures, Laboratory Experiments	Sessional Performance
CO4	**Design** power electronic circuits with appropriate considerations to safety, cultural, societal, and environmental considerations.	PO(c)	C6	Project	Project presentation and discussion
CO5	**Assess** impact of power electronic equipment on Societal, Health, Safety, Legal and Cultural Issues.	PO(f)	C5	Interactive discussions	Report, demonstration, presentation
CO6	**Evaluate** sustainability and impact of the power electronic equipment in the Societal and Environmental Contexts.	PO(g)	C5	Interactive discussions	Report, demonstration, presentation
CO7	Implementation of **teamwork, project management, and effective communication skills.**	PO(i), PO(j), PO(k)	A1-4, P7	Project, Oral presentation	Project presentation and discussion, viva

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.47.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓		✓	

20.47.10 Lecture Plan

Week	**Mode**	**Topic**	**COs**
1	Experiment 01	Power semiconductor switches	CO1
2-3	Experiment 02	Switching Regulator IC for Control of DC-DC Converters and Single-Phase Square Wave Inverter.	CO1
4-5	Experiment 03	Switching DC-DC Converter Circuits: Buck, Boost, Buck-Boost, Cuk, Sepic, and Zeta Converters	CO2
6	Project Proposal	Discussion Of Project Proposals and Designs.	CO3, CO4
7	Experiment 04	Single Phase Inverter Circuits: Square Wave Push Pull and Half Bridge Voltage Source Inverters.	CO2
8	Experiment 05	Stepper motor control.	CO2
9	Experiment 06	Operation of Single and Three Phase Uncontrolled Rectifiers.	CO2
10-11	Office Hour	Project Discussion	CO5, CO6, CO7
12	Evaluation	Viva	
13	Exam	Final Quiz	
14	Presentation	Final Project Demonstration	CO7

20.47.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Lab Reports: Comprehensive report submitted by students based on their activity in the Lab.
- Sessional Performance: Continuous assessment of the activities and tasks performed according to the lab manual.
- Viva: An oral exam on the topics covered.
- Final Quiz: A Comprehensive Final examination will be held on the 13^{th} week.
- Final Project: Evaluation of the project submitted based on problem analysis, design ideas, innovation, performance, management, and environmental/societal impact analysis.

20.47.12 Distribution of Marks

Class Participation	05%
Lab Reports	10%
Sessional Performance	15%
Final Quiz	25%
Final Project	45%
Total	100%

20.47.13 Textbook/References
N/A

20.48 Description of Course EEE 317

Section A: General Information

20.48.1 Course Title	Control System I
20.48.2 Type of Course	Compulsory, Theory
20.48.3 Offered to	EEE
20.48.4 Pre-requisite Course(s)	None

Section B: Course Details

20.48.5 Course Content (As approved by the Academic Council)

- Review of Laplace transform, Initial and Final value theorems,
- Transfer Functions: Open-loop stability, Poles, Zeros, Time response, Transients, Steady-state, Block diagrams and signal flow diagram,
- Feedback principles: Open versus Closed-loop control, High gain control, Inversion;
- State variables: Signal flow diagram to state variables, transfer function to state variable and state variable to transfer function,
- Stability of closed-loop systems: Routh's method, Root locus,
- PID control: Structure, Design using root locus,
- Pole assignment: Sylvester's theorem, PI and PID synthesis using pole assignment,
- Frequency Response: Nyquist plot, Bode diagram, Nyquist stability theorem, Stability margins, Closed-loop sensitivity functions, Model errors, Robust stability,
- Controller design using frequency response: Proportional control, Lead-lag control, PID control, Digital control systems: introduction, sampled data systems, stability analysis in Zdomain.

20.48.6 Course Objectives

- To demonstrate fundamental concepts, algorithms, and applications of control system engineering.
- To enable students to apply control system to their own field of interests and to provide a basis for the study of more advanced topics and applications.

20.48.7 Knowledge required

Fundamental understanding of concepts of Continuous Signals and Linear Systems and Digital Signal Processing I courses.

20.48.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the control system principles to solve problems relevant to the time and frequency domain operations	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse** the control system engineering techniques applied to real-life applications based on the underlying principles	PO(b)	C4	Lectures, Discussions	Assignment, Presentation, Class test, Final exam

3	**design** control systems such that specified performance characteristics are attained	PO(c)	C5, C6	Lectures, Discussions	Assignment, Class test, Final exam

*Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.48.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓		✓	✓	✓									

20.48.10 Lecture Plan

Week	**Lectures**	**Topic**
1	1-3	Introduction to control system and its applications. Review of Laplace transform, Initial and Final value theorems
2	4-6	Transfer Functions: Open-loop stability, Poles, Zeros
3	7-9	Transfer Functions: Time response, Steady-state, Block diagrams and signal flow diagram
4	10-12	Feedback principles: Open versus Closed-loop control, High gain control, Inversion
5	13-15	State variables: Signal flow diagram to state variables, transfer function to state variable and state variable to transfer function
6	16-18	Stability of closed-loop systems: Routh's method, Root locus
7	19-21	PID control: Structure, Design using root locus,
8	20-24	Pole assignment: Sylvester's theorem, PI and PID synthesis using pole assignment
9	25-27	Frequency Response: Nyquist plot, Bode diagram
10	28-30	Frequency Response: Nyquist stability theorem, Stability margins
11	31-33	Frequency Response: Closed-loop sensitivity functions, Model errors, Robust stability
12	34-36	Controller design using frequency response: Proportional control, Lead-lag control, PID control
13	37-39	Digital control systems: introduction, sampled data systems, stability analysis in Z domain.

20.48.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.

- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.48.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.48.13 Textbook/References

- Norman S. Nise, Control Systems Engineering, John Wiley & Sons, 8th Ed., 2019 (required).
- Richard C. Dorf, and Robert H. Bishop, Modern Control Systems, Pearson, 12th Ed., 2022 (required).

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.49 Description of Course EEE 318

Section A: General Information

20.49.1 Course Title	Control System I Laboratory
20.49.2 Type of Course	Compulsory, Sessional
20.49.3 Offered to	EEE
20.49.4 Pre-requisite Course(s)	None

Section B: Course Details

20.49.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 317. In the second part of the course, the students will perform design projects related to EEE 317 course contents to achieve specific program outcomes.

20.49.6 Course Objectives

- To provide basic knowledge of modelling physical systems, principles of feedback control and limitations of real control devices.
- To provide hands-on training to design, implement and test control algorithms using Matlab and Simulink
- To provide hands-on training to accomplish a control system project that includes writing a proposal, purchasing parts for controllers and actuators, building the system, testing, demonstration, and writing a final report

20.49.7 Knowledge required

Fundamental understanding of concepts of continuous signals and linear systems

20.49.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** Matlab, Control System Toolbox, and Simulink to implement the basic concepts of control systems	PO(e)	P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests

2	**compare** the performance of theoretical model and implemented design in terms of transient and steady state response, stability analysis	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	**analyse** frequency response and root locus for different systems	PO(b)	C4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
4	**implement** a PID controller for the speed control of a DC motor	PO(a)	C2	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
5	**use** a programmable logic controller (PLC) to demonstrate the control of a conveyor system	PO(e)	P4, A3	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
6	**design** and **implement** the custom control system project	PO(c)	C6	Lectures, interactive discussions	Report, Project demonstration
7	**demonstrate** the control system project	PO(j)	A3	Interactive discussions	Project demonstration and Presentation
8	demonstrate effective **individual and team-working skills**	PO(i)	A3		Peer and instructor assessment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.49.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓		✓	

20.49.10 Lecture Plan

Week	Delivery	Topic	COs (POs)
1	Introduction	Introduction to control systems and its major applications Overview on lab experiments, projects, policies, grading; group formation	--
2	Expt. 1	a) Modelling of Physical Systems and Study of Their Open Loop Response b) PID Design Method for DC Motor Speed Control	CO1 (PO), CO4 (PO1)
3	Expt.- 2	Control of a conveyor system using Programmable Logic Controller (PLC)	CO5 (PO5)
4	Project Proposal Presentation	Project proposal, discussion on overall outcome of the project, technical requirement, task distribution among the group members	CO7 (PO10)

5	Expt.- 3	a) Equivalency of block diagram b) System stability and effect of pole location	CO1 (PO5)
6	Expt.- 4(a)	Effect of input waveform, loop gain, and system type upon steady-state errors	CO2 (PO4)
7	Project Design Presentation	• Present/demonstrate the technical progress of the project • Literature review, data collection, algorithm development, discussion on preliminary findings	CO6 (PO3)
8	Expt.- 4(b) + 5	4b) Effect of open-loop poles and zeros upon the shape of the root locus 5) PID Controller Design Using Root Locus Method	CO3 (PO2)
9	Expt.- 6	a) Sketching Bode Plot with MATLAB's sisotool b) Compensator Design via Frequency Response	CO3 (PO2)
10	Project Progress Presentation	• Present/demonstrate the technical progress of the project • Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project • Evaluate the **limitations of the technology** used in the project • Present the draft project report and draft presentation	CO7 (PO10)
11	Quiz and Lab Test	• Quiz and Lab Test based on Experiment 1-6	CO1-5 (PO1-5)
12	Peer Assessment and Viva	• Present/demonstrate the technical progress, **team and individual contribution** and **ethical principles** applied to the design and implementation of the project • Answer Technical Questions related to the project **Individually** and **ethical principles** applied to the design and implementation of the project • Complete the Peer Assessment Survey to **ethically** evaluate the contribution to the project **individually** and as a **team**	CO8 (PO9)
13	Project Demonstration	• Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project** • Participate in the project showcase and **communicate** the design to industry stakeholders	CO7 (PO10), CO8 (PO9)

20.49.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design and implementation of control systems has to be completed by the end of this course. A project report has to be submitted and the project has to demonstrated and presented in the class.

20.49.12 Distribution of Marks

To be decided by course instructor(s)

20.49.13 Textbook/References

- Control Systems Engineering, Norman S. Nise, 8th edition 2019, Wiley Inc.
- Modern Control Systems, Richard C. Dorf and Robert H. Bishop, 12th edition, Prentice Hall
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.50 Description of Course IPE 493

Section A: General Infromation

20.50.1 Course Title	Industrial Management
20.50.2 Type of Course	Compulsory, Theory, Non-departmental
20.50.3 Offered to	EEE
20.50.4 Pre-requisite Course(s)	None

Section B: Course Details

20.50.5 Course Content (As approved by the Academic Council)

Management functions and organization: Evolution, management function: organization, theory and structure, span of control, authority delegation, manpower planning. Personnel management: importance, need hierarchy, motivation, leadership, wage incentives, performance appraisal, participative management.

Operation management: production planning and control (PPC) functions, quantitative methods applied in production, quality management, location and layout planning safety and loss management.

Cost and financial management: elements of cost of products, cost analysis, investment analysis, benefit-cost analysis, risk analysis.

Management accounting: cost planning and control, budget, and budgetary control.

Marketing management: concepts, strategy, sales promotion, patent laws.

Technology management: management of innovation and changes, technology life cycle.

Case studies.

20.50.6 Course Objectives

- To understand and apply concepts and techniques associated with the primary functional management disciplines.
- Enhancing the ability of students to identify various operational strategies related to Demand, Procurement, Planning, Processes, and overall Supply Chain
- To understand and design analytical tools to apply cost and management accounting principles in practice.

20.50.7 Knowledge required

N/A

20.50.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Explain** the importance of leadership, strategic planning, and management control functions in an industrial organisation	PO(i)	C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
2	**Develop** relationship between operations and other business area in an organization	PO(c)	C5	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
3	**Apply** the operational knowledge to solve problems relevant to manufacturing and service sectors employee	PO(b)	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
4	**Analyse** performance of organizations quantitatively using basic accounting tools and techniques	PO(b)	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.50.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.50.10 Lecture Plan

Week	Lectures	Topic	COs
1	1-3	*Introduction to Management and Organization:* Classify managers and non-managerial employees, describe the functions, roles and skills of managers and how the manager's job is changing, and describe the characteristics of an organization.	CO4
2	4-6	*The Evaluation of Management Theory:* Explain various theories in the classical approach, describe the quantitative approach, discuss the development and uses of behavioural approach.	CO1
3	7-9	*Organizational Structure and Design:* Describe six key elements in organizational design, identify the contingency factors, compare and contrast traditional and contemporary organizational designs.	CO4
4	10-12	*Power and Distribution of Authority:* Empowerment, scalar principle in organization, process of delegation.	CO1
5	13-15	*Motivating Employees:* Early Theories of Motivation, Contemporary Theories of Motivation, Current Issues in Motivation.	CO4
6	16-18	*Managers as Leaders:* Early Leadership Theories, Contingency Theories of Leadership, Contemporary Views of Leadership, Leadership Issues in The Twenty-First Century.	CO4
7	19-21	*Facility Layout:* Necessity, Product Layout, Process Layout, Cellular Layout.	CO1
8	20-24	*Capacity Planning:* Importance, Defining and Measuring Capacity, Determinants, Capacity Requirements, Developing Alternatives.	CO3
9	25-27	*Forecasting:* Elements of good forecasting, Steps, Approaches to Forecasting, Time series Analysis, Associative techniques.	CO2
10	28-30	*Total Quality Control:* Cost of Poor Quality, Customer Satisfaction, Employee Involvement, Continuous Improvement, Improving Quality through TQM.	CO4
11	31-33	*Aggregate Planning*: Concept of Aggregation, Overview, Purpose and Scope, Demand and Capacity Options, Planning Techniques	CO2
12	34-36	*Capital Budgeting Decisions:* overview, payback method, net present value method, internal rate of return, expanding the net present value	CO2

Week	Lectures	Topic	COs
		method, uncertain cash flow, preference decisions, simple rate of return method, post audit of investment products	
13	37-39	*Flexible Budgets and Performance Analysis*: variance analysis cycle, flexible budgets, flexible budget variances, flexible budgets with multiple cost drivers, some common errors. popular organization-wide incentive plans., Explain how to use incentives to improve	CO3

20.50.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.50.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.50.13 Textbook/References

- Management by Stephen P. Robbins and Mary Coulter (10th Edition)
- Management by James A. F. Stoner, Daniel R. Gilbert, R. Edward Freeman (6th Edition)
- Chase, R. B., Aquilano, N. J. and Jacobs, F. R., "Production and Operations Management: Manufacturing and Services", McGraw-hill
- Managerial Accounting (15th Edition) by Ray H Garrison, Eric Noreen, Peter C. Brewer

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.51 Description of Course EEE 414

Section A: General Information

20.51.1 Course Title	Electrical Services Design
20.51.2 Type of Course	Compulsory, Sessional
20.51.3 Offered to	EEE
20.51.4 Pre-requisite Course(s)	None

Section B: Course Details

20.51.5 Course Content (As approved by the Academic Council)

Familiarization with CAD tools for building services design. Introduction to building regulations, codes and standards: BNBC, NFPA etc. Terminology and definitions: fuses, circuit breakers, distribution boxes, cables, bus-bars and conduits. Familiarization with symbols and legends used for electrical services design. Classification of wiring. Design for illumination and lighting: lux, lumen, choice of luminaries for various applications- domestic building, office building and industry. Wattage rating of common electrical equipment.

Designing electrical distribution system for low and high rise domestic, office and academic buildings, for multipurpose buildings. Size selection of conductors and breakers, bus-bar trunking (BBT) system for various applications. Single line diagram (SLD) of a typical 11kV/0.415kV, 500kVA sub-station and a 200kVA pole-mounted transformer.

Earthing requirements, various earthing methods. Earthing and lightning protection system design.

Familiarization with indoor and underground telephone and fiber optic cables, UTP and CAT5/6 data cables. Designing routing layout and installation of intercom, PABX, telephone, public address (PA) systems, cable TV distribution, LAN and wireless data systems for a building.

Safety regulations, design of security systems including CCTV, burglar alarm.

Concept of fire prevention and its importance. Fire detection (smoke, heat etc.) and alarm system (with voice evacuation), firefighting system (sprinkler system, hose).

Installation of air-conditioning, heating, lifts and elevators.

20.51.6 Course Objectives

- To realize the steps in the electrical services design and to recognize the symbols used in plans.
- To acquire knowledge about the wiring types and to learn the selection process of cables and CBs.
- To obtain a good understanding of various components of an electrical plan, including general and specialized loads, lighting systems, and distribution systems.
- To identify the standards and regulations that guide the electrical design processes for buildings.
- To learn the procedure of designing lightning and earthing systems.
- To interpret the estimation and wiring calculation for domestic/ commercial/ industrial buildings.

20.51.7 Knowledge required

Fundamental understanding of Electrical/Electronic Circuits and the basics of Power Systems.

20.51.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**understand** the electrical services design concepts.	PO(a)	C2	Lectures, Tutorials, Homework	Report. Assignment, Quiz
CO2	**apply** the electrical services design concepts to ensure quality of lights, selection of appropriate luminaries, quantity of fans and other electrical & safety appliances	PO(a)	C3	Lectures, Tutorials, Homework	Report, Assignment, Quiz
CO3	**review** electrical services design	PO(b)	C4	Lectures, Tutorials, Homework	Report, Assignment, Quiz
CO4	**design** electrical services for domestic/ commercial/ industrial building with appropriate considerations to safety, cultural, societal, and environmental considerations	PO(c)	C6	Lectures, interactive discussions	Report, demonstration
CO5	**Assess** impact of electrical services design on Societal, Health, Safety, Legal and Cultural Issues	PO(f)	C5	Interactive discussions	Report, demonstration, presentation
CO6	**Evaluate s**ustainability and impact of the designed electrical services project in the Societal and Environmental Contexts	PO(g)	C5	Interactive discussions	Report, demonstration, presentation

CO7	**Demonstrate** participation and leadership in designing electrical services	PO(i)	P7	Interactive discussions	Project logbook, Peer assessment, Viva, Presentation
CO8	**Communicate** effectively on electrical services design with presentation and detailed report	PO(f)	A2	Interactive discussions	Presentation, Design Report
CO9	**Demonstrate** project management and cost analysis for electrical services design	PO(k)	A3	Interactive discussions	Presentation, Project Report
CO10	**recognize** new tool and technology in electrical services design	PO(l)	P6	-	-

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.51.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓

20.51.10 Lecture Plan

Week	Lectures	Topic	COs
1	1	(i) Familiarization with CAD tools for building services design: Part 1. (ii) Introduction to building regulations, codes and standards: BNBC, NFPA etc. Terminology and definitions: fuses, circuit breakers, distribution boxes, cables, bus-bars and conduits. Familiarization with symbols and legends used for electrical services design.	CO1 CO2 CO3
2	2	(i) Familiarization with CAD tools for building services design: Part 2. (ii) Classification of wiring. Design for illumination and lighting: lux, lumen, choice of luminaries for various applications- domestic building, office building and industry. Wattage rating of common electrical equipment.	CO1 CO2 CO3
3	3	(i) Familiarization with CAD tools for building services design: Part 3. (ii) Designing electrical distribution system for low and high rise domestic, office and academic buildings, for multipurpose buildings. Size selection of conductors and breakers, bus-bar trunking (BBT) system for various applications. Single line diagram (SLD) of a typical 11kV/0.415kV, 500kVA sub-station and a 200kVA pole-mounted transformer.	CO1 CO2 CO3

Week	Lectures	Topic	COs
4	4	(i) Familiarization with CAD tools for building services design: Part 4. (ii) Earthing requirements, various earthing methods. Earthing and lightning protection system design.	CO1 CO2 CO3
5	5	(i) Familiarization with indoor and underground telephone and fiber optic cables, UTP and CAT5/6 data cables. Designing routing layout and installation of intercom, PABX, telephone, public address (PA) systems, cable TV distribution, LAN and wireless data systems for a building. (ii) Safety regulations, design of security systems including CCTV, burglar alarm.	CO1 CO2 CO3 CO4
6	6	(i) Concept of fire prevention and its importance. Fire detection (smoke, heat etc.) and alarm system (with voice evacuation), firefighting system (sprinkler system, hose). (ii) Installation of air-conditioning, heating, lifts and elevators.	CO1 CO2 CO3 CO4
7	7	• Describe specific technical requirements to be attained during the project • Describe **sustainability and impact of the work** in societal and environmental contexts • Arrangement of Seminar on Electrical Services Design	CO4
8	8	• Present/demonstrate the technical progress of the project • Describe **contextual knowledge to assess** societal, health, safety, legal and cultural issues relevant to the project • Arrangement of Seminar on Electrical Services Design	CO4 CO5 CO6 CO7
9	9	• Present/demonstrate the technical progress of the project. • Checking the design problem CAD plan layout submitted by the students. • Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project	CO4 CO5 CO6 CO7
10	10	• Present/demonstrate the technical progress of the project. • Checking the design problem CAD fittings and fixture layout submitted by the students. • Describe multidisciplinary aspects of the project • Describe how each team member has been effectively working (individually and as a member or leader) to attain the goals	CO4 CO5 CO6 CO7
11	11	• Present/demonstrate the technical progress of the project. • Checking the design problem CAD switchboard and other connection layout submitted by the students. • Checking the design problem CAD conduit layout submitted by the students.	CO4 CO5 CO6 CO7
12	12	**Practical demonstration of the project**: show evidence that specific technical requirements have been attained by the project	CO8 CO9
13	13	• Describe how **engineering management principles and economic decision-making applied to the project.** • Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project**	CO8 CO9

20.51.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Design Project: In light of the concepts covered under this course, each student has to submit a complete **Design** on a domestic/ commercial/ industrial building. In addition to this, each student also has to submit another **Design** on any one of the following topics:
    - Communication System Design for domestic/ commercial/ industrial building
    - Security System Design for domestic/ commercial/ industrial building
    - Fire Prevention and Detection System Design for domestic/ commercial/ industrial building
    - Fire Suppression System Design for domestic/ commercial/ industrial building
    - Electromechanical System Design for domestic/ commercial/ industrial building
    - Earthing and Lightning Protection System Design domestic/ commercial/ industrial building

20.51.12 Distribution of Marks

Class Participation	10%
Assignment	20%
*Design Project	50% <u>(marks distribution of the project will be declared at the beginning of the semester)</u>
Quiz	20%
Total	100%

*Assessment will be performed by internal and external evaluators with industry experience

20.51.13 Textbook/References

- Electrical Installation Designs by B. Atkinson, R. Lovegrove, G. Gundry; Wiley, 2013
- Handbook of Electrical Installation Practice edited by Geoffrey Stokes, Blackwell, 2003
- Electrical Installation Calculations by A. J. Watkins, C. Kitcher, Elsevier, 2009
- Bangladesh National Building Code (BNBC), 2006 (Draft 2015)
- Electrical Rate Schedules, (PWD, 2014 or later)
- BS7671:2008, (IEE Wiring Regulation 17th edition), IET, UK
- Bangladesh Electricity and Relevant Acts (1910-2015)
- Relevant Parts of NFPA

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.52 Description of Course EEE 415

Section A: General Information

20.52.1 Course Title	Microprocessor and Embedded Systems
20.52.2 Type of Course	Compulsory, Theory
20.52.3 Offered to	EEE
20.52.4 Pre-requisite Course(s)	None

Section B: Course Details

20.52.5 Course Content (As approved by the Academic Council)

Fundamentals of microprocessor and computer design, processor data path, architecture, microarchitecture, complexity, metrics, and benchmark; Instruction Set Architecture, introduction to CISC and RISC, Instruction-Level Parallelism, pipelining, pipelining hazards and data dependency, branch prediction, exceptions and limits, super-pipelined vs superscalar processing; Memory hierarchy and management, Direct Memory Access, Translation Lookaside Buffer; cache, cache policies, multi-level cache, cache performance; Multicore computing, message passing, shared memory, cache-coherence protocol, memory consistency, paging, Vector Processor, Graphics Processing Unit, IP Blocks, Single Instruction Multiple Data and SoC with microprocessors. Simple Arm/RISC-V based processor design with VerilogHDL

Introduction to embedded systems design, software concurrency and Realtime Operating Systems, Arm Cortex M / RISC-V microcontroller architecture, registers and I/O, memory map and instruction sets, endianness and image, Assembly language programming of Arm Cortex M / RISC-V based embedded microprocessors (jump, call-return, stack, push and pop, shift, rotate, logic instructions, port operations, serial communication and interfacing), system clock, exceptions and interrupt handling, timing analysis of interrupts, general purpose digital interfacing, analog interfacing, timers: PWM, real-time clock, serial communication, SPI, I2C, UART protocols, Embedded Systems for Internet of Things (IoT)

20.52.6 Course Objectives

- Illustrate the architecture, programming and operating principle of an ARM microprocessor
- Introduce Microprocessor design using VerilogHDL
- Interpret assembly language programs by executing ARM instruction sets

Introduce design of embedded systems and RTOS

20.52.7 Knowledge required

Fundamental understanding of concepts of EEE 303 Digital Electronics

20.52.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Explain** the architecture, instruction set, memory and input/output interface of a ARM Microprocessor	PO(a)	C4	Lectures, Handouts	Class test, Final exam
CO2	**Design** Embedded Systems solutions with relevant appropriate consideration	PO(e)	C3	Lectures, Handouts	Class test, Final exam
CO3	**Illustrate** emerging technologies and trends in Microprocessor design to recognize the need to always learn the state-of-the art	PO(l)	C2	--	Video Presentation, Report

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.52.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓		✓			✓	✓	✓									

20.52.10 Lecture Plan

Week	**Lectures**	**Topic**	**Textbook**	**COs**
1	1-3	Fundamentals of microprocessor and computer design, processor data path, architecture, microarchitecture, introduction to CISC and RISC, complexity, metrics, and benchmark	Patterson 1	
2	4-6	Assembly Language,	Harris 6.1-6.3	
3	7-9	Assembly Language Programming,	Harris 6.3	
4	10-12	Machine Language, Compiling, Assembling,	Harris 6.4	
5	13-15	Performance Analysis, Single Cycle and Multicycle Processor	Harris 7.1-7.4	
6	16-18	Pipelining, Hazards, Advanced Microarchitecture	Harris 7.5,7.7	
7	19-21	Memory Systems – Cache and Virtual Memory	Harris 8.2-8.4	
8	20-24	Introducing Embedded System Design, IoT, Arm Cortex m4	Lecture Slides	
9	25-27	General Purpose Input Output	Zhu 14	
10	28-30	General Purpose Timers	Zhu 15.1-15.3	
11	31-33	Interrupts	Zhu 11, 15.4	
12	34-36	ADC + DAC	Zhu 20,21	
13	37-39	Serial Communication	Zhu 22	

20.52.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- One Video presentation will be prepared by individual students
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.52.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.52.13 Textbook/References

- Sarah Harris, David Harris – "Digital Design and Computer Architecture, ARM Edition, Morgan Kaufmann (2015)
- David A. Patterson and John L. Hennessy, "Computer Organization and Design – The Hardware / Software Interface ARM edition" Morgan Kaufmann
- Yifeng Zhu "Embedded Systems with ARM Cortex-M Microcontrollers with Assembly Language and C"

20.53 Description of Course EEE 416

Section A: General Information

20.53.1 Course Title	Microprocessor and Embedded Systems Laboratory
20.53.2 Type of Course	Compulsory, Sessional
20.53.3 Offered to	EEE
20.53.4 Pre-requisite Course(s)	None

Section B: Course Details

20.53.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 415 course. In the second part of the course, the students will perform design projects related to EEE 415 course contents to achieve specific program outcomes.

20.53.6 Course Objectives

- To perform experiments in relevance with the theoretical concepts of the course EEE 415: Microprocessor and Embedded Systems
- To conduct design projects in order achieve specific program outcomes described in the Course Outline

20.53.7 Knowledge required

Fundamental understanding of concepts of EEE 303 - Digital Electronics

20.53.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**utilize** VerilogHDL, ARM assembly, C programming and microcontrollers boards for implementing and analyzing theoretical concepts at software and hardware levels	PO(e)	P4, C4	--	Lab Performance, Lab Test, Quiz, Viva, Project
CO2	**design** an embedded system with appropriate considerations to safety, cultural, societal, and environmental considerations	PO(c)	C6	--	Project Report and Hardware demonstration
CO3	**Assess** impact of embedded systems project design on Societal, Health, Safety, Legal and Cultural Issues	PO(f)	C5	--	Presentation and Report
CO4	**Evaluate** Sustainability the and Impact of the Designed embedded systems Project in the Societal and Environmental Contexts	PO(g)	C5	--	Presentation and Report
CO5	**Demonstrate** membership and leadership in designing embedded system related problem solving	PO(i)	P7	--	Project logbook , Peer assessment, Viva, Presentation
CO6	**Communicate** effectively on embedded system related design with presentation and detailed report	PO(j)	A2	--	Video Presentation, Design Report
CO7	**Demonstrate** project management and cost analysis for embedded system project	PO(k)	A3	--	Project Report and Presentation

* Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.53.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
				✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓	

20.53.10 Lecture Plan

Week	Mode	Topic	COs (POs)
1	Introduction	Introductory discussions and overview of the experiments and projects; formation of Teams for design project and lab works	-
2	Experiment 01	Running Assembly Code on the Arm Education Core and Armv8-A Instruction Encoding	CO1 (PO5)
3	Experiment 02	Single-Cycle Arm Processor: Instruction Fetch, Decode, Execution, Memory Access, and WriteBack	CO1 (PO5)
4	Experiment 03	Forwarding Paths, Stalls, and Control Hazards	CO1 (PO5)
5	Experiment 04	GPIO: Interfacing LED, Push-Button and Stepper Motor	CO1 (PO5)
6	Experiment 05	General Purpose Timers: PWM, Interrupts and Timer	CO1 (PO5)
7	Experiment 06	ADC, DAC and Serial Communication	CO1 (PO5)
8	Project Proposal Presentation	• Describe specific technical requirements to be attained during the project • Describe **<u>sustainability and impact of the work</u>** in societal and environmental contexts	CO4 (PO7)
9	Project Demonstration/ Presentation	• Present/demonstrate the technical progress of the project • Describe **<u>contextual knowledge to assess</u>** societal, health, safety, legal and cultural issues relevant to the project	CO2 (PO3) CO4 (PO6)
10	Project Demonstration/ Presentation	• Present/demonstrate the technical progress of the project • Describe **<u>any necessary modification proposed to address</u>** public health and safety, cultural, societal, and environmental considerations related to the project	CO2 (PO3) CO4 (PO6)
11	Project Demonstration/ Presentation	• Present/demonstrate the technical progress of the project • Describe multidisciplinary aspects of the project • Describe how each team member has been effectively working (individually and as a member or leader) to attain the goals	CO5 (PO9) CO7 (PO11)
12	Project Demonstration	• **<u>Practical demonstration of the project</u>**: show evidence that specific technical requirements have been attained by the project	CO2 (PO3
13	Final Presentation	• Describe how **<u>engineering management principles and economic decision-making applied to the project</u>**	CO7 (PO11)

		• Use multimedia and necessary documentation (user manual, video demonstration and project report) to **<u>clearly communicate the project</u>**	CO6 (PO10)

20.53.11 Assessment Strategy

As per distribution in the next section

20.53.12 Distribution of Marks

Class Participation 10%

Lab Reports 10%

Lab test/Viva/Quiz 30%

*Final Project <u>50% (marks distribution of the project will be declared at the beginning of the semester)</u>

Total 100%

*Assessment will be performed by internal and external evaluators with industry experience

20.53.13 Textbook/References

- Sarah Harris, David Harris – "Digital Design and Computer Architecture, ARM Edition, Morgan Kaufmann (2015)
- David A. Patterson and John L. Hennessy, "Computer Organization and Design – The Hardware / Software Interface ARM edition" Morgan Kaufmann
- Yifeng Zhu "Embedded Systems with ARM Cortex-M Microcontrollers with Assembly Language and C"

20.54 Description of Course EEE 439

Section A: General Information

20.54.1 Course Title	Communication Systems II
20.54.2 Type of Course	Compulsory, Theory
20.54.3 Offered to	EEE
20.54.4 Pre-requisite Course(s)	None

Section B: Course Details

20.54.5 Course Content (As approved by the Academic Council)

- *Baseband digital transmission:* Limitations, ISI, Pulse shaping, Nyquist Criterion I, Nyquist Criterion II, sinc pulse, Raised cosine pulse, Root raised cosine pulse, Spectral efficiency.
- *Digital modulations:* Signal space representation, basis functions, constellation diagrams, BASK, BFSK, BPSK, M-PSK, M-PAM, M-QAM, Demodulations, derivation of BER expressions.
- *Digital receivers:* Detection and demodulation techniques, Optimum receiver, matched filter and correlator demodulator, MAP and ML detector.
- *Error correction coding:* Significance, Types, Block codes, Generator matrix, Syndrome decoding, Convolutional code, Viterbi decoding.
- *Cellular Communications:* Cellular concept, cell shapes, Generic architecture, Cluster and frequency reuse, Network capacity, frequency reuse distance, Path-loss model, SIR, Techniques for increasing capacity, MAC techniques.
- *Satellite Communications:* Basics, Advantages and limitations, Applications, Frequency bands, Satellite services, Satellite orbits, LEO, MEO, GEO, HEO, HAP, Ground and space segment, transponder types and details, Design factors, Satellite link budget, MAC techniques.
- *Optical fiber communication system:* Principles, Light propagation, Fiber characteristics, Distortion and Dispersion, SM/MM and SI/GI fiber, Optical sources – LED & LASER, DWDM, Digital link design.
- *Computer Networks:* OSI & TCP/IP model, LAN/MAN/WAN/WLAN, CS & PS, Network topologies, Client-Server model, Firewall, IP address.

- *MAC techniques:* TDMA – narrowband & wideband, FDMA, CDMA, ALOHA.

20.54.6 Course Objectives

- To develop the foundation on digital communications technologies, such as digital transmission and reception, digital modulations and BER, pulse shaping techniques for ISI mitigation, optimum receiver design for AWGN channels and error correction coding.
- To deliver the basic concepts on various communication systems including optical fiber communication systems, satellite systems, cellular networks and computer networks.
- To acquire essential knowledge for designing and analyzing digital communication links.

20.54.7 Knowledge required

Fundamental understanding of telecommunication systems (EEE 309 Communication System I), and Linear Signal and Systems

20.54.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Explain** the concept of pulse shaping for ISI mitigation	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
CO2	**Derive** the expressions for SER/BER for performance evaluations of various constellations for digital modulations	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
CO3	**Explain** the concept of optimum receivers (demodulator and detector) for digital communication systems and **evaluate** the output of such receivers	PO(a)	C2, C5	Lectures, Discussions	Assignment, Class test, Final exam
CO4	**Explain** the coding and decoding techniques of error correction coding for digital communications	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
CO5	**Explain** the core concepts of cellular communications, satellite communications, optical fiber communications and computer networks	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.54.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓					✓	✓	✓									

20.54.10 Lecture Plan

Week	Lectures	Topic
1-2	1-6	*Baseband digital transmission:* Limitations, ISI, Pulse shaping, Nyquist Criterion I, Nyquist Criterion II, Sinc pulse, Raised cosine pulse, Root raised cosine pulse, Spectral efficiency.
3-4	7-12	*Digital modulations:* Signal space representation, basis functions, constellation diagrams, BASK, BFSK, BPSK, M-PSK, M-PAM, M-QAM, Demodulations, derivation of BER expressions.
5-6	13-17	*Digital receivers:* Detection and demodulation techniques, Optimum receiver, matched filter and correlator demodulator, MAP and ML detector.
6-7	18-21	*Error correction coding:* Significance, Types, Block codes, Generator matrix, Syndrome decoding, Convolutional code, Viterbi decoding.
8-9	22-26	*Cellular Communications:* Cellular concept, cell shapes, Generic architecture, Cluster and frequency reuse, Network capacity, frequency reuse distance, Path-loss model, SIR, Techniques for increasing capacity, MAC techniques.
9-10	27-30	*Satellite Communications:* Basics, Advantages and limitations, Applications, Frequency bands, Satellite services, Satellite orbits, LEO, MEO, GEO, HEO, HAP, Ground and space segment, transponder types and details, Design factors, Satellite link budget, MAC techniques.
11-12	31-34	*Optical fiber communication system:* Principles, Light propagation, Fiber characteristics, Distortion and Dispersion, SM/MM and SI/GI fiber, Optical sources – LED & LASER, DWDM, Digital link design.
12-13	35-39	*Computer Networks:* OSI & TCP/IP model, LAN/MAN/WAN/WLAN, CS & PS, Network topologies, Client-Server model, Firewall, IP address.
14	40-42	*MAC techniques:* TDMA – narrowband & wideband, FDMA, CDMA, ALOHA.

20.54.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of class tests, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.54.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.54.13 Textbook/References

- Communication systems, 4th edition by Simon Haykin

- Modern Analog and Digital Communications, 4th edition by B P Lathi and Zhi Ding,
- Wireless Communications and Networking, Jon W. Mark and Weihua Zhuang
- Lecture Slides
- Communication systems, 5th edition by Simon Haykin
- Satellite communications systems: Systems, Techniques and Technology – G. Maral and M. Bousquet
- Data Communications and Network - Forouzan, Behrouz
- Communication Systems Engineering - J. G. Proakis and M. Salehi

Besides going through relevant topics of the textbooks, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.55 Description of Course EEE 400

Section A: General Information

20.55.1 Course Title	Thesis
20.55.2 Type of Course	Compulsory
20.55.3 Offered to	EEE
20.55.4 Pre-requisite Course(s)	None

Section B: Course Details

20.55.5 Course Content (As approved by the Academic Council)

The students will perform experimental and/or theoretical investigation of a research topic related to electrical and electronic engineering discipline Students will attend seminars, review research literature and related contemporary aspects of the topic, identify problem, formulate a proposal to solve a specific problem related to the topic, interpret data, and analyze the problem using first principles of mathematical, natural or engineering sciences. Students will conduct investigations of the problem using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions. Students will understand and adhere to professional ethics and ethical principles of research. The students will be required to present a progress report at the end of the first semester, and present and submit a thesis at the end of the work.

20.55.6 Course Objectives

- To perform experimental and/or theoretical investigation of a research topic
- To review research literature and related contemporary aspects of the topic,
- To identify, formulate a proposal to solve a specific problem related to the topic, interpret data, and analyze the problem using first principles of mathematical, natural or engineering sciences
- To conduct investigations of the problem using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions
- To attend seminars and communicate effectively with oral presentation and detailed thesis report
- To understand and adhere to professional ethics and ethical principles of research

20.55.7 Knowledge required

Fundamental understanding of concepts of Electrical and Electronic Engineering, Different concepts, tools and software specific to the research problem

20.55.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Identify, **formulate**, research literature, interpret data, and	PO(b)		--	Thesis Book Thesis Presentation

	analyze problems using principles of mathematical, natural and engineering sciences				
CO2	**Investigate** of problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	PO(d)			Thesis Book Thesis Presentation
CO3	**Apply** knowledge of mathematics, science, and engineering to solve research problems	PO(a)			Thesis Book Thesis Presentation
CO4	**Demonstrate** adherence to professional ethics and ethical principles of research	PO(h)	C5	--	Thesis Book
CO5	**Communicate** effectively with oral presentation and detailed thesis report	PO(j)	A2	--	Thesis Book Thesis Presentation
CO6	**Research** contemporary aspects related to the problem and topic through detailed literature review and understand	PO(l)	P6	-	Thesis Book Thesis Presentation

*Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.55.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓				✓	✓	✓	✓				✓	✓	✓	✓		✓

20.55.10 Lecture Plan

- Weekly meeting and discussion with Supervisor regarding thesis
- Mandatory attendance of at least 3 technical/professional development seminars throughout the semester

Timeline	Milestone	CO	PO
Semester I: Before Midterm	Attend Seminar on Responsible and Ethical Conduct of Research	CO4	PO(h)
Semester I: Week after Midterm	Thesis proposal presentation	CO1	PO(b)
		CO6	PO(l)
Semester I: Final Week	Thesis progress report	CO2	PO(d)
		CO3	PO(a)

Semester II: Week after Midterm	• Thesis progress presentation • Thesis draft/outline submission	CO5	PO(j)
Semester II: After Final Exam	• Final Thesis presentation • Thesis book submission	CO1	PO(b)
		CO2	PO(d)
		CO3	PO(a)
		CO4	PO(h)
		CO5	PO(j)
		CO6	PO(l)

20.55.11 Assessment Strategy
As per BUGS decision

20.55.12 Distribution of Marks

As per BUGS decision

20.55.13 Textbook/References
N/A

Elective/Optional Courses

Interdisciplinary

20.56 Description of Course EEE 401

Section A: General Information

20.56.1 Course Title	Artificial Intelligence and Machine Learning
20.56.2 Type of Course	Optional, Theory
20.56.3 Offered to	EEE
20.56.4 Pre-requisite Course(s)	None

Section B: Course Details

20.56.5 Course Content (As approved by the Academic Council)

Introduction to Artificial Intelligence (AI): perception and intelligence, history; intelligent agent, algorithms in AI; ethical AI. Search and Optimization: graph search, uniform search, heuristic search, adversarial search, local search with constraint satisfaction. Logical Intelligence: logical agents, propositional logic, syntax, semantics, logical statement, first order logic. Introduction to Machine Learning: supervised, unsupervised, and reinforcement learning; components of the learning problem. Data mining and statistical pattern recognition. Learning models: linear classification and linear regression; extending linear models through nonlinear transforms, logistic regression, maximum likelihood, and gradient descent. Supervised learning: parametric/non-parametric algorithms; support vector machines; kernels. Unsupervised learning: clustering; dimensionality reduction; recommender systems. Deep learning and neural networks: multi-layer perceptron, backpropagation; convolutional networks; recurrent networks; attention mechanism and transformers. Best practices in machine learning: bias/variance theory; hyperparameter tuning. Case studies and applications.

20.56.6 Course Objectives

- To understand the fundamentals of AI and machine learning algorithms
- To be able to implement AI based algorithms to solve real-life problems
- To analyze various challenges in implementing machine learning and deep learning algorithms
- To design machine learning and deep learning algorithms to solve real life applications

20.56.7 Knowledge required

Computer programming and fundamental mathematics courses.

20.56.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**understand** the fundamentals of AI and machine learning algorithms with real life applications	PO(a), PO(b)	C2	Lectures, Discussions	Assignment, Class test, Final exam
2	**solve** real-life problems by designing suitable AI based algorithm	PO(d)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**analyze** real life challenges in implementing supervised and unsupervised learning algorithms	PO(b)	C4	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam
4	**apply** knowledge of regression analysis for effective recommendation	PO(d)	C3	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam
5	**design** deep learning models suitable for performing classification task	PO(c)	C6	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam
6	**experience** real life applications of ML and DL techniques	PO(b)	C4	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.56.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.56.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Introduction to AI and machine learning, history of AI. Intelligent agent: perception and intelligence, rational agent, reflex agent, problem solving agent. Ethical AI and biases.
2	4-6	Search and Optimization: graph search, tree search, uniform search strategies, breadth-first search, depth-first search, bidirectional search. Heuristic search: greedy search, A* search;
3	7-9	Local search with constraint satisfaction; adversarial search. Logical intelligence: logical agents, knowledge based agents.
4	10-12	Propositional logic, syntax, semantics, logical statement, truth table enumeration, first order logic.
5	13-15	Supervised, unsupervised and semi-supervised learning, reinforcement learning, components of the learning problem, relationship between in-sample and out-of-sample, K-nearest neighbour classifier.
6	16-18	Introduction with unsupervised learning, K-means clustering, hierarchical clustering, clustering evaluation. Dimensionality reduction, feature extraction, principle component analysis, feature selection: filtering and wrapper method.
7	19-21	Introduction to linear classification and linear regression, extending linear models through nonlinear transforms.
8	22-24	Parametric/non-parametric algorithms, support vector machines, introduction to kernels.
9	25-27	Introduction to logistic regression, maximum likelihood, gradient descent, recommender systems.
10	28-30	Introduction to data mining, statistical pattern recognition.
11	31-33	Multi-layer perceptron, backpropagation, convolutional neural networks.
12	34-36	Recurrent networks, attention mechanism, augmentation and transformers.
13	37-39	Bias/variance theory, hyperparameter tuning, segmentation architecture.
14	40-42	Case studies: application of learning algorithms to building smart robots (perception, control), computer vision, medical informatics, voice/audio, image database and other areas.

20.56.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.56.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.56.13 Textbook/References

- Artificial Intelligence: A Modern Approach by Stuart Jonathan Russell and Peter Norvig.
- Kernel Methods and Machine Learning by Sun Yan Kung
- Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville.
- Artificial Intelligence: A New synthesis by Nils J. Nilsson.
- Pattern Recognition and Machine Learning by Christopher M. Bishop.
- Introduction to Machine Learning, Second Edition by Ethem Alpaydin
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.57 Description of Course EEE 402

Section A: General Information

20.57.1 Course Title	Artificial Intelligence and Machine Learning Laboratory
20.57.2 Type of Course	Optional, Sessional
20.57.3 Offered to	EEE
20.57.4 Pre-requisite Course(s)	None

Section B: Course Details

20.57.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 401 course. In the second part of the course, the students will perform design projects related to EEE 401 course contents to achieve specific program outcomes.

20.57.6 Course Objectives

- To perform experiments in relevance with the theoretical concepts of the course EEE 401: Artificial Intelligence and Machine Learning
- To conduct design projects in order to achieve specific program outcomes described in the Course Outline

20.57.7 Knowledge required

Fundamental understanding of concepts of Mathematics courses.

20.57.8 Course Outcomes

CO No.	CO Statement	Correspon ding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**understand** different AI and machine learning algorithms and use programming software to implement them	PO(a), PO(e)	P1, P4	Lectures, Lab work, Lab test	Lab Performance Lab Report Lab Test Quiz
CO2	**solve** real-life problems by using AI and machine learning based algorithms	PO(d)	C4, C5	Lectures, Lab work Lab test	Lab Performance Lab Report Lab Test Quiz
CO3	**analyze** real life challenges in implementing supervised and unsupervised learning algorithms	PO(c)	C4, C5	Lectures, Lab work Lab test	Lab Performance Lab Report Lab Test Quiz
CO4	**demonstrate** application of ethical principles and practices in the project, and **evaluate** peer team members ethically	PO(h)	A3	--	Peer evaluation, Report

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO5	**work** effectively as an individual and as a team member towards the successful completion of the project	PO(i)	P4	--	Viva, Peer evaluation
CO6	**report** effectively on the design done for CO4 with presentation, user-manual and detailed report	PO(j)	A3	--	Video Presentation Project Report

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.57.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.57.10 Lecture Plan

Week	**Delivery**	**Topic**
1	Introduction and Expt.-1 (A)	Introduction to fundamentals of artificial intelligence and machine learning and their major applications Overview on lab experiments, projects, policies, grading; group formation Introduction to Python programming.
2	Expt. 1 (B, C)	Implementation of Python basic libraries Performing basic tasks using Python programming, data handling, statistical operations, data reshaping, filtering, merging, handling missing values. Implementation of basic AI operations
3	Expt.- 2	Implementation of Breadth First Search (BFS), A* Search and Tree Search algorithm Implement BFS in Tic-Tac-Toe problem or Robot Grid Movement
4	Project Proposal Presentation	Project proposal, discussion on overall outcome of the project, technical requirement, task distribution among the group members
5	Expt.- 3	Implementation of KNN and Kmeans algorithm and test with a dataset.
6	Expt.- 4	Implementation of linier regression and logistic regression algorithms and test with a dataset.
7	Project Design Presentation	• Present/demonstrate the technical progress of the project • Literature review, data collection, algorithm development, discussion on preliminary findings • Describe **contextual knowledge to assess** societal, health, safety, legal and cultural issues relevant to the project

8	Expt.- 5	Implementation of support vector machine algorithm and test with a dataset.
9	Expt.- 6	Implementation of simple convolutional neural network (CNN) architecture and test with a dataset.
10	Project Progress Presentation	• Present/demonstrate the technical progress of the project • Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project • Evaluate the **limitations of the technology** used in the project • Present the draft project report and draft presentation
11	Quiz and Lab Test	• Quiz and Lab Test based on Experiment 1-5
12	Peer Assessment and Vivat	• Present/demonstrate the technical progress, **team and individual contribution** and **ethical principles** applied to the design and implementation of the project • Answer Technical Questions related to the project **Individually** and **ethical principles** applied to the design and implementation of the project • Complete the Peer Assessment Survey to **ethically** evaluate the contribution to the project **individually** and as a **team**
13	Project Demonstration	• Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project** • Participate in the project showcase and **communicate** the design to industry stakeholders

20.57.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design of a digital system performing a specific task with the help of various signal processing operations has to be completed by the end of this course following the detailed guideline. A project report has to be submitted as per the instructions and the project has to demonstrated and presented in the class for evaluation.

Instructions on Lab Project

Students are to demonstrate the culmination of Course Outcomes through a small project, that can be implemented in roughly 5 weeks. A Project Proposal needs to be prepared by the student group.

Project Requirements:

- Must have conflicting / wide range solution (say improving speed of a circuit might also increase power consumption) (P(a))
- Must be an open-ended real-life problem with no obvious solution (P(b)) (Complex Engineering problem)
- Project should address community needs, public health and safety, cultural, societal, and environmental considerations [CO3 (PO(c))]
- Project must involve real-life data and its necessary processing using software. Understand the limits of the used technology. [CO2 (PO(e))]

Evaluation

- 10 Minutes recorded video presentation [with PPT slides] [CO6 (P(j))]
- Peer Evaluation of Group Members [CO4 (PO(h))], [CO5 (PO(i))]
- Report in prescribed format with:

l. Literature survey on concerned technology [CO4 (PO(l))]
m. Technical Details of the Solution [CO6 (PO(j))]
n. Teamwork and Individual Performance Report [CO5 (PO(i))]
o. Technological Limit Evaluation [CO2 (PO(e))]
p. Public health and safety, cultural, societal, and environmental considerations [CO3 (PO(c))]
q. Ethics declaration statement [CO4 (PO(h))]

20.57.12 Distribution of Marks

Class Participation	10%
Lab Reports and Lab Performance	10%
Lab test/Viva/Quiz	40%
*Final Project	40%
Total	100%

*Assessment will be performed by internal and external evaluators with industry experience
* marks distribution of the project will be declared at the beginning of the semester

20.57.13 Textbook/References

- Artificial Intelligence: A Modern Approach by Stuart Jonathan Russell and Peter Norvig.
- Kernel Methods and Machine Learning by Sun Yan Kung
- Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville.

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the lab manuals, class lectures and discussions regularly for a thorough understanding of the topics.

20.58 Description of Course EEE 403

Section A: General Information

20.58.1 Course Title	Robotics and Automation
20.58.2 Type of Course	Optional, Theory
20.58.3 Offered to	EEE
20.58.4 Pre-requisite Course(s)	None

Section B: Course Details

20.58.5 Course Content (As approved by the Academic Council)

History of robotics, elements of robotic systems, mathematics of manipulators, classification of robots. Kinematic modelling, forward and inverse dynamics. Robot path planning, navigation, and localization. Various types of sensor operations for robot sensing. Electrical and mechanical actuators. Robot vision. Linear and non-linear controls, adaptive controls. Microcontroller and embedded systems for robotics, robot programming. AI and machine learning for robot operations. Robot applications for industry 4.0: underwater robotics, unmanned aerial vehicle (UAV), humanoid robots.

20.58.6 Course Objectives

- Introduce to robotics and automation including robot classification, design and selection, analysis and applications in industry
- Impart knowledge on the kinematics and dynamic of robot manipulators
- Educate on various robot localization and path planning/navigation techniques
- Explain the essentials of feedback control to implement sensor/motor control loops
- Elucidate robot automation using sensors, actuators, image analysis, and AI
- Help design, plan, and build interdependent autonomous machines using robotics parts
- Enable to design intelligent practical robotics systems

20.58.7 Knowledge required

Programming in C, MATLAB, and Python, and understanding of Linear Algebra concepts (vector and matrix operations).

20.58.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**understand** the relationship between mechanical structures of industrial robots and their operational workspace characteristics.	PO(a), PO(b)	C2	Lectures, Discussions, Problem-solving	Assignment/Short quiz, Final exam
2	**solve** kinematic and dynamic modelling problems of simple robot manipulators.	PO(c)	C4	Lectures, Discussions, Problem-solving	Assignment/Short quiz, Final exam
3	**explain** localization and navigation tasks for mobile robots.	PO(b)	C2	Lectures, Discussions, Problem-solving	Assignment/Short quiz, Final exam
4	**apply** knowledge of robot controllers and autonomous systems.	PO(b)	C3	Lectures, Discussions, Problem-solving	Assignment/Short quiz, Final exam
5	**design** simple robots	PO(c)	C6	Lectures, Discussions, Problem-solving	Assignment/Short quiz, Final exam

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.58.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.58.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Brief history of robotics, components of a robot, classification of robots. Kinematics systems; definition of mechanisms and manipulators, robot degrees of freedom. Robot joints, robot coordinates, robot reference frames, programming modes, robot workspace, robot languages, robot applications.
2	4-6	Kinematic modelling: translation and rotation representation, coordinate transformation, DH parameters, forward and inverse kinematics, solvability, solution methods, closed form solution, Jacobian, singularity, static forces in manipulators.

Week	Lectures	Topic
3	7-9	Dynamic Modelling: Forward and inverse dynamics, equations of motion using Euler-Lagrange formulation, Newton Euler.
4	10-12	Robot path planning and localization: position and orientation planning, Trajectory planning, interpolated motion, map generation, road map path planning, obstacle avoidance, robot localization methods, landmark based navigation, multi-agent systems.
5	13-15	Sensors: non-visual sensors and algorithms, contact and proximity, position, velocity, force, tactile etc. Internal sensors, infrared sensors, sonar, radar, laser range finders. Introduction to cameras, camera calibration, geometry of image formation.
6	16-18	Actuators: Electrical- DC motors, servo motors, stepper motors, motor control. Mechanical- hydraulic and pneumatic; transmission- gears, timing belts and bearings. Parameters for selection of actuators.
7	19-21	Image processing and analysis with robot vision systems.
8	22-24	Feedback control in robots, linear control schemes, PID control scheme, force and accelerator control, disturbance and dynamic effects, stability analysis.
9	25-27	Non-linear and adaptive control.
10	28-30	Embedded systems: microcontroller architecture and integration with sensors, actuators, components, robot operating system (ROS), introduction to industrial robot programming.
11	31-33	AI and machine learning (ML), unsupervised learning, clustering, supervised learning, support vector machine, deep learning, ML based robot operations.
12	34-36	Different aspects of mobile robotics, underwater robotics- types and classification, environmental factors, hydraulics, underwater manipulators, sensing/surveillance, communications, command/ control, applications.
13	37-39	Different aspects of assistive robotics. unmanned aerial vehicle (UAV)- types and characteristics, propulsion, internal combustion, on-board flight control, payloads, sensing/surveillance, communications, command/ control, ground control stations.
14	40-42	Humanoids: Wheeled and legged, legged locomotion and balance, arm movement, gaze, face and auditory orientation control, motion learning from demonstration, interaction, safety and robustness. Different aspects of social robotics and robot safety.

20.58.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.58.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.58.13 Textbook/References

- Robotics, Vision & Control, Peter Corke, Springer Verlag (2011)
- Introduction to Robotics, John J. Craig, Addison-Wesley Publishing, Inc., 1989

- Introduction to Robotics, P. J. McKerrow, ISBN: 0201182408
- Modern Robotics: Mechanics, Planning, and Control, Kevin Lynch and Frank Park, Cambridge University Press, 2017. ISBN: 9781107156302
- Introduction to Robotics: Analysis, Systems, Applications, Saeed Niku, Prentice Hall, 2002
- Introduction to Robotics, Saeed B. Niku, 2e, Wiley, 2011
- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.59 Description of Course EEE 404

Section A: General Information

20.59.1 Course Title	Robotics and Automation Laboratory
20.59.2 Type of Course	Optional, Sessional
20.59.3 Offered to	EEE
20.59.4 Pre-requisite Course(s)	None

Section B: Course Details

20.59.5 Course Content (As approved by the Academic Council)

The sessional course will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 403 course. In the second part of the course, the students will perform design projects related to EEE 403 course contents to achieve specific program outcomes.

20.59.6 Course Objectives

- To perform experiments in relevance with the theoretical concepts of the course EEE 403
- To conduct design projects in order to achieve specific program outcomes described in the Course Outline

20.59.7 Knowledge required

Computer programming and fundamental mathematical courses, some major EEE courses, such as Electronics, Digital Logic Design, Energy Conversion, Digital Signal Processing, Communication Theory, Control System I, and Microprocessor and Embedded System.

20.59.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**understand** different **kinematics** algorithms and **use** programming software to implement them	PO(a), PO(e)	P1, P4	Lectures, Lab work, Lab test	Lab Performance Lab Report Lab Test Quiz
CO2	**experiment** using modern equipment and tools to verify theoretical knowledge and **compare** theoretical and experimental results	PO(d), PO(e)	C3, C5	Lectures, Lab work Lab test	Lab Performance Lab Report Lab Test Quiz
CO3	**design** various types of robots to perform specific tasks with due considerations to public health and safety, societal, cultural, and environmental consideration	PO(c), PO(l)	P7	Lectures, Lab work, Lab test	Lab Performance Lab Report Lab Test Quiz

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO4	**demonstrate** application of ethical principles and practices in the project, and **evaluate** peer team members ethically	PO(h)	A3	--	Peer evaluation, Report
CO5	**work** effectively as an individual and as a team member towards the successful completion of the project	PO(i)	P4	--	Viva, Peer evaluation
CO6	**report** effectively on the design done for CO4 with presentation, user-manual and detailed report	PO(j)	A3	--	Video Presentation Project Report

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.59.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.59.10 Lecture Plan

Week	Delivery	Topic
1	Introduction	Introduction to Robotics and its major applications Overview on lab experiments, projects, policies, grading; group formation Introduction to ROS
2	Expt- 1	Robot kinematics and robot design using ROS
3	Expt.- 2	Design and implementation of a line follower manual robot with obstacle avoidance
4	Project Proposal Presentation	Project proposal, discussion on overall outcome of the project, technical requirement, task distribution among the group members
5	Expt.- 3	Design and implementation of a map generating autonomous robot
6	Expt.- 4	Design and implementation of an UAV and testing its characteristics
7	Project Design Presentation	• Present/demonstrate the technical progress of the project • Literature review, data collection, algorithm development, discussion on preliminary findings • Describe **contextual knowledge to assess** societal, health, safety, legal and cultural issues relevant to the project
8	Expt.- 5	Multi-degree of freedom robotic arm manipulator
9	Expt.- 6	Human machine interaction and specific task completion by Humanoids
10	Project Progress Presentation	• Present/demonstrate the technical progress of the project • Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project • Evaluate the **limitations of the technology** used in the project

		• Present the draft project report and draft presentation
11	Quiz and Lab Test	• Quiz and Lab Test based on Experiment 1-6
12	Peer Assessment and Viva	• Present/demonstrate the technical progress, **team and individual contribution** and **ethical principles** applied to the design and implementation of the project • Answer Technical Questions related to the project **Individually** and **ethical principles** applied to the design and implementation of the project • Complete the Peer Assessment Survey to **ethically** evaluate the contribution to the project **individually** and as a **team**
13	Project Demonstration	• Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project** • Participate in the project showcase and **communicate** the design to industry stakeholders

20.59.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.

A group project on the design of a digital system performing a specific task with the help of various signal processing operations has to be completed by the end of this course following the detailed guideline. A project report has to be submitted as per the instructions and the project has to demonstrated and presented in the class for evaluation.

Instructions on Lab Project

Students are to demonstrate the culmination of Course Outcomes through a small project, that can be implemented in roughly 5 weeks. A Project Proposal needs to be prepared by the student group.

Project Requirements:

- Must have conflicting / wide range solution (say improving speed of a circuit might also increase power consumption) (P(a))
- Must be an open-ended real-life problem with no obvious solution (P(b)) (Complex Engineering problem)
- Project should address community needs, public health and safety, cultural, societal, and environmental considerations [CO3 (PO(c))]
- Project must involve real-life data and its necessary processing using software. Understand the limits of the used technology. [CO2 (PO(e))]

Evaluation

- 10 Minutes recorded video presentation [with PPT slides] [CO6 (P(j))]
- Peer Evaluation of Group Members [CO4 (PO(h))], [CO5 (PO(i))]
- Report in prescribed format with:
  - r. Literature survey on concerned technology [CO4 (PO(l))]
  - s. Technical Details of the Solution [CO6 (PO(j))]
  - t. Teamwork and Individual Performance Report [CO5 (PO(i))]
  - u. Technological Limit Evaluation [CO2 (PO(e))]
  - v. Public health and safety, cultural, societal, and environmental considerations [CO3 (PO(c))]
  - w. Ethics declaration statement [CO4 (PO(h))]

20.59.12 Distribution of Marks

Class Participation	10%
Lab Reports and Lab Performance	10%
Lab test/Viva/Quiz	40%
*Final Project	40%
Total	100%

* Assessment will be performed by internal and external evaluators with industry experience

* Marks distribution of the project will be declared at the beginning of the semester

20.59.13 Textbook/References
No textbooks are required. Lab Manual will be provided by instructors.

20.60 Description of Course EEE 421

Section A: General Information

20.60.1 Course Title	Control System II
20.60.2 Type of Course	Optional, Theory
20.60.3 Offered to	EEE
20.60.4 Pre-requisite Course(s)	None

Section B: Course Details

20.60.5 Course Content (As approved by the Academic Council)

Compensation using pole placement technique. State equations of digital systems with sample and hold, state equation of digital systems, digital simulation and approximation. Solution of discrete state equations: by z transform, state equation and transfer function, state diagrams, state plane analysis. Stability of digital control systems. Digital simulation and digital redesign. Time domain analysis. Frequency domain analysis. Controllability and observability. Optimal linear digital regulator design. Digital state observer. Microprocessor control. Introduction to neural network and fuzzy control, adaptive control. Hα Control, nonlinear control. Elements of System Identification, Introduction to Multivariable control (decoupling, interaction, analysis &design), Introduction to optimal control and estimation, Case studies.

20.60.6 Course Objectives

- To develop an in-depth understanding of advanced control systems and strategies, including state-space methods, system identification, multi-variable, nonlinear, and digital control.
- Design, simulate, and evaluate control systems using pole placement technique, adaptive, learning, fuzzy, and optimal control.
- To develop the ability to conduct and communicate research involving control system

20.60.7 Knowledge required

Fundamental understanding of concepts of Control System I, and Continuous Signals and Linear Systems.

20.60.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**explain** advanced control system concepts such as state space representation, controllability, observability, digital control, system identification, multivariate system	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse control systems** using time-domain and frequency-domain analysis	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	define the specifications of a control system to ensure adequate performance	PO(b)	C3	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam

4	evaluate the stability, performance and robustness of a control system	PO(d)	C5	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam
5	develop several control solutions, formulates the trade-offs, chooses the options	PO(c)	C6	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam
6	Justify methodological choices and validate the results with respect to the specifications	PO(c)	C6	Lectures, Discussion, Demonstration	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.60.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.60.10 Lecture Plan

Week	**Lectures**	**Topic**
1	1-3	State space methods for control and estimation, state equation and transfer function, state diagrams, state plane analysis
2	4-6	Analog vs digital control, modelling of sampled-data systems by z-transform
3	7-9	State equation of digital systems, solution of discrete state equations
4	10-12	Stability of digital control systems, digital simulation and digital redesign.
5	13-15	Time domain analysis, frequency domain analysis, controllability and observability, digital state observer.
6	16-18	Design considerations for robust control, compensation using pole placement technique
7	19-21	Optimal feedback control and optimal estimation
8	20-24	Adaptive control
9	25-27	Microprocessor control
10	28-30	Neural network and fuzzy control
11	31-33	Hα Control, Nonlinear control
12	34-36	System Identification, multivariable control
13	37-39	Case studies: industrial control (SCADA), intelligent control, flight control, robotic control

20.60.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.60.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.60.13 Textbook/References

- Modern Control Engineering: K. Ogata.
- Control System Design: G. Goodwin, S. Grabe and M. Salgado
- Multivariable Feedback Control: S. Skogestad and I. Postlethwaite
- Robust and Optimal Control: K. Zhou, J. Doyle and K. Glover
- Applied Nonlinear Control: J.-J. Slotine and W. Li
- Digital Control System Analysis and Design: C. L. Phillips and H. T. Nagle
- W. S. Levine. The Control Handbook: Control System Advanced Methods. The Electrical Engineering Handbook Series. CRC Press, Boca Raton, FL, second edition, 2011.
- W. S. Levine. The Control Handbook: Control System Applications. The Electrical Engineering Handbook Series. CRC Press, Boca Raton, FL, second edition, 2011.
- W. S. Levine. The Control Handbook: Control System Fundamentals. The Electrical Engineering Hand- book Series. CRC Press, Boca Raton, FL, second edition, 2011.
- Z. Bubnicki. Modern Control Theory. Springer-Verlag Berlin Heidelberg, Heidelberg, Germany, 2005.
- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.61 Description of Course EEE 422

Section A: General Information

20.61.1 Course Title	Control System II Laboratory
20.61.2 Type of Course	Optional, Sessional
20.61.3 Offered to	EEE
20.61.4 Pre-requisite Course(s)	None

Section B: Course Details

20.61.5 Course Content (As approved by the Academic Council)

The sessional courses will be conducted in two parts. In the first part of the sessional course, the students will perform experiments in relevance with the EEE 421. In the second part of the course, the students will perform design projects to achieve specific program outcomes.

20.61.6 Course Objectives

- To perform experiments in relevance with the theoretical concepts of the course EEE 421: Control System II
- To conduct design projects in order achieve specific program outcomes described in the Course Outline

20.61.7 Knowledge required

Fundamental understanding of concepts of Control System I and its lab (EEE 317 and EEE 318).

20.61.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**understand** different control system algorithms and **use** programming software to implement them	PO(a), PO(e)	P1, P4	Lectures, Lab work, Lab test	Lab Performance Lab Report Lab Test Quiz
CO2	**experiment** using modern equipment and tools to verify theoretical knowledge and **compare** theoretical and experimental results	PO(d), PO(e)	C3, C5	Lectures, Lab work Lab test	Lab Performance Lab Report Lab Test Quiz
CO3	**design** a digital system to solve a relevant problem with due considerations to public health and safety, societal, cultural and environmental consideration	PO(c), PO(l)	P7	--	Project Demonstration, Project Report
CO4	**demonstrate** application of ethical principles and practices in the project, and **evaluate** peer team members ethically	PO(h)	A3	--	Peer evaluation, Report
CO5	**work** effectively as an individual and as a team member towards the successful completion of the project	PO(i)	P4	--	Viva, Peer evaluation
CO6	**report** effectively on the design done for CO4 with presentation, user-manual and detailed report	PO(j)	A3	--	Video Presentation Project Report

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.61.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.61.10 Lecture Plan

Week	Delivery	Topic
1	Introduction	Introduction to digital signal processing and its major applications Overview on lab experiments, projects, policies, grading; group formation Matlab and Simulink based system representation and state space representation
2	Expt- 1	Digital servo closed loop speed and position control: transient characteristics and disturbances (a) Motor Shaft Angular Position Control (b) Linear Position Sensing and Control with Error Analysis Project topic discussion

3	Expt.- 2	System identification using open-loop and closed-loop response (a) System modeling and identification (b) Effect of noise in system identification
4	Project Proposal Presentation	Project proposal, discussion on overall outcome of the project, technical requirement, task distribution among the group members
5	Expt.- 3	Stability analysis of the pendulum: (a) Crane control system: to move the cart into a desired position with an oscillation of the load (pendulum arms) (b) Inverted pendulum: stabilizing the inverted pendulums in an upright position (self-erecting control problem)
6	Expt.- 4	Controller design and stability analysis (a) Optimal state controller design (b) Design of neural network and fuzzy logic controller (c) Design of adaptive control.
7	Project Design Presentation	• Present/demonstrate the technical progress of the project • Literature review, data collection, algorithm development, discussion on preliminary findings • Describe **contextual knowledge to assess** societal, health, safety, legal and cultural issues relevant to the project
8	Expt.- 5	Programmable Logic Controller Based Design (a) Multivariable control using PLC (b) PLC Application Modules: Traffic Light Control/Conveyor Control/Elevator Control
9	Expt.- 6	Nonlinear Control System Design and Simulation (a) characteristics of nonlinear system design via a defined Lyapunov function. (b) design a state feedback controller and analyze nonlinear dynamic system **(c)** H^{α} Control
10	Project Progress Presentation	• Present/demonstrate the technical progress of the project • Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project • Evaluate the **limitations of the technology** used in the project • Present the draft project report and draft presentation
11	Quiz and Lab Test	• Quiz and Lab Test based on Experiment 1-6
12	Peer Assessment and Vivat	• Present/demonstrate the technical progress, **team and individual contribution** and **ethical principles** applied to the design and implementation of the project • Answer Technical Questions related to the project **Individually** and **ethical principles** applied to the design and implementation of the project • Complete the Peer Assessment Survey to **ethically** evaluate the contribution to the project **individually** and as a **team**
13	Project Demonstration	• Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project** • Participate in the project showcase and **communicate** the design to industry stakeholders

20.61.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design of a digital system performing a specific task with the help of various signal processing operations has to be completed by the end of this course following the detailed guideline. A project report has to be submitted as per the instructions and the project has to demonstrated and presented in the class for evaluation.

Instructions on Lab Project

Students are to demonstrate the culmination of Course Outcomes through a small project, that can be implemented in roughly 4-5 weeks. A Project Proposal needs to be prepared by the student group.

Project Requirements:

- Must have conflicting / wide range solution (say improving speed of a circuit might also increase power consumption) (P(a))
- Must be an open-ended real-life problem with no obvious solution (P(b)) (Complex Engineering problem)
- Project should address community needs, public health and safety, cultural, societal, and environmental considerations [CO3 (PO(c))]
- Project must involve real-life data and its necessary processing using software. Understand the limits of the used technology. [CO2(PO(e))]

Evaluation

- 10 Minutes recorded video presentation [with PPT slides] [CO6(P(j))]
- Peer Evaluation of Group Members [CO4(PO(h))], [CO5(PO(i))]
- Report in prescribed format with:
  - x. Literature survey on concerned technology [CO4(PO(l))]
  - y. Technical Details of the Solution [CO6(PO(j))]
  - z. Teamwork and Individual Performance Report [CO5(PO(i))]
  - aa. Technological Limit Evaluation [CO2(PO(e))]
  - bb. Public health and safety, cultural, societal, and environmental considerations [CO3(PO(c))]
  - cc. Ethics declaration statement [CO4(PO(h))]

20.61.12 Distribution of Marks

Class Participation	10%
Lab Reports and Lab Performance	10%
Lab test/Viva/Quiz	40%
*Final Project	40%
Total	100%

*Assessment will be performed by internal and external evaluators with industry experience
* marks distribution of the project will be declared at the beginning of the semester

20.57.13 Textbook/References

No Textbooks are required. Lab Manual will be provided by instructors

20.62 Description of Course EEE 425

Section A: General Information

20.62.1 Course Title	Biomedical Signals, Instrumentations and Measurement
20.62.2 Type of Course	Optional, Theory
20.62.3 Offered to	EEE
20.62.4 Pre-requisite Course(s)	None

Section B: Course Details

20.62.5 Course Content (As approved by the Academic Council)

Origin and major types of biological signals: Human body: cells and physiological systems, bioelectric potential, bio-potential electrodes and amplifiers, blood pressure, flow, volume and sound, electrocardiogram, electromyogram, electroencephalogram, phonocardiogram, vector cardiogram. Interpretation of bio-signals. Noise in bio-signals.
Measurement of bio-signals: transducers, amplifiers and filters. Measurement and detection of blood pressure. Blood flow measurement: plethysmograph and electromagnetic flow meter. Measurement of respiratory volumes and flow, related devices. X-ray. Tomograph: positron emission tomography and computed tomography. Magnetic resonance imaging. Ultrasonogram. Patient monitoring system and medical telemetry. Therapeutic devices: cardiac pacemakers and defibrillators. Electrical safety in bio instrumentations and sensing.

20.62.6 Course Objectives

- Introduction of the main physiological systems of human body and their functioning
- Process of generation and transmission of bio-signals in cells, tissues and organs
- Understanding of the characteristics of bio-signals in normal and abnormal conditions
- Measurement of body signals for interpretation, diagnosis, and therapy
- Design, development and modification of different types of medical devices

20.62.7 Knowledge required

Fundamental understanding of concepts of Biology and Electronic Circuits courses

20.62.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Understand** the functioning of major human physiological systems	PO(a)	C2	Lectures, Tutorials, Home works	Assignment, Class test, Final exam
2	**Interpret** signals generated in different parts of human body	PO(b)	C3	Lectures, Tutorials, Home works	Assignment, Class test, Final exam
3	**Analyze** the measurement, recording and transmission biomedical signals	PO(b)	C4	Lectures, Tutorials, Home works	Assignment, Class test, Final exam
4	**Design** medical instruments to acquire medical signals and images	PO(c)	C5	Lectures, Tutorials, Home works	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.62.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.62.10 Lecture Plan

Week	Lectures	Topic	COs
1-2	1-6	Introduction Different physiological systems	**CO1**

Week	Lectures	Topic	COs
3	7-9	Bioelectric Potential: cell characteristics, generation and propagation of resting and action potentials, characteristics of potential in different physiological systems.	**CO2**
4-5	10-15	Biomedical Signals: Characteristics and significances of ECG, EMG, EEG, ERG, etc.	**CO2**
6	16-18	Biosensors: electrodes, transducers	**CO3, CO4**
7	19-21	Bioelectric Amplifiers: requirements, characteristics, design	**CO3, CO4**
8	20-24	Biomedical Instrumentations	**CO3, CO4**
9	25-27	Biomedical Measurements: measurement of electrical and nonelectrical variables and parameters (ECG, EMG, EEG, heart rate, body fluids, etc.)	**CO2, CO3**
10	28-30	Therapeutic Devices: pacemakers, defibrillators	**CO3, CO4**
11	31-33	Biomedical Imaging: working and interpretation of X-ray, USG, CT, MRI, PET, SPECT	**CO2, CO3**
12	34-36	Noise in Signals and Images: characteristics, detection and removal	**CO3, CO4**
13	37-39	Emerging Technologies: patient monitoring, BCI, medical telemetry	**CO3, CO4**
14	40-42	**Review**	---

20.62.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.62.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.62.13 Textbook/References

- R Anandanatarajan: Biomedical Instrumentation and Measurements, Prentice-Hall India
- Webster: Medical instrumentation application and design, John Wiley & Sons
- Cromwell, Weibell, Pfeiffer: Biomedical Instrumentation and Measurements, Prentice-Hall India
- Carr, Brown: Introduction to biomedical equipment technology, Prentice Hall India
- Jerry L. Prince: Medical Imaging Signals and Systems
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.63 Description of Course EEE 426

Section A: General Information

20.63.1 Course Title	Biomedical Signals, Instrumentation and Measurement
20.63.2 Type of Course	Optional, Sessional
20.63.3 Offered to	EEE
20.63.4 Pre-requisite Course(s)	None

Section B: Course Details

20.63.5 Course Content (As approved by the Academic Council)

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 425. In the second part, students will design simple systems using the principles learned in EEE 425.

20.63.6 Course Objectives

- To provide hands-on training on fundamental concepts and algorithms of digital signal processing.
- To provide hands-on training on experimental techniques used to apply digital signal processing algorithms in real-life applications.

20.63.7 Knowledge required

Fundamental understanding of concepts of Electrical and Electronic Circuits, Continuous Signals and Linear Systems course and Mathematics courses.

20.63.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**understand** the behaviour of different biomedical signals.	PO(a)	P1, P4	Lectures, Lab demonstrations,	Lab-tasks, Assignment
2	**compare** experimental and emulation results found.	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment
3	**design** biomedical instruments to measure the biological activity of human body.	PO(c), PO(i)	C6	Lectures, interactive discussions	Lab-tasks, Report, Assignment
4	**Analyse** the behaviour of different biological signals to detect abnormality and find solutions of different problems in human body.	PO(i), PO(j), PO(k), PO(l)	P7, C6, A3	Interactive discussions	Project demonstration and Presentation

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.63.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.63.10 Lecture Plan

Week	Experiment no.	Topic
1	1	Introduction to the scope and objectives Discussion on various applications to help students selecting project
2	2	Machine Learning based non-invasive approach for blood cholesterol level estimation
3	3	Non-invasive Oxygen Saturation Measurement for Hypoxemia Detection Using Pulse Oximetry
4	4	Design and Development of a Cost-Effective Continuous Heart Rate Measuring Device using Fingertip to Detect Drowsy Driving
5	5	Diabetic retinopathy Detection
6	6	Presenting project update
7	7	Extracting SpO2, heart rate, and clinical symptoms by pulse oximetry and machine learning to detect pneumonia using a non-invasive method.
8	8	Wearable and Low-Cost Device For Detecting Amyotrophic Lateral Sclerosis (ALS) Using Electromyography (EMG) Signal
9	9	EMG Signal Based Intelligent Wheel Chair
10	10	Presenting project update and feedback
11	11	Presenting project update and feedback
12	12	Presenting project update and feedback
13	13	Final project demonstration and presentation

20.63.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design of a digital system performing a specific task with the help of various signal processing operations has to be completed by the end of this course. A project report has to be submitted and the project has to demonstrated and presented in the class.

20.63.12 Distribution of Marks

To be decided by course instructor(s)

20.63.13 Textbook/References

- Robert B. Northrop, Non-Invasive Instrumentation and Measurement in Medical Diagnosis, CRC press, 2nd Ed., 2022 (required).

- R. Anandanatarajan, Biomedical Instrumentation and Measurements, PHI Learning Private Limited, 2nd Ed., 2022 (required).

  Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.64 Description of Course EEE 427

Section A: General Information

20.64.1 Course Title	Measurement and Instrumentation
20.64.2 Type of Course	Optional, Theory
20.64.3 Offered to	EEE
20.64.4 Pre-requisite Course(s)	None

Section B: Course Details

20.64.5 Course Content (As approved by the Academic Council)

Measurement is an essential activity in every branch of Engineering for monitoring, controlling, alarm and safety operation of a plant. It is therefore important, that the study of measurement forms part of courses in further and higher education. Modern measurement systems use highly sophisticated sensors and electronic instruments. To exploit these sensors and instruments, it is essential to understand how the measurements and instrumentation are made. There is a strong emphasis on transducers/sensors (mechanical, electrical and optical types), fundamentals of analogue, electronics and digital instrumentations. This course will also include areas such as, signal conditioning elements, noise elimination techniques, impedance matching, telemetry, data transmission both in time and frequency domain techniques.

20.64.6 Course Objectives

This course covers the basic use and application of sensors, transducers, signal conditioning, telemetering and electronic measuring instruments. The theory of analog DC and AC measuring instruments is first interpreted which is then used to study analog electronic and digital meters. The use and application of different measuring instruments are covered in this course. Different types of sensors and transducer are studied with their analog and digital interfacing for measurement of non-electrical quantities. Basics causes of signal impairment in a measurement device and their mitigation are also introduced in this course. This course also covers the microprocessor-based instrumentation and telemetering system for remote sensing and measurement.

20.64.7 Knowledge Required

N/A

20.64.8 Course Outcomes

COs	**CO Statements**	**Corresponding PO(s)**	**Learning Domain and Taxonomy Levels**
CO1	**Understand** Some important terminologies of measurement systems and measurement standards; Applications of measurement systems. Functional elements of a generalized instrumentation system; classifications of instruments. Understand different techniques for measuring resistance, inductance and capacitance and Apply for localization of cable faults.	PO(a)	Cognitive (Comprehension+Application)
CO2	**Analyze** different analogue types of instruments and techniques (PMMC, Moving iron type, electrodynamometer type, rectifier based instrument, extension of instrument range and instrument	PO(a), PO(b)	Cognitive (Comprehension+Application)

	transformers) and Apply for measurement of electrical quantities.		
CO3	Understand the different types of transducers (mechanical, electrical and optical) used for measuring the non electrical quantities and then select the appropriate transducer/sensor for measurement the non electrical quantities. Understand Different techniques for Measurement of Pressure, Temperature, Flow, Force, Strain	PO(a), PO(b)	Cognitive (Comprehension + Analysis + Application)
CO4	Understand and Design the signal condition elements for conversion (A/D, D/A), amplification, noise elimination, linearization, impedance matching and protection (high voltage/high current).	PO(a), PO(b)	Cognitive (Comprehension + Analysis)
CO5	Understand Data Transmission and Telemetry: methods, media; analog and pulse (including digital) transmission; Details of PCM; multiplexing	PO(a), PO(b)	Cognitive (Comprehension + Analysis)

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.64.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.64.10 Lecture Plan

Topics (According to syllabus in Academic Calendar, 2016)	**Lectures (**Weeks)	**Mapping with COs**
Introduction: Some important terminologies of measurement systems; Applications of measurement systems. Functional elements of a generalized measurement system; Classifications of instruments. Measurement of Resistance, Inductance and capacitance, Localization of cable Faults, Problems.	1-4 (1.33)	CO1
Analog Instruments and Measurement of electrical quantities; Galvanometer: D'Arsonval type, Its construction, Torque equation, Dynamic behaviour and Equation of motion Under-damped, undamped, critically-damped and over-damped motion of galvanometer, Damping mechanisms, Sensitivities. Problem PMMC meter, Temperature compensation DC ammeter and voltmeter, Rectifier-based AC meters ; Electrodynamometer type meter, Electronic analog meters: (DC , AC) ; solving problems, Power measurement: Electrodynamometer type; Energy measurement: Induction type, Instrument transformers (CT,PT):	5-13 (3)	CO1 CO2
Transducers: Introduction , Electric transducers and their advantages and types ; Strain gauges, Resistance thermometers , thermistors; Variable inductance type transducers: variation of self inductance,	14-25 (4)	CO3

Topics (According to syllabus in Academic Calendar, 2016)	Lectures (Weeks)	Mapping with COs
Transducers working on variation of mutual inductance and production of eddy current; linear variable differential transformer, Reluctance Type Transducer, Capacitive transducers change in overlapping area and change in distance between plates, differential arrangement; Variation of dielectric constant for measurement of distance and liquid level, advantages, disadvantages and uses of capacitive transducers, Optical transducers: photo multiplier tubes, photodiodes and photovoltaic cell Measurement of Pressure, Temperature, Flow, Force, Strain		
Signal Conditioning Systems: Amplification, Linearization, Protection, Conversion and Impedance matching **Noise:** Sources of noise, noise elimination and compensation, Filtering **Conversion** : A/D converters: basics, techniques parallel/flash, single slope (ramp), successive approximation, sample and hold circuits D/A converters: basics, weighted-resistor and ladder type D/A converters, performance Characteristics Display Devices: introduction, digital display methods, LED display basics	26-34 (3)	CO4
Telemetering: Data Transmission and Telemetry: methods, media; analog and pulse (including digital) transmission; Details of PCM; multiplexing (TDM and FDM)	35-37 (1)	CO3 CO5
Review	38-39 (0.67)	CO5

20.64.11 Assessment Strategy

- **Class Attendance and Participation**

Class participation and attendance will be recorded in every class. Participation and attendance for the students may be considered in case the student could not attend the class due to a valid reason (power failure, internet problem, device problem, health problem, etc.). The student has to inform the teacher over email in case of such occurrences. A maximum of three (03) such missed classes can be considered for this course

- **Quiz, Assignment, Viva and Presentation**

Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.

- **Final Examination**

A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.64.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.64.13 Textbook/References

- 'A Course in Electrical and Electronic Measurements and Instrumentation' by A. K. Sawhney, 19th Revised Edition, Publisher: Dhanpat Rai and Sons, Delhi

- ‘Electronic Instruments and Instrumentation Technology’, by M. M. S. Anand, @2004 by Prentice-Hall of India
- ‘Modern Electronic Instrumentation and Measurement Techniques’ by A. D. Helfrick and W. D. Cooper, @1990 by Prentice-Hall Inc.
- ‘Principles of Measurement Systems’, John P. Bentley, 4th Ed @2005, Pearson-Prentice Hall.

20.65 Description of Course EEE 428

Section A: General Information

20.65.1 Course Title	Measurement and Instrumentation Laboratory
20.65.2 Type of Course	Optional, Sessional
20.65.3 Offered to	EEE
20.65.4 Pre-requisite Course(s)	None

Section B: Course Details

20.65.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 427 Measurement and Instrumentation

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 427. In the second part, students will design simple systems using the principles learned in EEE 427.

20.65.6 Course Objectives

- To provide hands-on training on different measurement techniques for measure resistance, capacitance, power, energy, frequency, phase angle etc.
- To design and present simple measurement and instrumentation devices/systems

20.65.7 Knowledge required

Fundamental understanding of electrical and electronic concepts

20.65.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** modern tools to measure resistance, capacitance, power, energy, frequency, phase angle etc.	PO(e)	P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests
2	**compare** theoretical and experimental results of measured quantities under experiments	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	**design** measurement and instrumentation devices/systems so that specific performance characteristics are attained	PO(c)	C6	Lectures, interactive discussions	Report, Project demonstration
4	**present** designed measurement and	PO(j)	A3	Interactive discussions	Project demonstration and Presentation

	instrumentation devices/systems				
5	demonstrate effective **individual and team-working skills**	PO(i)	A3		Peer and instructor assessment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.65.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CA1	CA2	CA3	CA4	CA5
				√	√		√	√	√	√					√	√	√		

20.65.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	Resistance Measurement by Wheatstone Bridge
3	2	High Resistance Measurement by Loss of Charge Method
4	3	Capacitance Measurement using 555 Timers
5	4	Signal Processing: Precision Rectification
6	5	Power Measurement with Integrated Circuit Multipliers
7	6	Electronic and Digital Energy Measurement
8	7	Active Low Pass Filtering of Input Signals for Measurement Purposes
9	-	Project Proposal submission and discussion
10	8	Design of an Active Low-Pass Butterworth Filter & Presentation on project updates
11	9	Frequency Measurement with Integrated Circuits & Presentation on project updates
12	10	Phase Angle Measurement with Integrated Circuits & Presentation on project updates
13	-	Laboratory test & Quiz
14	-	Final project demonstration and presentation

20.65.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.

- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design of measurement and instrumentation devices/systems has to be completed by the end of this course. A project report has to be submitted and the project has to demonstrated and presented in the class.

20.65.12 Distribution of Marks

To be decided by course instructor(s)

20.65.13 Textbook/References

- Electrical and Electronics Measurement and Instrumentation by AK Sawhney
- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.66 Description of Course CSE 451

Section A: General Information

20.66.1 Course Title	Computer Networks
20.66.2 Type of Course	Optional, Theory, Non-departmental
20.66.3 Offered to	EEE
20.66.4 Pre-requisite Course(s)	None

Section B: Course Details

20.65.5 Course Content (As approved by the Academic Council)

Switching and multiplexing; ISO, TCP-IP and ATM reference models. Different Data Communication Services: Physical Layer- wired and wireless transmission media, Cellular Radio: Communication satellites; Data Link Layer: Elementary protocols, sliding window protocols. Error detection and correction, HDLC, DLL of internet, DLL of ATM; Multiple Access protocols, IEEE.802 Protocols for LANs and MANs, Switches, Hubs and Bridges; High speed LAN; Network layer: Routing, Congestion control, Internetworking, Network layer in internet: IP protocol, IP addresses, ARP; NI in ATM transport layer: transmission control protocol. UDP, AT M adaptation layer; Application layer: Network security; Email, Domain Name System; Simple Network Management Protocol; HTTP and World Wide Web.

20.66.6 Course Objectives

The students are expected to:

- Study and analyze architectures of different types of computer networks.
- Design and evaluate protocols of computer networks.
- Create and critique different types of computer networks with determining suitable alternatives.

20.66.7 Knowledge required

Technical

- Data Communication

Mathematics

- Number system and conversions

20.666.8 Course Outcomes

CO No.	**CO Statement** After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Study** and **analyze** architectures of different types of computer networks	PO(a), PO(b), PO(g)	C4, A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	**Design** and **evaluate** protocols of computer networks.	PO(d), PO(f)	C6, A2	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	**Create** and critique different types of computer networks with determining suitable alternatives.	PO(e), PO(c)	C6, A5	Lecture	Class Tests or Assignments or Projects, and Final Exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.65.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1							√		√	√	√					√				
CO2		√	√		√				√	√	√			√		√	√			
CO3					√	√		√	√	√	√				√	√		√		√

20.66.10 Lecture Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to computer networks, OSI reference model and TCP/IP	CO1
Week 2	Transmission media: Wired and Wireless transmission	CO1
Week 3	Data Link layer design issues and DL protocols	CO1
Week 4	Multiple Access protocols, Ethernet	CO1 and CO2
Week 5	Wireless LANs	CO2
Week 6	Data Link layer switching	CO2
Week 7	Network devices, Circuit and Packet switching	CO2
Week 8	Flooding, IPv4 and IPv6 addressing	CO2
Week 9	Routing Algorithms, DV and LS and OSPF routing algorithms	CO3
Week 10	ARP, DHCP, Introduction to TCP	CO3

Week	Lecture Topics	Corresponding CO(s)
Week 11	TCP flow control, Congestion control, UDP	CO3
Week 12	Application layer protocols: HTTP, DNS, DNS, SMTP, IMAP, POP3	CO3
Week 13	Network Security and Cryptography	CO3
Week 14	Summary and Revision	CO1, CO2 and CO3

20.66.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

20.66.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.66.13 Textbook/References

- Computer Networking: A Top-Down Approach, 8th Edition, Jim Kurose, Keith Ross
- Computer Networks, 6th Edition, Andrew S. Tanenbaum, David J. Wetherall

20.67 Description of Course CSE 452

Section A: General Information

20.67.1 Course Title	Computer Networks Sessional
20.67.2 Type of Course	Optional, Sessional, Non-departmental
20.67.3 Offered to	EEE
20.67.4 Pre-requisite Course(s)	None

Section B: Course Details

20.67.5 Course Content (As approved by the Academic Council)

Switching and multiplexing; ISO, TCP-IP and ATM reference models. Different Data Communication Services: Physical Layer- wired and wireless transmission media, Cellular Radio: Communication satellites; Data Link Layer: Elementary protocols, sliding window protocols. Error detection and correction, HDLC, DLL of internet, DLL of ATM; Multiple Access protocols, IEEE.802 Protocols for LANs and MANs, Switches, Hubs and Bridges; High speed LAN; Network layer: Routing, Congestion control, Internetworking, Network layer in internet: IP protocol, IP addresses, ARP; NI in ATM transport layer: transmission control protocol. UDP, AT M adaptation layer; Application layer: Network security; Email, Domain Name System; Simple Network Management Protocol; HTTP and World Wide Web.

20.67.6 Course Objectives

The students are expected to:

- Understandand simulate architectures of different types of computer networks and its components.
- Develop contemporary and new protocols of computer networks.
- Identify and implement applications of computer networks.

20.67.7 Knowledge required

Technical

- Programming

20.67.8 Course Outcomes

CO No.	**CO Statement** After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Understand** and **simulate** architectures of different types of computer networks and its components.	PO(a), PO(b), PO(g)	C4, A4, P4	Lecture, Demonstration, and hands-on	Lab. and home assignments, participation in hands on sessions
CO2	**Develop** contemporary and new protocols of computer networks.	PO(d), PO(f)	C6, A2, P3	Lecture, Demonstration, and hands-on	Lab. and home assignments, participation in hands on sessions
CO3	**Identify** and **implement** applications of computer networks.	PO(e), PO(c)	C6, A5, P5	Lecture, Demonstration, and hands-on	Lab. and home assignments, participation in hands on sessions

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.67.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√	√	√	√	√	√		√	√	√					√				
CO2		√	√	√	√	√			√	√	√			√		√	√			
CO3		√	√	√	√	√		√	√	√	√				√	√		√		√

20.67.10 Lecture Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Lecture on Socket Programming	CO3
Week 2	Practice Session at Lab and Assignment 1 Declaration	CO3
Week 3	Assignment 1 Evaluation	CO3
Week 4	Lecture on Internet Applications (HTTP/DNS) and Assignment 2 declaration	CO2, CO3
Week 5	Lecture on basic Packet Tracer and	CO1
Week 6	Evaluation of Assignment 2	CO2, CO3
Week 7	Online on basic Packet Tracer and practice session	CO1
Week 8	Lecture on subnetting and practice session	CO1, CO2

Week	Lecture Topics	Corresponding CO(s)
Week 9	Lecture on advanced Packet Tracer and practice session	CO1
Week 10	Online on subnetting and advanced packet tracer	CO1, CO2
Week 11	Lecture on ARP/DHCP and practice session	CO2
Week 12	Assignment 3 Declaration	CO2, CO3
Week 13	Assignment 3 Evaluation	CO2, CO3
Week 14	Final Quiz	CO1, CO2, and CO3

20.67.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Online/ Offline Assignments: There will be 3/4 online or offline assignments
- Projects: There will be a project related to topics covered in the sessional
- Final Quiz: A comprehensive Final Quiz will be held at the end of the semester as per the institutional ordinance.

20.67.12 Distribution of Marks

Attendance:	10%
Online Assignment:	25%
Offline Assignment	25%
Final Project:	20%
Final Quiz:	20%
Total:	**100%**

20.67.13 Textbook/References

- Computer Networking: A Top-Down Approach, 8th Edition, Jim Kurose, Keith Ross
- Computer Networks, 6th Edition, Andrew S. Tanenbaum, David J. Wetherall

Communication and Signal Processing Group

20.68 Description of Course EEE 417

Section A: General Information

20.68.1 Course Title	Random Signals and Processes
20.68.2 Type of Course	Optional, Theory
20.68.3.3 Offered to	EEE
20.68.4 Pre-requisite Course(s)	None

Section B: Course Details

20.68.5 Course Content (As approved by the Academic Council)

Concept of random variables and process is essential for the understanding of electrical engineering systems such as telecommunications, signal, image and video processing, biomedical signal processing, genomic signal processing, power systems, evaluation of reliability of engineering systems, computing and son, and interestingly they also have wide range of applications in other fields for example meteorology, genomics, finance, economics, epidemiology etc. Topics include: basics of probability, random variables and their properties and transformations for single and joint densities, moments and characteristic functions, conditional densities and expectations, Inequalities, evaluation of reliability of engineering systems, Central Limit Theorem, estimation of parameters for statistical models, random processes and their stationarity and ergodicity, spectral estimation and input-output relation of LTI systems.

20.68.6 Course Objectives

- To introduce basic concepts of random variables and processes and develop a solid background as well as the ability to design, analyze and interpret electrical engineering systems and also, apply it in similar systems in other areas in a stochastic setting.
- To give a foundation for future courses such as Digital Signal Processing II，Wireless Communications, Radar and Satellite Communication, Introduction to Digital Image Processing, Information and Coding Theory, Introduction to Medical Imaging, Speech Communication, Wireless and Mobile Networks and Power System Reliability.
- Provides an essential background for postgraduate study and research in communication and signal processing and interdisciplinary areas.

20.68.7 Knowledge required

Fundamental understanding in Calculus, Statistics, Linear Signals and Systems and Signal Processing.

20.68.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Recall the basics of probability, employ the concept of Bernouli trials to estimate outcomes repeated experiments and evaluation of the reliability of electrical engineering systems	PO(a), PO(b)	C2 C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO2	Recognize uni-variate and bi-variate random variables, analyze their properties and perform transformations of uni- and bi-variate random variables and interpret the outcomes	PO(a), PO(b)	C2 C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO3	Estimate the moments of uni-rand bi-random variables, and employ to obtain bounds (inequalities) with applications and interpret the outcomes	PO(a), PO(b)	C2 C3 C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO4	Identify random processes and analyze their properties including interpretation and estimation of stationarity and ergodicity	PO(a), PO(b)	C2 C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO5	Analyze and interpret the output and input-output relation of electrical engineering systems for given random inputs; perform statistical modeling of electrical engineering signals and systems and estimate relevant parameters.	PO(a), PO(b)	C2 C3 C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.68.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.68.10 Lecture Plan

Week	**Lectures**	**Topic**	**Textbook**	**COs**
1	1-3	**Introduction:** Overall aspects of the course and its applications, Review of Sample space, set theory, probability measure, Axioms of probability, joint probability, conditional probability, total probability, Bayes theorem, Independence	**Chapter 1**	CO1
2	4-6	**Repeated Trials:** Bernouli Trials, Laplace-DeMoivre and Poisson approximations, Weak and Strong Law of Large numbers	**Chapter 2 and 4**	CO1
3-4	7-12	**Random Variable:** Continuous and discrete random variables, transformation method for single random variable, probability density function (pdf) and cumulative density function (CDF), probability mass function (pmf), commonly used pdfs/pmfs, and CDFs	**Chapter 3**	CO2
5	13-15	**Moments:** Expectation, Variance, and characteristic function, applications of moments and characteristic functions, Inequalities, Reliability applications	**Chapters 3-6**	CO1 CO3
6-7	16-21	**Two Random Variables:** Joint pdfs and CDFs, joint pmfs, independence and uncorrelatedness, Bivariate Gaussian pdf, Transformation methods for: (i) Two Functions of Two Random Variables, (ii) One Function of Two Random Variables, (iii) method of auxiliary variable,	**Chapters 7-9**	CO2
8-9	22-27	**Moments:** Joint Moments and Joint Characteristic Functions and applications, Central Limit Theorem, Conditional Density Functions and Conditional Expected Values, hypothesis testing	**Chapters 10-11**	CO3
10-11	28-33	**Random Process:** continuous and discrete random process, Gaussian, Poisson and Markov Process, Stationarity and Ergodicity, correlation and covariance, wide-sense stationary (WSS) process: (i) properties, (ii) verification of ergodicity, existence of continuity, derivative and integral, process measurements	**Chapters 14 and 15**	CO4
12-13	34-39	**Analysis of systems:** Spectral Estimation. Correlation and power spectrum. Cross spectral densities. Response of linear systems to random inputs, noise models, statistical parameter estimation techniques	**Chapter 18**	CO5

20.68.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of the Academic Council.

20.68.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.68.13 Textbook/References

- Probability, Random Variables and Stochastic Processes, Fourth Edition, by Athanasios Papoulis and S. Unnikrishna Pillai, McGraw-Hill.
- Probability, Random Variables and Random Signal Principles, Peyton Peebles, Tata McGraw-Hill, 4^{th} edition, 2012.
- Fundamentals of Applied Probability and Random Processes, Oliver C. Ibe, Elsevier, 2014.
- Probability, Statistics and Random Processes for Electrical Engineering, Alberto Leon Garcia, Pearson Publishers, 2008.

20.69 Description of Course EEE 431

Section A: General Information

20.69.1 Course Title	Digital Signal Processing II
20.69.2 Type of Course	Optional, Theory
20.69.3 Offered to	EEE
20.69.4 Pre-requisite Course(s)	None

Section B: Course Details

20.69.5 Course Content (As approved by the Academic Council)

- *Spectral estimation of random processes*: classical methods, minimum variance method, parametric methods: AR and ARMA spectral estimation, Levinson-Durbin algorithm, super resolution techniques: Pisarenko, and MUSIC.
- *Adaptive signal processing*: Applications, e.g., equalization, interference suppression, acoustic echo cancellation. FIR and IIR adaptive filters. Recursive least squares algorithm, steepest descent and Newton algorithm, least mean-square (LMS) algorithm, convergence analysis. Variable step-size LMS algorithm.
- *Multirate DSP*: Interpolation and decimation, single-stage and multistage implementation, design of anti-aliasing and anti-imaging filters. Polyphase representation of multirate systems. Multirate implementation of ideal LP filter, digital filter banks, narrowband filters. Perfect reconstruction filters banks. Short time Fourier transform, subband decomposition and wavelet transform, CWT, DWT, inter-scale relationship of DWT coefficients, multirate implementation. Applications of wavelet transform.

20.69.6 Course Objectives

- To develop an in-depth understanding of advanced signal processing methods and techniques, such as power spectrum estimation, adaptive filtering, multirate signal processing and wavelet transform

- To develop the skill to apply signal processing techniques in order to solve practical engineering problems, such as spectral analysis, noise cancellation, sampling-rate conversion, feature extraction, and machine learning.
- To develop the ability to conduct and communicate research involving signal processing

20.69.7 Knowledge required

Fundamental understanding of concepts of Digital Signal Processing I, and Continuous Signals and Linear Systems.

20.69.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**explain** advanced signal processing concepts related to spectral estimation, adaptive filters, multirate systems, filter banks, wavelet transform	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse** signal using spectral analysis, time-frequency representation and wavelet transform	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**evaluate a**nd **compare** the performance and computational complexity of different implementation techniques	PO(d)	C5	Lectures, Discussion, Demonstration	Assignment, Class test, Final exam
4	**design** filters or filter banks of desired properties	PO(c)	C6	Lectures, Discussions	Assignment, Class test, Final exam
5	**apply** signal processing techniques to solve practical problems having various conflicting requirements	PO(c)	C6	Lectures, Discussion, Demonstration	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.69.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.69.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Spectral estimation:* Periodogram, Modified Periodogram, Barlett Method
2	4-6	Welchs Method, Blackman-Tukey Approach, minimum variance method
3	7-9	*Parametric methods:* AR and ARMA spectral estimation, Levinson-Durbin algorithm
4	10-12	*Super resolution techniques:* Pisarenko and MUSIC
5	13-15	*Adaptive signal processing*: Overview and applications, steepest descent and Newton algorithm
6	16-18	Least mean-square (LMS) algorithm, convergence analysis
7	19-21	variable step-size LMS algorithm, Recursive least squares (RLS) algorithm
8	20-24	*Multirate DSP:* Interpolation and decimation, design of anti-aliasing and anti-imaging filters
9	25-27	Polyphase representation of multirate systems
10	28-30	Single-stage and multistage implementation, multirate implementation of ideal LP filter
11	31-33	Digital filter banks, perfect reconstruction filters banks
12	34-36	Short time Fourier transform, subband decomposition and wavelet transform, CWT
13	37-39	DWT, inter-scale relationship of DWT coefficients, multirate implementation, applications of wavelet transform

20.69.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.69.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.69.13 Textbook/References

- Statistical Digital Signal Processing and Modeling, Hayes, M. (1996), Wiley.
- Digital Signal Processing, A Computer Based Approach, Mitra, S. K. (fourth edition), Wcb/McGraw-Hill
- Statistical and Adaptive Signal Processing, Manolakis, D. G., Ingle, V. K., and Kogon, S. M. (2005), Artech House Publishers
- Advanced Digital Signal Processing, Proakis, J. G., Rader, C. M., Ling, F., and Nikias, C. L. (1992), Macmillan.
- Modern Spectral Estimation: Theory and Application, Kay, S. M. (1999), Prentice-Hall
- Adaptive Filter Theory (5th Edition), Haykin, S. (2013), Prentice-Hall
- Multirate Filtering for Digital Signal Processing: MATLAB Applications, Ljiljana Milic
- A Wavelet Tour of Signal Processing: The Sparse Way, Stephane Mallat

- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.70 Description of Course EEE 433

Section A: General Information

20.70.1 Course Title	Microwave Engineering
20.70.2 Type of Course	Optional, Theory
20.70.3 Offered to	EEE
20.70.4 Pre-requisite Course(s)	None

Section B: Course Details

20.70.5 Course Content (As approved by the Academic Council)

Transmission Lines: The Lumped-Element Circuit Model for a Transmission Line, Field Analysis of Transmission Line, The Terminated Lossless Transmission Lines, The Smith Chart, The Quarter-Wave Transformers, Generator and Load Mismatches, Impedance Matching and Tuning, Lossy Transmission Lines. Waveguides: General Formulation, Modes of Propagation and Losses in Parallel Plate, Rectangular and Circular Waveguides. Microstrips Lines: Structures and Characteristics. Microwave Resonators: Waveguide Cavity Resonators, Microstrip Resonators. Microwave Network Analysis: Scattering Matrices and Multiport Analysis Techniques. Radiation and Antennas: Types of Antenna and their Applications, Radiating Field Regions, Radiation Pattern-Isotropic, Directional and Omni Directional Patterns, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency and Gain, Polarization, Vector Effective Length, Effective Aperture, Equivalent Circuit Model and Corresponding Parameters, Friss Transmission Equation, Mathematical Formalism for Far Field Analysis, Infinitesimal Dipole Antenna, Finite Length Dipole Antenna, Infinitesimal Loop Antenna, Antenna Array, N Element Linear Array, Endfire and Broadside Array-Array Factor and Directivity.

20.70.6 Course Objectives

- The main objective of this course is to implement the knowledge of electromagnetic theory to learn basic microwave structures and devices.
- The course aims to give students the necessary background to analyze transmission line, waveguides and resonators and their characteristics and design.
- Students will become familiar with the techniques of microwave network analysis.
- The course aims to design and analyze different types of antennas with specified properties.

20.70.7 Knowledge required

Vector Calculus, Partial Differential Equation, Electromagnetic Theory.

20.70.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
1	**Explain** the circuit model and different aspects of lossless and lossy transmission lines.	PO(a)	C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
2	**Employ** electromagnetic theory to understand wave propagation in different waveguide structures.	PO(b)	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

3	**Explain** the techniques of solving microwave networks.	PO(a)	C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
4	**Design** different types of antennas with specific radiation properties and antenna parameters.	PO(c)	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.70.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CA1	CA2	CA3	CA4	CA5
CO1	√	√	√																	
CO2		√			√	√														
CO3			√	√	√															
CO4					√	√		√	√											

20.70.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-6	1-4	Transmission Lines: The Lumped-Element Circuit Model for a Transmission Line, Field Analysis of Transmission Line, The Terminated Lossless Transmission Lines, The Smith Chart, The Quarter-Wave Transformers, Generator and Load Mismatches, Impedance Matching and Tuning, Lossy Transmission Lines.	CO1
7-12	5-7	Waveguides: General Formulation, Modes of Propagation and Losses in Parallel Plate, Rectangular and Circular Waveguides. Microstrips Lines: Structures and Characteristics.	CO2
13-18	7-8	Microwave Resonators: Waveguide Cavity Resonators, Microstrip Resonators.	CO2
19-24	8-9	Microwave Network Analysis: Scattering Matrices and Multiport Analysis Techniques.	CO3
25-30	10-14	Radiation and Antennas: Types of Antenna and their Applications, Radiating Field Regions, Radiation Pattern-Isotropic, Directional and Omni Directional Patterns, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency and Gain, Polarization, Vector Effective Length, Effective Aperture, Equivalent	CO4

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
		Circuit Model and Corresponding Parameters, Friss Transmission Equation, Mathematical Formalism for Far Field Analysis, Infinitesimal Dipole Antenna, Finite Length Dipole Antenna, Infinitesimal Loop Antenna, Antenna Array, N Element Linear Array, Endfire and Broadside Array-Array Factor and Directivity.	

20.70.11 Assessment Strategy

- Class participation and attendance will be recorded in every class. Participation and attendance for the students may be considered in case the student could not attend the class due to a valid reason (power failure, internet problem, device problem, health problem, etc.). The student has to inform the teacher over email in case of such occurrences. A maximum of three (03) such missed classes can be considered for this course
- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guidelines of academic Council.

20.70.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.70.13 Textbook/References

- Microwave Engineering: David M Pozer
- M. N. O. Sadiku, “Principles of Electromagnetics”, Sixth Edition, Oxford University Press, 2015

20.71 Description of Course EEE 434

Section A: General Information

20.71.1 Course Title	Microwave Engineering Laboratory
20.71.2 Type of Course	Optional, Sessional
20.71.3 Offered to	EEE
20.71.4 Pre-requisite Course(s)	None

Section B: Course Details

20.71.5 Course Content (As approved by the Academic Council)

This is Laboratory course based on the content of the Theory Course EEE 433: Microwave Engineering.

20.71.6 Course Objectives

- Familiarize the students with different microwave tools and components such as cables, connectors, waveguide, microwave tees, antennas, etc.
- Enable the students to gain hands-on experience on microwave measurement procedure of different parameters of a microwave system such as VSWR, reflection-transmission coefficient, unknown load impedance, and finding important antenna properties.

- Performing simulation software based experiments for understanding, analyzing and visualizing microwave device characteristics.

20.71.7 Knowledge required

Understanding theories and concepts of Electromagnetic Fields and Waves.

20.71.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
1	**Identify** different microwave components and passive devices.	PO(a)	C2	Lectures, Laboratory discussions	Report Writing, Presentation, Viva
2	**Utilize** modern tools to measure microwave parameters of transmission lines, waveguides, and antennas.	PO(e)	C4, P4	Lectures, Lab demonstrations	Report Writing, Lab Tasks, Lab Quiz
3	**Compare** different parameters of microwave devices obtained by measurement and simulation software.	PO(d)	C5	Lectures, Lab demonstrations, Using simulation software	Report Writing, Lab Tasks, Lab Quiz
4	**Demonstrate** effective individual and team working skills during experiments.	PO(i)	P4	Interactive discussions	Presentation, Report writing, Peer/ Instructor Assessment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.71.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.67.10 Lecture Plan

Week	Experiment No.	Name of the Experiment	COs(POs)
1-2	1	Study of microwave components and passive devices, and measurement of microwave power.	CO1(PO1)
3-4	2	Measurement of wavelength, VSWR, reflection coefficient, transmission coefficient using a slotted coaxial transmission	CO2(PO5)

Week	Experiment No.	Name of the Experiment	COs(POs)
		line, microwave generator, and unknown load impedance of a terminated transmission line using Smith Chart.	CO4(PO9)
5-6	3	Measurement of wavelengths and wave impedance by slotted waveguide section and Smith Chart.	CO2(PO5) CO4(PO9)
7	4	Study of microwave propagation, gain and radiation pattern of a test antenna by measurements.	CO2(PO5) CO4(PO9)
8	5	Design and analysis of i) rectangular and, ii) cylindrical waveguides using a standard electromagnetic simulation software.	CO3(PO4) CO4(PO9)
9	6	Design and analysis of ferrite circulator using a standard electromagnetic simulation software.	CO3(PO4) CO4(PO9)
10	7	Design and analysis of i) dipole and, ii) microstrip antennas using a standard electromagnetic simulation software.	CO3(PO4) CO4(PO9)
11	8	Design and analysis of an antenna array using a standard electromagnetic simulation software.	CO3(PO4) CO4(PO9)
12	-	Lab test	-
13	-	Quiz and Viva	-

20.71.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing, presentation and viva.

20.71.12 Distribution of Marks

To be decided by course instructor(s)

20.71.13 Textbook/References

- Microwave Engineering: David M Pozer
- M. N. O. Sadiku, “Principles of Electromagnetics”, Sixth Edition, Oxford University Press, 2015

20.72 Description of course EEE 435

Section A: General Information

20.72.1 Course Title	Optical Communications
20.72.2 Type of Course	Optional, Theory
20.72.3 Offered to	EEE
20.72.4 Pre-requisite Course(s)	None

Section B: Course Details

20.72.5 Course Content (As approved by the Academic Council)

- Introduction to optical communication. Guided and unguided optical communication system

- Light propagation through guided medium, Optical Fibers: SMF and MMF, SI fibers and GI fibers. Fiber modes, mode theory for light propagation through fibers, single mode condition and multimode condition.
- Transmission impairments: fiber loss, chromatic dispersion in a fiber, polarization mode dispersion (PMD). Different types of fibers: DSF, DCF, Dispersion compensation schemes. Fiber cabling process, Fiber joints/connectors and couplers
- Optical transmitter: LED and laser, Operating principles, Characteristics and driver circuits.
- Optical receivers: PN, PIN and APD detectors, Noise at the receiver, SNR and BER calculation, Receiver sensitivity calculation. IM/DD and Coherent communication systems.
- Nonlinear effects in optical fibers.
- Optical amplifiers, Optical modulators
- Multichannel optical systems: Optical FDM, OTDM and WDM. Optical Access Network, Optical link design and Free space optical communication.

20.72.6 Course Objectives

- This course is intended to introduce to students an overview of optical communication systems – guided and unguided
- To provide students with the basic theory, design and operating principles of modern optical communication systems
- The students should be familiar with different types of fibers, components, transmitters, receivers, different detection methods and receiver noise and they will be able to design a simple optical communication link

20.72.7 Knowledge required

Fundamental understanding of concepts of Communication System and Electromagnetic courses

20.72.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Understand** the physics-based knowledge of lightwave propagation and **apply** it to solve the problems relevant to lightwave propagation in free space and optical fibers	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**Classify** optical fibers and lightwave transmission systems and **explain** the impairments of light propagation in optical fibers and free space; **analyse** the operation of optical sources, detectors, amplifiers, modulators and demodulators etc.	PO(a), PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**Compare** different optical communication systems and **evaluate** their performance	PO(b)	C4	Lectures, Discussions	Assignment, Final exam
4	**Design** optical communication system considering different impairments and components	PO(c)	C5	Lectures, Discussions	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.72.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.72.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Introduction to Optical Fiber Communication
2	4-6	Guided and unguided light propagation, Light Propagation theory – Ray optics theory and Mode theory.
3-4	7-12	Optical Fibers- SI Fibers, GI Fibers, Wave Propagation, Fiber Modes, Single mode Fiber, Multimode fiber, Fiber Birefringence, PMD
5	13-15	Transmission impairments – Dispersion in Single Mode Fiber (SMF), Dispersion-induced limitation, Different types of fibers: DSF, NZDSF, DCF, Fiber Loss
6	16-18	Nonlinear Effects- SRS, SBS, SPM, XPM, and FWM
7	19-21	Optical Transmitters – Light Emitting Diodes (LED), LASER Diodes (LD); their basic mechanisms, structures, characteristics, applications
8-10	19-27	Optical Receivers – Photo-Detectors (PD): Detector responsivity, PN photodiode, PIN photo-detector, Avalanche photo-detector, Direct detection (IM/DD system) and coherent detection, Phase modulated system, Noise at the receiver, BER and Eye pattern
11	31-33	Optical Amplifiers – Optoelectronic amplifier, Fiber amplifier: Erbium doped fiber amplifier (EDFA) and Raman amplifier, SOA
12	34-36	Optical Modulators: MZI, MZM, EAM, EOM
13	37-39	Multichannel Optical Systems – Optical FDM, TDM and WDM
14	40-42	Power Budget/link design and Free space optical communication

20.72.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.72.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.72.13 Textbook/References

- Fiber-Optic Communication Systems- Govind P. Agrawal, 4th Edition, John Wiley & Sons, Inc.
- Optical Fiber Communications- John M. Senior, 3rd Edition, PHI
- Nonlinear Optics – Robert W. Boyd, 4th Edition, AP
- Nonlinear Fiber Optics - Govind P. Agrawal, 5th Edition, AP

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.73 Description of course EEE 437

Section A: General Information

20.73.1 Course Title	Wireless Communications
20.73.2 Type of Course	Optional, Theory
20.73.3 Offered to	EEE
20.73.4 Pre-requisite Course(s)	None

Section B: Course Details

20.73.5 Course Content (As approved by the Academic Council)

- Introduction: Wireless communication systems, regulatory bodies.
- Radio wave propagation: Free-space and multi-path propagation, ray tracing models, empirical path loss models, large-scale and small scale fading, power delay profile, Doppler and delay spread, coherence time and bandwidth.
- Statistical channel models: Time varying channel models, narrowband and wideband fading models, baseband equivalent model, discrete-time model, space-time model, auto- and cross-correlation, PSD, envelope and power distributions, scattering function.
- Channel capacity: Flat-fading channels - CSI, capacity with known/partially known/unknown CSI. Frequency selective fading channels - time-invariant channels, time-varying channels.
- Performance of digital modulations: Error and outage probability, inter-symbol interference, MPSK, MPAM, MQAM, CPFSK.
- Diversity techniques: Time diversity - repetition coding, beyond repetition coding. Antenna diversity - SC, MRC, EGC, space time coding. Frequency diversity - fundamentals, single-carrier with ISI equalization, DSSS, OFDM.
- Space-time communications: Multiantenna techniques, MIMO channel capacity and diversity gain, STBC, OSTBC, QOSTBC, SM, BLAST, smart antennas, frequency selective MIMO channels.
- Broadband communications: DSSS, FHSS, spreading codes, RAKE receivers, MC-CDMA, OFDM, OFDMA, multiuser detection, LTE, WiMAX.

20.73.6 Course Objectives

- To provide knowledge on the fundamental theories and concepts of wireless and digital communications so that these knowledges help students for pursuing research in wireless communications and working in communication industries
- To build capacity of the students for signal level analysing of wireless communication systems and their performances.

20.73.7 Knowledge required

Fundamental understanding of concepts of Electromagnetic Wave Propagation and Digital Communication Theory.

20.73.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**understand** the radio wave propagation and **apply** the knowledge of physics, mathematics, and engineering to model wireless channel	PO(a)	C2, C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**understand** the various transmission schemes for wireless communications, **apply** the knowledge of mathematics as well as propagation models, and **analysis** and **evaluation** of the performances of various transmission schemes	PO(a)	C2, C3, C4, C5	Lectures, Discussions	Assignment, Class test, Final exam
3	**design** the parameters of wireless communication system so that certain requirements are satisfied	PO(a)	C6	Lectures, Discussions	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.73.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.73.10 Lecture Plan

Week	Lectures	Topic
1-2	1-6	*Introduction*: Wireless communication systems, regulatory bodies. *Radio wave propagation:* Free-space and multi-path propagation, ray tracing models, empirical path loss models, large-scale and small scale fading, power delay profile, Doppler and delay spread, coherence time and bandwidth.
3	7-9	*Statistical channel models:* Time varying channel models, narrowband and wideband fading models, baseband equivalent model, discrete-time model, space-time model, auto- and cross-correlation, PSD, envelope and power distributions, scattering function.
4-5	10-15	*Channel capacity*: Flat-fading channels - CSI, capacity with known/partially known/unknown CSI. Frequency selective fading channels - time-invariant channels, time-varying channels.

Week	Lectures	Topic
6-7	16-21	*Performance of digital modulations:* Error and outage probability, inter-symbol interference, MPSK, MPAM, MQAM, CPFSK..
8-9	22-27	*Diversity techniques:* Time diversity - repetition coding, beyond repetition coding. Antenna diversity - SC, MRC, EGC, space time coding. Frequency diversity - fundamentals, single-carrier with ISI equalization, DSSS, OFDM.
10-11	28-33	*Space-time communications*: Multiantenna techniques, MIMO channel capacity and diversity gain, STBC, OSTBC, QOSTBC, SM, BLAST, smart antennas, frequency selective MIMO channels.
12-13	34-39	*Broadband communications:* DSSS, FHSS, spreading codes, RAKE receivers, MC-CDMA, OFDM, OFDMA, multiuser detection, LTE, WiMAX.

20.73.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.73.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.73.13 Textbook/References

- Wireless Communications by Andrea Goldsmith
- Wireless Communications by T.S. Rapaport
- Introduction to space-time wireless communications, Cambridge University Press (2003) by A. Paulraj, R. Nabar and D. Gore
- Modern Wireless Communications by S. Haykin and M. Moher
- Wireless Communications and Networking by J. W. Mark and W. Zhuang
- Fundamentals of Wireless Communication by D.Tse
- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics

20.74 Description of course EEE 438

Section A: General Information

20.74.1 Course Title	Wireless Communication Laboratory
20.74.2 Type of Course	Optional, Sessional
20.74.3 Offered to	EEE
20.74.4 Pre-requisite Course(s)	None

Section B: Course Details

20.74.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 437: Wireless Communication.

20.74.6 Course Objectives

- To provide hands-on training on experimental techniques for analysing wireless communication systems
- To provide hands-on training on simulating and analysing wireless communication systems

20.74.7 Knowledge required

Fundamental understanding of telecommunication systems.

20.74.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Build and troubleshoot** wireless communications experimental setup, **measure** data and **interpret** data	PO(d)	P3, C4	Lectures, Lab demonstrations	Lab-tasks, Report, Lab-tests, Quiz
CO2	**Simulate and analyse** wireless communication systems using MATLAB and other software	PO(e)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Lab-tests, Quiz
CO3	Display effective **individual and team-working skills** by formulating and completing experiments on wireless communications	PO(i)	A5	Lectures, Lab demonstrations	Lab-tasks, Projects, Assignments, Lab-tests
CO4	**Communicate effectively** by preparing lab reports, project report and presenting project outcomes	PO(j)	A2	Interactive discussions	Reports, Viva voce, Project demonstration and Presentation

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.74.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
	√			√	√		√	√	√	√	√				√	√	√		

20.74.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	Basic Digital Modulation Techniques
3	2	Study of M-PSK and M-QAM Communication Systems over Noisy Channel
4	3	Wireless Propagation Path-Loss Modeling using Measurements for Indoor Communication Systems
5	4	Channel Models for Wireless Communication Systems
6	-	Project Proposal submission and discussion
7	5	Multiple Input Multiple Output (MIMO) Wireless Communication Systems: BER Performance and Channel Capacity Analysis
8	6	Multiple Input Multiple Output (MIMO) Wireless Communication Systems: Space-Time Block Code (STBC)
9	7	Orthogonal Frequency Division Multiplexing (OFDM) for Wireless Communications: Generation, Transmission and Detection
10	-	Presentation on project updates
11	8	Throughput and Outage Analysis of OFDMA Based LTE Cellular Networks
12	-	Final project demonstration and presentation
13	-	Final project demonstration and presentation
14	-	Viva & Quiz

20.74.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the modelling, simulating and analysing wireless communication has to be completed by the end of this course. A project report has to be submitted and the project has to demonstrated and presented in the class.

20.74.12 Distribution of Marks

To be decided by the course instructor(s)

20.74.13 Textbook/References

- Contemporary Communication Systems Using MATLAB by J. G. Proakis, P. Salehi and G. Bauch
- MIMO-OFDM Wireless Communications with MATLAB by Y. S. Cho, J. Kim, W. Y. Yang, C. G. Kang
- Wireless Communications by T.S. Rapaport
- Wireless Communications by Andrea Goldsmith

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.75 Description of course EEE 441

Section A: General Information

20.75.1 Course Title	Telecommunication Engineering
20.75.2 Type of Course	Optional, Theory
20.75.3 Offered to	EEE
20.75.4 Pre-requisite Course(s)	None

Section B: Course Details

20.75.5 Course Content (As approved by the Academic Council)

- Introduction: Principle, evolution and telecommunication networks.
- National and International regulatory bodies, Telephone apparatus, telephone Exchanges, subscriber loop, supervisory tones, PSTN.
- Switching systems: Introduction to analog system: Strowger and Crossbar switching systems, Stored program control (SPC) systems, Digital switching systems: space division switching, time division switching, blocking probability and multistage switching, and digital memory switch.
- Traffic analysis: Traffic characterization, grades of service, network blocking probabilities, delay system and queuing.
- Integrated services digital network (ISDN): N-ISDN and B-ISDN, architecture of ISDN, B-ISDN implementation. Digital subscriber loop (DSL), Wireless local loop (WLL), FTTx, SONET/SDH, WDM Network, IP telephony and VoIP, ATM network and Next Generation Network (NGN).

20.75.6 Course Objectives

- This course is intended to introduce to students an overview of telecommunication systems – guided and unguided
- To provide students with the design and operation of different telecommunication switching systems and communication networks
- The students should be familiar with different types of transmission media, switching technology, teletraffic analysis and network architecture

20.75.7 Knowledge required

Fundamental understanding of concepts of Communication System and Electromagnetic courses

20.75.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Understanding** different telecommunication switching technologies, telephone transmitters, receivers, and other apparatus, signalling, transmission media, teletraffic, circuit-switched and packet-switched networks etc.	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
2	**apply** the above technological knowledge to solve the problems of telecommunication depending on the situations and requirements	PO(b)	C3	Lectures, Discussions	Assignment, Class test, Final exam

3	**analyse** transmission media, teletraffic, switching systems and network architecture so that desired telecommunication network can be implemented with required grade-of-service and quality-of-service	PO(c)	C4	Lectures, Discussions	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.75.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.75.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Introduction: Principle, evolution, Telecommunication networks, Telephone Exchange, National and International regulatory bodies.
2	4-6	Telephone apparatus: Microphone, speakers, ringer, ASTIC, pulse dialing and tone dialing mechanisms.
3-4	7-12	Side-tone mechanism in Telephone, Local and Central batteries and advanced features.
5-6	13-18	Switching system: Introduction to analog system: Strowger and Crossbar switching system, digital switching systems, space division switching, SPC.
7	19-21	Blocking probability and multistage switching, time division switching and two-dimensional switching.
8	22-24	Traffic analysis: Traffic characterization, grades of service (GOS), network blocking probabilities, delay system and queuing.
9-11	25-33	Modern telephone services and networks: Internet telephony (VoIP), facsimile (Fax), Integrated services digital network (ISDN): N-ISDN and B-ISDN, DSL
12-13	34-39	Asynchronous transfer mode (ATM), FTTx, SONET/SDH
14	40-42	WDM Network and Next Generation Network (NGN).

20.75.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.75.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.75.13 Textbook/References

- Digital Telephony – by John Bellamy, 4th Ed., John Wiley & Sons.
- Telecommunication System Engineering - by Roger L. Freeman, 4th Ed., John Wiley & Sons
- Telecommunication Switching Systems and Networks – by Thiagarajan Viswanathan, PHI
- Connection-Oriented Networks, by Harry G. Perros, John Wiley & Sons

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.76 Description of course EEE 443

Section A: General Information

20.76.1 Course Title	Radar and Satellite Communications
20.76.2 Type of Course	Optional, Theory
20.76.3 Offered to	EEE
20.76.4 Pre-requisite Course(s)	None

Section B: Course Details

20.76.5 Course Content (As approved by the Academic Council)

Introduction to Satellite Communication, Satellite frequency bands, satellite orbits, satellite types, regulation of the spectrum and interference, propagation channel, air interfaces, link budget analysis, Digital Modulation, Error Correction Codes, Multiple Access, receiver synchronization, baseband processing, fixed and mobile applications, basics of satellite networking. Radar equation, radar cross section, information contents in radar signals, noise and clutter, radar detectors, Doppler and MTI radar, pulse compression, CW and FM-CW radar, radar transmitter and receivers, introduction to polarimetric radar and synthetic aperture radar.

20.76.6 Course Objectives

- To understand the fundamental technologies of satellite communications and networking.
- To develop the essential theories of RADAR systems.
- To apply the acquired concepts to design and analyse satellite link budget, satellite orbits and radar signals

20.76.7 Knowledge required

Fundamental understanding communication theory and signal processing covered in EEE 211 Continuous Signals and Linear Systems, EEE 309 Communication Systems I, EEE 311 Digital Signal Processing I and EEE 439 Communication Systems II.

20.76.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Understand** the underlying technology of satellite	PO(a)	C2	Lectures, Discussions	Class test, Assignment, Final exam

	communications and networking				
CO2	**Design** appropriate link parameters, orbit, and modulation scheme for satellite communications	PO(a)	C6	Lectures, Discussions	Class test, Assignment, Final exam
CO3	**Understand** the essential concepts of radar systems	PO(a)	C2	Lectures, Discussions	Class test, Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.76.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.76.10 Lecture Plan

Week	Lectures	Topic	COs
1	**1 – 3**	Radar equation, radar cross section, information contents in radar signals.	**CO3**
2	**4 – 6**	Noise and clutter, radar detectors, Doppler radar.	**CO3**
3	**7 – 9**	MTI radar, Pulse compression, CW and FM-CW radar.	**CO3**
4	**10 – 12**	Radar transmitters and receivers.	**CO3**
5	**13 – 15**	Introduction to polarimetric radar and synthetic aperture radar.	**CO3**
6	**16 – 18**	Introduction to Satellite Communication, Satellite frequency bands, satellite orbits.	**CO1**
7	**19 – 21**	Satellite types, regulation of the spectrum and interference, propagation channel, air interfaces.	**CO1**
8	**22 – 24**	Link budget analysis.	**CO2**
9	**25 – 27**	Digital Modulation, Error Correction Codes, Multiple Access	**CO2**
10	**28 – 30**	Receiver synchronization.	**CO2**
11	**31 – 33**	Baseband processing.	**CO1**
12	**34 – 36**	Fixed and mobile applications of satellites.	**CO1**
13	**37 – 39**	Basics of satellite networking.	**CO1**

20.76.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.

- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.76.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.76.13 Textbook/References

- Satellite Communications, 3rd Edn, Timothy Pratt, Charles W. Bostain, Jeremy E. Allnutt, John Wiley & Sons, 2020, ISBN 9781119482178 (hardback).
- Introduction to RADAR systems, 3rd Edn, Merrill I. Skolnik, Tata McGraw Hill Publishing Company Ltd., 2001, ISBN 0–07–044533–8.
- Satellite Communications, 2nd Edn, Timothy Pratt, Charles W. Bostain, Jeremy E. Allnutt, John Wiley & Sons, 2003, ISBN 9814–12–684–5.
- Satellite Communications Systems – Systems, Techniques and Technology, By G. Maral and M. Bousquet, 5th Edition, Wiley, 2002, ISBN: 978–0–470–71458–4 (H/B).
- RADAR HANDBOOK, 3rd Edn, Merrill I. Skolnik, Tata McGraw Hill Publishing Company Ltd., 2008, ISBN 978–0–07–148547–0.
- Online resources or supplementary materials will be shared with the class on a need basis.

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.77 Description of course EEE 445

Section A: General Information

20.77.1 Course Title	Multimedia Communications
20.77.2 Type of Course	Optional, Theory
20.77.3 Offered to	EEE
20.77.4 Pre-requisite Course(s)	None

Section B: Course Details

20.77.5 Course Content (As approved by the Academic Council)

Introduction and classification of multimedia signals, auditory and visual systems of humans, representations of text, audio and video signals, color representations of visual signals. Compression of multimedia signals for communication: sampling, orthogonal transforms and subband coding of signals. Techniques of compressions for communication: text compression using Huffman and Lempel Ziv coding, audio compression using LPC, GSM/CELP, MP3/AAC, image compression using JPEG, JPEG2000, video compression using H.363, MPEG-4. Mutlimedia communication networks and protocols: MPEG transport stream, H.221 framing, IP-based transport protocols such as UDP, TCP, RTP, DCCP, RTCP and VoIP. Quality of Services. Synchronization and signaling of multimedia communications using SS7, H.323, SIP, SDP, RTSP, Megaco. Digital television, HDTV. Multimedia content creation and management. Wireless communications of multimedia signals. Security issues of multimedia communications.

20.77.6 Course Objectives

- To introduce fundamental concepts related to text/audio/video based multimedia signals
- To compare and analyse different compression techniques and networking protocols related to multimedia signals

- To explain practical aspects and security issues related to multimedia signal transmission through different communication channels

20.77.7 Knowledge required

Fundamental understanding of communication theory and single processing.

20.77.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Explain** fundamental concepts related to text/audio/video based multimedia signals	PO(a)	C1, C2	Lectures, Discussions, Recorded video	Class test, Final exam
CO2	**Analyse** and compare different compression techniques of multimedia signals	PO(b)	C4, C5	Lectures, Discussions, Handouts, Recorded video	Class test, Assignment, Final exam
CO3	**Evaluate** different networking protocols of multimedia signals in communication systems	PO(a)	C3, C5	Lectures, Discussions, Recorded video	Class test, Assignment, Final exam
CO4	**Explain** practical aspects related to wireless communication and security of multimedia signals	PO(f)	C2	Lectures, Discussions, Recorded video	Class test, Final exam

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

Program Outcomes (PO): PO1 Engineering Knowledge, **PO2** Problem Analysis, **PO3** Design/development Solution, **PO4** Investigation, **PO5** Modern tool usage, **PO6** The Engineer and Society, **PO7** Environment and sustainability, **PO8** Ethics, **PO9** Individual work and team work, **PO10**. Communication, **PO11** Project management and finance, **PO12** Life-long Learning
****Cognitive Domain Taxonomy Levels: C1** – Remember, **C2** – Explain, **C3** – Apply, **C4** – Analysis, **C5** – Evaluation, **C6** – Synthesis/Design

20.77.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.77.10 Lecture Plan

Week	Lectures	Topic	COs
1	**1 – 3**	Introduction and classification of multimedia signals, auditory and visual systems of humans.	**CO1**

2	**4 – 6**	Representations of text, audio and video signals, color representations of visual signals.	**CO1**
3	**7 – 9**	Compression of multimedia signals for communication: sampling, orthogonal transforms and subband coding of signals.	**CO2**
4	**10 – 12**	Techniques of compressions for communication: text compression using Huffman and Lempel Ziv coding, audio compression using LPC.	**CO2**
5	**13 – 15**	GSM/CELP, MP3/AAC, image compression using JPEG, JPEG2000.	**CO2**
6	**16 – 18**	Video compression using H.363, MPEG-4.	**CO2**
7	**19 – 21**	Mutlimedia communication networks and protocols: MPEG transport stream, H.221 framing.	**CO3**
8	**22 – 24**	Mutlimedia communication protocols: IP-based transport protocols such as UDP, TCP, RTP, DCCP, RTCP.	**CO3**
9	**25 – 27**	Mutlimedia communication protocols: VoIP. Quality of Services. Synchronization multimedia communications.	**CO3**
10	**28 – 30**	Signalling of multimedia communications using SS7, H.323, SIP, SDP, RTSP, Megaco.	**CO3**
11	**31 – 33**	Digital television, HDTV. Multimedia content creation and management.	**CO4**
12	**34 – 36**	Wireless communications of multimedia signals.	**CO4**
13	**37 – 39**	Security issues of multimedia communications.	**CO4**

20.77.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.77.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.77.13 Textbook/References

- Multimedia Communications – Directions and Innovations. Edited By Jerry D. Gibson, 2001, Academic Press. ISBN: 0 –12–282160–2.
- Multimedia Communication Systems: Techniques, Standards, and Networks, By K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, 1st Edition. Prentice Hall, 2002, ISBN–10: 013031398X, ISBN–13: 978-0130313980 (Relevant Chapters and Topics).
- Telecommunication Switching and Networks. By P. Gnanasivam, 2nd Edition, 2006, New Age International Publishers, ISBN (10): 81–224–2349–3, ISBN (13): 978–81–224–2349–5. (Relevant Chapters and Topics)
- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.78 Description of course EEE 447

Section A: General Information

20.78.1 Course Title	Introduction to Digital Image Processing
20.78.2 Type of Course	Optional, Theory
20.78.3 Offered to	EEE
20.78.4 Pre-requisite Course(s)	None

Section B: Course Details

20.78.5 Course Content (As approved by the Academic Council)

With the advent of large-scale computing power, digital image processing has become one of the most rapidly growing fields in electrical engineering. This course is designed to provide an introduction to the basic concepts, methodologies and algorithms of digital image processing. The introductory topics that will be covered in this course include image acquisition, sampling, representation and transformation, image analysis in frequency domain, image enhancement both in spatial and frequency domains, image restoration from degradation process. Some advanced image processing techniques such as image reconstruction from projections, wavelet and multiresolution processing, and image compression will also be studied in this course.

20.78.6 Course Objectives

The major goal of the course is to furnish a solid foundation for the students to study advanced topics in image analysis such as computer vision systems, biomedical image analysis, multimedia processing, and artificial intelligence. With the exercise of mathematical formulations both in the theoretical and practical problems, the students will be able to implement advanced algorithms of image analysis and evaluate the performance of image processing algorithms and systems.

20.78.7 Knowledge required

Fundamental knowledge of digital signal processing

20.78.8 Course Outcomes

COs	**CO Statements**	**Mapping with POs**	**Learning Domain (Taxonomy Level)**
CO1	**Recall** the fundamental rules of linear algebra and the concept of sampling and frequency to **solve** the engineering problems of image processing.	PO(a)	Cognitive (Comprehension)
CO2	**Relate** the biological system of human vision to **interpret** the functions of image processing units.	PO(a), PO(b)	Cognitive (Comprehension + Analysis)
CO3	**Apply** the deterministic and stochastic theories to **formulate** estimation problems of images in different real-life applications.	PO(a), PO(b)	Cognitive (Comprehension + Analysis + Application)
CO4	**Describe** the properties of multiresolution analysis and **apply** the concepts in wavelet-based image processing.	PO(a), PO(b)	Cognitive (Comprehension + Analysis + Application)
CO5	**Understand** the relation between data and information and **employ** the idea in formulating image compression algorithms.	PO(a), PO(b)	Cognitive (Comprehension + Analysis + Application)

CO6	**Identify** real-life applications of image processing and **design** efficient engineering solution.	PO(a), PO(b), PO(c)	Cognitive (Comprehension + Analysis +Design)

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.78.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.78.10 Lecture Plan

Topics (According to syllabus in Academic Calendar, 2021)	**Lectures (**Weeks)	**Mapping with COs**
Introduction: Historical perspective, classical and emerging applications, image acquisition, sampling, representation, image processing system	1-3 (1)	CO1
Visual Sensors: Human visual system, imaging characteristics of electromagnetic spectrum, imaging sensors, contrast in image, just noticeable difference	4-6 (2)	CO1 CO2
Image Transforms: Image intensity transformations, stochastic transformation, deterministic transformation, coordinate transformation, smoothing and sharpening filters, Fuzzy filters, 2D DFT and its properties, filtering in frequency domain, implementation of 2D DFT and 2D IDFT	7-15 (3-5)	CO1 CO3
Image Restoration: Linear degradation model for images, noise models and estimation of parameters, denoising, linear position invariant degradation and estimation of degradation function, inverse filtering, image reconstruction from projections	16-24 (6-8)	CO1 CO3
Wavelets for Images: History of wavelet, motivation of scale-space theory, subband coding, multiresolutional analysis, 2D DWT, fast implementation of wavelets, wavelet packet analysis, and applications of wavelets in image processing	25-30 (9-10)	CO1 CO4
Image Compression: Fundamentals of image compression, compression models and standards, basic compression methods for grayscale and binary images, block transform coding and JPEG, optimal quantization, wavelet-based image compression and JPEG-2000, image watermarking	31-36 (11-12)	CO1 CO5
Review	37-39 (13)	CO6

20.78.11 Assessment Strategy

- **Class Attendance and Participation**
- Class participation and attendance will be recorded in every class. Participation and attendance for the students may be considered in case the student could not attend the class due to a valid reason (power failure, internet problem, device problem, health problem, etc.). The student has to inform the teacher over email in case of such occurrences. A maximum of three (03) such missed classes can be considered for this course
- **Quiz, Assignment, Viva and Presentation**
- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- **Final Examination**
- A comprehensive term final examination will be held at the end of the Term following the guideline of Academic Council.

20.78.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.78.13 Textbook/References

- Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing," Fourth Edition, Parsons Education, 2018
- W. K. Pratt, "Digital Image Processing," Fourth Edition, Wiley Inter-Science, 2007
- M. Petrou and P. Bosdogianni, "Image Processing – The Fundamentals," Second Edition, Wiley Inter-Science, 2010
- A. K. Jain, "Fundamentals of Digital Image Processing," Prentice Hall, 1989

20.79 Description of course EEE 449

Section A: General Information

20.79.1 Course Title	Information and Coding Theory
20.79.2 Type of Course	Optional, Theory
20.79.3 Offered to	EEE
20.79.4 Pre-requisite Course(s)	None

Section B: Course Details

20.79.5 Course Content (As approved by the Academic Council)

Entropy and Mutual Information: Entropy, joint entropy and conditional entropy, Relative entropy and mutual information, chain rules for entropy, relative entropy and mutual information, Jensen's inequality and log-sum inequality

Differential Entropy: Differential entropy and discrete entropy, joint and conditional differential entropy, properties of differential entropy, relative entropy and mutual information

Entropy Rates of Stochastic Process: Markov Chain, Entropy rate and hidden Markov models

Source Coding: Kraft inequality, optimal codes, Huffman code and its optimality, Shannon-Fano-Elias coding, arithmetic coding

Channel Capacity: Binary symmetric channels and properties of channel capacity, channel coding theorems, joint source and channel coding theorem

Block coding and decoding, BCH, RS codes, Convolutional coding, Viterbi Decoder, Turbo codes, decoding techniques STBC, SFBC, STFBC

Gaussian Channel: Introduction to Gaussian Channel, Band limited channel, Parallel Gaussian Channel, Gaussian Channel with feedback.

20.79.6 Course Objectives

- The main objective of this course is to introduce information theoretic concepts and develop the bounds on source coding and channel capacity.
- Students will also become familiar with different source encoding and channel encoding techniques.

20.79.7 Knowledge required

Basics of communication systems, random signals and processes.

20.79.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
1	**Understand** entropy, mutual information. Differential entropy, entropy rate, source coding, channel coding, channel capacity	PO(a)	C1, C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
2	**Employ** source coding, channel coding theorems to solve various communication problems.	PO(a)	C1, C2, C3, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.79.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
		√	√					√	√	√									

20.79.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-6	1-2	Entropy and Mutual Information: Entropy, joint entropy and conditional entropy, Relative entropy and mutual information,	CO1

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
		chain rules for entropy, relative entropy and mutual information, Jensen's inequality and log-sum inequality	CO2
7-12	3-4	Differential Entropy: Differential entropy and discrete entropy, joint and conditional differential entropy, properties of differential entropy, relative entropy and mutual information	CO1 CO2
13-18	5-6	Entropy Rates of Stochastic Process: Markov Chain, Entropy rate and hidden Markov models	CO1 CO2
19-24	7-8	Source Coding: Kraft inequality, optimal codes, Huffman code and its optimality, Shannon-Fano-Elias coding, arithmetic coding	CO1 CO2
25-30	9-10	Channel Capacity: Binary symmetric channels and properties of channel capacity, channel coding theorems, joint source and channel coding theorem	CO1 CO2
31-36	11-12	Block coding and decoding, BCH, RS codes, Convolutional coding, Viterbi Decoder, Turbo codes, decoding techniques STBC, SFBC, STFBC	CO1 CO2
37-42	13-14	Gaussian Channel: Introduction to Gaussian Channel, Band limited channel, Parallel Gaussian Channel, Gaussian Channel with feedback	CO1 CO2

20.79.11 Assessment Strategy

- Class participation and attendance will be recorded in every class.
- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.79.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.79.13 Textbook/References

- Elements of Information Theory by Joy A. Thomas and Thomas M. Cover
- Other Resources (Online Resources or Others, if any)

20.80 Description of course EEE 491

Section A: General Information

20.80.1 Course Title	Introduction to Medical Imaging
20.80.2 Type of Course	Optional, Theory
20.80.3 Offered to	EEE
20.80.4 Pre-requisite Course(s)	None

Section B: Course Details

20.80.5 Course Content (As approved by the Academic Council)

Introduction to imaging, medical imaging modalities, Medical imaging before x-rays, Hippocratic thermography, dissection, laproscopy, X-radiography, Computed tomography (CT), evolution of CT scanner design, image reconstruction algorithms, filtered back-projection method, iterative method, low dose computed tomography, Ultrasound, Sonar and other early applications of acoustics, basic principles of ultrasound imaging, Evolution of ultrasound technology and clinical applications, Magnetic resonance imaging, Early use of nuclear magnetic resonance (NMR) spectroscopy, Principles of NMR and MRI, Evolution of magnetic resonance imaging (MRI) technology and clinical applications, development and applications of functional MRI, Introduction to Nuclear imaging.

20.80.6 Course Objectives

Not provided

20.80.7 Knowledge required

N/A

20.80.8 Course Outcomes

COs	**CO Statements**	**Mapping with POs**	**Learning Domain (Taxonomy Level)**
CO1	**Introduce** the major medical imaging modalities: X-Ray, CT, Ultrasound and MRI.	PO(a)	Cognitive (Comprehension)
CO2	**Understand** the mathematical and physical principles, instrumentation and image quality issues in medical imaging.	PO(a), PO(b)	Cognitive (Comprehension + Analysis)
CO3	**Apply** the fundamentals of signal and image processing for the formation of medical images and **analyze** image quality issues.	PO(a), PO(b)	Cognitive (Comprehension + Analysis + Application)
CO4	**Identify** clinical applications of medical imaging and **develop** efficient engineering solution.	PO(a), PO(b), PO(c)	Cognitive (Comprehension + Analysis+Application)

20.80.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.80.10 Lecture Plan

Not Provided

20.80.11 Assessment Strategy
Not provided

20.80.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.80.13 Textbook/References
Not provided

20.81 Description of course EEE 493

Section A: General Information

20.81.1 Course Title	Digital Filter Design
20.81.2 Type of Course	Optional, Theory
20.81.3 Offered to	EEE
20.81.4 Pre-requisite Course(s)	None

Section B: Course Details

20.81.5 Course Content (As approved by the Academic Council)
Application of digital filters, analog filters, linear phase FIR filters, optimal filter design, Remez exchange algorithm, multiband filters, approximately linear phase IIR filter, all pass filter, design of IIR filter using optimization methods: Newton's method, Quasi-Newton algorithms, Minimax algorithms, improved Minimax algorithms, filter design in time-frequency domain, design of special filters: Hilbert transformer, narrowband filter, fractional delay filter, Wiener filter, filter design using Kalman filter/parallel Kalman filter, Wavelet filter.

20.81.6 Course Objectives
The major goal of the course is to provide a solid foundation for the students to study advanced topics in designing digital filters including the recursive, non-recursive and special type of filters. With the exercise of mathematical formulations for given specifications of practical problems, the students will be able to design and evaluate the performance of digital filters.

20.81.7 Knowledge required
N/A

20.81.8 Course Outcomes
Upon completion of this course, the successful student will be able to-

COs	CO Statements	Mapping with POs	Learning Domain (Taxonomy Level)
CO1	**Recall** the concept of sampling and frequency, and the fundamentals of digital signal processing to **solve** the engineering problems of digital filter design.	PO(a)	Cognitive (Comprehension)

CO2	**Apply** the theory of Z-transform and Fourier transform to **formulate** the parameters of the filter as per design specifications.	PO(a), PO(b)	Cognitive (Comprehension + Analysis + Application)
CO3	**Understand** the methodology of optimization technique and **employ** the idea in obtaining the parameters of the digital filters.	PO(a), PO(b)	Cognitive (Comprehension + Analysis + Application)
CO4	**Identify** real-life applications of digital filter and **design** efficient engineering solution.	PO(a), PO(b), PO(c)	Cognitive (Comprehension + Analysis + Design)

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.81.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.81.10 Lecture Plan

Topics (According to syllabus in Academic Calendar, 2021)	**Lectures (**Weeks)	**Mapping with COs**
Introduction: Preliminaries of finite word length of digital filters, review of Z-transforms and discrete Fourier transform, application of digital filters	1-3 (1)	CO1
Analog Filters: Introductory concepts, approximations by Butterworth filter, Chebyshev filter, elliptic filter, and Bessel filter	4-6 (2)	CO1
Recursive Filters: IIR filter, Realizability constraint, invariant-impulse-response method, matched z-transformation, bilinear transformation. Filter design procedure, constant group delay, amplitude equalization	7-12 (3-4)	CO2
Non-recursive Filters: FIR filter, Properties of non-recursive filters, window functions, numerical analysis, comparisons between recursive and non-recursive filters	13-18 (5-6)	CO2
Finite Length Digital Filters: Number representation, quantization, signal scaling, error-spectrum shaping	19-24 (7-8)	CO2
Recursive Filters and Optimization: Problem formulation, quasi-Newton algorithm, minimax algorithm, designing recursive delay equalizers, real-life appltcations	25-30 (9-10)	CO2 CO3 CO4

Topics (According to syllabus in Academic Calendar, 2021)	Lectures (Weeks)	Mapping with COs
Non-recursive Filters and Optimization: Problem formulation, Remez exchange algorithm, gradient information, search methods, digital differentiators, multiband filters, real-life appltcations	31-36 (11-12)	CO2 CO3 CO4
Special Filters:, Hilbert transform, narrow band filter, Wiener filter, Kalman Filter, Wavelet filters	37-39 (13)	CO2 CO3

20.81.11 Assessment Strategy

- **Class Attendance and Participation**

Class participation and attendance will be recorded in every class. Participation and attendance for the students may be considered in case the student could not attend the class due to a valid reason (power failure, internet problem, device problem, health problem, etc.). The student has to inform the teacher over email in case of such occurrences. A maximum of three (03) such missed classes can be considered for this course

- **Quiz, Assignment, Viva and Presentation**

Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.

- **Final Examination**

A comprehensive term final examination will be held at the end of the Term following the guideline of Academic Council.

20.81.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.81.13 Textbook/References

- Andreas Antoniou, “Digital Filters: Analysis Design, and Applications,” Second Edition, McGraw-Hill, 2008
- Dietrich Schlichthärle, “Digital Filters: Basics and Design,” Springer Nature, 2011
- Takao Hinamoto, Wu-Sheng Lu, “Digital Filter Design and Realization,” River Publishers, 2017

20.82 Description of course EEE 495

Section A: General Information

20.82.1 Course Title	Speech Communication
20.82.2 Type of Course	Optional, Theory
20.82.3 Offered to	EEE
20.82.4 Pre-requisite Course(s)	None

Section B: Course Details

20.82.5 Course Content (As approved by the Academic Council)

Speech production and phonetics: articulatory and acoustic features; Speech analysis: formant, pitch, time and frequency domain analysis techniques, spectrogram; Speech coding: linear predictive coding, vocoders, vector quantization; Speech enhancement: spectral subtraction based techniques; Speech synthesis: formant synthesizers; Speech and speaker recognition: feature extraction and conventional recognition methods.

20.82.6 Course Objectives

- To demonstrate fundamental concepts, algorithms, and applications of digital speech signal processing.
- To enable students to apply digital signal processing theories to speech communication and application fields to provide a basis for the study of more advanced topics.

20.82.7 Knowledge required

Fundamental understanding of concepts of Digital Signal Processing course and Mathematics courses.

20.82.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the digital signal processing principles to solve problems relevant to the time and frequency domain operations of speech signals	PO(a)	C3	Lectures, Discussions, Practice problem solving sessions	Assignment, Class test, Final exam
2	**analyse** the speech signal processing techniques applied to real speech data based on the underlying principles	PO(b)	C4	Lectures, Discussions, Practice problem solving sessions	Assignment, Presentation, Class test, Final exam
3	**design** efficient algorithms for speech feature extraction, different applications, i.e. speech recognition and speaker identification	PO(c)	C5, C6	Lectures, Discussions, Practice problem solving sessions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.82.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.82.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Speech Production, excitation, voiced and unvoiced speech and silence
2	4-6	Phonetics: articulatory and acoustic features

Week	Lectures	Topic
3	7-9	Speech analysis: formant, pitch, time and frequency domain analysis techniques
4	10-12	Spectrogram analysis, non-linear scales (mel and bark scales)
5	13-15	Speech Modelling, Linear predictive coding, Speech coding
6	16-18	Vocoders, vector quantization for speech coding
7	19-21	Spectral subtraction and other speech enhancement techniques
8	20-24	Speech synthesis, Formant synthesizers
9	25-27	Speech feature extraction and applications
10	28-30	Speech Recognition
11	31-33	Speaker Identification
12	34-36	Practice Problems
13	37-39	Revision of the course materials

20.82.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.82.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.82.13 Textbook/References

- O'Shaughnessy. Speech communications: Human and machine. 1999 (required)
- Deller Jr, John R. "Discrete-time processing of speech signals." In Discrete-time processing of speech signals, pp. 908-908. 1993 (required)

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.83 Description of course EEE 497

Section A: General Information

20.83.1 Course Title	Telecommunication Networks
20.83.2 Type of Course	Optional, Theory
20.83.3 Offered to	EEE
20.83.4 Pre-requisite Course(s)	None

Section B: Course Details

20.83.5 Course Content (As approved by the Academic Council)

- Introduction to telecommunication system and network, Network architecture and topology: ring, bus, tree, star, types of networks
- Telecommunication switching system: TDM switching, space division switching, time-space switching, circuit switching and packet switching, switching fabrics
- Layering architecture and protocol stacks; overview on Application layer, TCP, UDP
- Access technologies: FDMA, TDMA, CDMA, Demand assignment multiple access, CSMA, CSMA-CD, CSMA-CA
- IP protocol and addressing, Routing: principles, hot potato routing, deflection routing, virtual path routing, shortest path routing, IP routing protocols
- Integrated service digital network (ISDN): switching and signalling, signalling system-7, protocols and standards, B-ISDN and Asynchronous transfer mode (ATM)
- Voice over IP
- WDM, Synchronous optical networks (SONET) and synchronous digital hierarchy (SDH), IP over SONET, WDM access technologies: hybrid fiber coax (HFC), fiber to the X (FTTX), Ethernet passive optical network (EPON), gigabit PON (GPN), next generation networks (NGN), Next generation SONET/SDH, Multiple Protocol Label Switching (MPLS), MPLS over WDM

20.83.6 Course Objectives

- To provide the fundamental knowledge of telephone networking, IP networking, and optical networking that include PSTN, ISDN, WLAN, VoIP, ATM, SONET and GPON etc
- To build capacity of the students in telecommunication networking technologies.

20.83.7 Knowledge required

Fundamental understanding of the concepts of Telecommunication systems.

20.83.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**understand** the various topologies and protocols in telecommunication networks	PO(a)	C2	Lectures, Discussions	Assignment, Class test, Final exam
2	**understand** the various switching and access schemes for telecommunication network and **evaluation** of their performances	PO(a)	C2, C5	Lectures, Discussions	Assignment, Class test, Final exam
3	**understand** the various telecommunication networking technologies	PO(a)	C2	Lectures, Discussions	Assignment, Final exam

Cognitive Domain Taxonomy Levels: C1 – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)** Communication, **PO(k)** Project management and finance, PO(l) Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.83.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.83.10 Lecture Plan

Week	**Lectures**	**Topic**
1	1-3	Introduction to telecommunication system and network, Network architecture and topology: ring, bus, tree, star, types of networks
2	4-6	Telecommunication switching system: TDM switching, space division switching, time-space switching, circuit switching and packet switching, switching fabrics
3	7-9	Layering architecture and protocol stacks; overview on Application layer, TCP, UDP
4-5	10-15	Access technologies: FDMA, TDMA, CDMA, Demand assignment multiple access, CSMA, CSMA-CD, CSMA-CA
6-8	16-24	IP protocol and addressing, Routing: principles, hot potato routing, deflection routing, virtual path routing, shortest path routing, IP routing protocols
9-10	25-30	Integrated service digital network (ISDN): switching and signalling, signalling system-7, protocols and standards, B-ISDN and Asynchronous transfer mode (ATM)
11	31-33	Voice over IP
12-13	34-39	WDM , Synchronous optical networks (SONET) and synchronous digital hierarchy (SDH), IP over SONET, WDM access technologies: hybrid fiber coax (HFC), fiber to the X (FTTX), Ethernet passive optical network (EPON), gigabit PON (GPN), next generation networks (NGN), Next generation SONET/SDH, Multiple Protocol Label Switching (MPLS), MPLS over WDM

20.83.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.83.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.83.13 Textbook/References

- “Telecommunication Switching and Networks”, 2nd Edition, P. Gnanasivam
- “Introduction to Telecommunications Network Engineering”, 2nd Edition, Tarmo Anttalainen
- “Communication Networks,” 2nd Edition, Alberto Leon-Garcia Indra Widjaja
- “Computer Networks” Andrew S. Tanenbaum and David. J. Wetherall
- “Data Communications and Networking, 5th Edition, BEHROUZ A. FOROUZAN
- “Fundamentals of Telecommunications”, Roger L. Freeman

- “Telecommunication System Engineering”, Roger L. Freeman
- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.84 Description of course EEE 498

Section A: General Information

20.84.1 Course Title	Telecommunication Networks Laboratory
20.84.2 Type of Course	Optional, Sessional
20.84.3 Offered to	EEE
20.84.4 Pre-requisite Course(s)	None

Section B: Course Details

20.84.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 497: Telecommunication Networks

20.84.6 Course Objectives

- To provide clear understanding of the network protocols, configuration and their performance through simulators
- To make capable in doing project for real life application by applying communication technologies

20.84.7 Knowledge required

Fundamental understanding of concepts of the physics of solid-state devices and engineering electromagnetics

20.84.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** software/modern tool to **understand** how to configure communication networks	PO(a), PO(e)	C2, C3	Lectures, Lab demonstrations	Lab-tasks, Lab-tests, Reports
2	**Evaluate** and **analysis** the performance various network technologies/protocols	PO(a), PO(d)	C4, C5	Lectures, Lab demonstrations	Lab-tasks, Report
3	**demonstrate** effective individual and team-working skills	PO(i)	A3		Peer and instructor assessment

Cognitive Domain Taxonomy Levels: C1 – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)** Communication, **PO(k)** Project management and finance, PO(l) Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.84.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CA1	CA2	CA3	CA4	CA5
				√			√	√	√	√					√	√	√		

20.84.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	IP Addressing and Network Configuration
3	2	Sub-networking and network configuration
4	3	Comparing the performance of different LAN devices
5	4	Performance analysis of different network topologies
6	-	Evaluation of the learning
7	5	Study the performance of WLANs
8	6	Study the performance of routing protocol based on distance-vector algorithm
9	7	Study of transmission Control Protocols
11	8	Study of Asynchronous transfer mode
12	-	Evaluation on the learning

20.84.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.

20.84.12 Distribution of Marks

To be decided by course instructor(s)

20.84.13 Textbook/References

- “Telecommunication Switching and Networks”, 2nd Edition, P. Gnanasivam
- “Introduction to Telecommunications Network Engineering”, 2nd Edition, Tarmo Anttalainen
- “Communication Networks,” 2nd Edition, Alberto Leon-Garcia Indra Widjaja
- Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.85 Description of course EEE 499

Section A: General Information

20.85.1 Course Title	Wireless and Mobile Networks
20.85.2 Type of Course	Optional, Theory
20.85.3 Offered to	EEE
20.85.4 Pre-requisite Course(s)	None

Section B: Course Details

20.85.5 Course Content (As approved by the Academic Council)

Overview of wireless networks, different generations of wireless networks. Wireless Transmission techniques: baseband transmission, Carrier modulated band pass transmission, Ultra wideband (UWB) transmission, wireless modems, Spread Spectrum techniques; direct system (DS) and Frequency Hopping (FH) Spread Spectrum Systems. Wireless Network topologies, Cellular networks, Cellular fundamentals, carrier to co channel interference ratio (C/CCI), Capacity expansion techniques. Access Techniques: FDMA, TDMA, CDMA, narrowband and wideband Access technologies, OFDMA, Hybrid multiple Access techniques: FDMA-TDMA, OFDMA-TDMA, MC-CDMA; Spectral Efficiency and Capacity of wireless networks. Diversity in Mobile networks: MIMO Wireless Networks, Space, Time and Frequency coding techniques. Switching technologies: Circuit switching, packet switching, Protocol Stack, Random Access Technology and Wireless LANs, Aloha, Slotted Aloha, CSMA-CA and W-LAN Protocols, Routing in Wireless Networks, Optimal Routing and Scheduling, Single-hop and Multi-hop Networks. Quality of Service (QoS) in Wireless Networks, Traffic Management, Wireless Adhoc Networks, Wireless Sensor Networks. Cellular Network standards: GSM, IS-95, UMTS, CDMA-2000, W-CDMA, 3G and future generation.

Note: For total credit hour fulfillment of the degree of B. Sc. Engg (EEE), credits of either EEE 497 or EEE 499 will be counted but not both.)

20.85.6 Course Objectives

- The main objective of this course is to introduce wireless and mobile network topology, transmission, capacity expansion technique, multiple access technique, diversity, switching, routing, traffic, QoS, standard.

20.85.7 Knowledge required

Basics of communication systems, random signals and processes

20.85.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
1	**Understand** wireless and mobile network topology, transmission, capacity expansion technique, multiple access technique, diversity, switching, routing, traffic, QoS, standard	PO(a)	C1, C2	Lectures, Tutorials, Homework Problems	Assignment, Class test, Final exam
2	**Employ** capacity expansion technique, multiple access technique, diversity, switching, routing to solve problems in wireless and mobile networks	PO(a)	C1, C2, C3, C4	Lectures, Tutorials, Homework Problems	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: C1 – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)** Communication, **PO(k)** Project management and finance, PO(l) Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.85.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CA1	CA2	CA3	CA4	CA5
		√	√					√	√	√									

20.85.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-6	1-2	Overview of wireless networks, different generations of wireless networks.	CO1 CO2
7-12	3-4	Wireless Transmission techniques: baseband transmission, Carrier modulated band pass transmission, Ultra wideband (UWB) transmission, wireless modems, Spread Spectrum techniques; direct system (DS) and Frequency Hopping (FH) Spread Spectrum Systems	CO1 CO2
13-18	5-6	Wireless Network topologies, Cellular networks, Cellular fundamentals, carrier to co channel interference ratio (C/CCI),	CO1 CO2
19-24	7-8	Capacity expansion techniques. Access Techniques: FDMA, TDMA, CDMA, narrowband and wideband Access technologies, OFDMA, Hybrid multiple Access techniques: FDMA-TDMA, OFDMA-TDMA, MC-CDMA; Spectral Efficiency and Capacity of wireless networks.	CO1 CO2
25-30	9-10	Diversity in Mobile networks: MIMO Wireless Networks, Space, Time and Frequency coding techniques.	CO1 CO2
31-36	11-12	Switching technologies: Circuit switching, packet switching, Protocol Stack, Random Access Technology and Wireless LANs, Aloha, Slotted Aloha, CSMA-CA and W-LAN Protocols, Routing in Wireless Networks, Optimal Routing and Scheduling, Single-hop and Multi-hop Networks.	CO1 CO2
37-39	13	Quality of Service (QoS) in Wireless Networks, Traffic Management, Wireless Adhoc Networks, Wireless Sensor Networks.	CO1 CO2
40-42	14	Cellular Network standards: GSM, IS-95, UMTS, CDMA-2000, W-CDMA, 3G and future generation.	CO1 CO2

20.85.11 Assessment Strategy

- Class participation and attendance will be recorded in every class.
- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.85.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.85.13 Textbook/References

- Alberto Leon Garcia, and Widjaja Indra. "Communication Networks: Fundamental Concepts and Key Architectures." -2nd edition. (2004).
- Dharama Prakash Agrawal and Qing-An Zeng. "Introduction to Wireless and Mobile Systems". -3rd edition (2012)
- Vijay K. Garg. "Wireless Communications and Networking" (2007)
- Aftab Ahmad. Wireless and mobile data networks. John Wiley & Sons (2005).
- Yu-Kwong Ricky Kwok, Vincent K.N. Lau - Wireless Internet and Mobile Computing, Interoperability and Performance-Wiley-IEEE Press (2007)

Electronics group

20.86 Description of course EEE 451

Section A: General Information

20.86.1 Course Title	Processing and Fabrication Technology
20.86.2 Type of Course	Optional, Theory
20.86.3 Offered to	EEE
20.86.4 Pre-requisite Course(s)	None

Section B: Course Details

20.86.5 Course Content (As approved by the Academic Council)

Substrate materials: Crystal growth and wafer preparation, epitaxial growth technique, molecular

beam epitaxy, chemical vapor phase epitaxy and chemical vapor deposition (CVD). Doping techniques: Diffusion and ion implantation. Growth and deposition of dielectric layers: Thermal oxidation, CVD, plasma CVD, sputtering and silicon-nitride growth. Introduction to Semiconductor Characterization Tools. Etching: Wet chemical etching, silicon and GaAs etching, anisotropic etching, selective etching, dry physical etching, ion beam etching, sputtering etching and reactive ion etching. Cleaning: Surface cleaning, organic cleaning and RCA cleaning. Lithography: Photo-reactive materials, pattern generation, pattern transfer and metalization. Steps of lithography. Non-optical lithography. Discrete device fabrication: Diode, transistor, resistor and capacitor. Integrated circuit fabrication: Isolation - pn junction isolation, mesa isolation and oxide isolation. BJT based microcircuits, p-channel and n-channel MOSFETs, complimentary MOSFETs and silicon on insulator devices. Testing, bonding and packaging.

20.86.6 Course Objectives

- To familiarize the microelectronic fabrication processes and techniques to students.
- To explain the working principles and models of individual fabrication processes.

- To understand conventional lithographic processes and its limitations.

20.86.7 Knowledge required

Fundamental understanding of electronic devices and concepts of semiconducting materials.

20.86.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**explain** the unit processes of microelectronic fabrication, thin-film growth, sputtering and conventional lithographic techniques.	PO(a), PO(e)	C2, C5	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse** unit process models, tools, and devices by applying concepts of micro and nano fabrication.	PO(a), PO(d)	C3, C4	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

Analysis, **C5** – Evaluation, **C6** – Synthesis/Design

20.86.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.86.10 Lecture Plan

Week	Lectures	Topic
1	3	**Why** Electronic fabrication is important: scales, sizes, technologies.
2-5	4-18	**Unit Processes:** Diffusion, Oxidation, Annealing, ion implantation, etching.
6-7	19-24	Methods of growth and sputtering: physical vapor deposition, chemical vapor deposition, MBE.
8-10	25-30	Conventional **Lithography**: 10-step process. Hard and soft bake, photoresist, alignment and exposure, develop.
11	31-33	Non-conventional techniques.
12-13	34-39	Cleanroom, bonding and packaging techniques, sources of contamination.
14	40-42	CMOS Technology

20.86.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.86.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.86.13 Textbook/References

- **Fundamentals of Microfabrication: The Science of Miniaturization** by Marc J. Madou, 2nd Ed.
- **Introduction to Microelectronic Fabrication** by Richard C. Jaeger.
- **Semiconductor Devices: Physics and Technology,** by S. M. Sze and M. K. Lee, 3rd ed. 2012.
- Online resources or supplementary reading materials will be shared with the class and MS Teams.

Besides going through relevant topics of the textbooks, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.87 Description of course EEE 455

Section A: General Information

20.87.1 Course Title	Compound Semiconductor Devices
20.87.2 Type of Course	Optional, Theory
20.87.3 Offered to	EEE
20.87.4 Pre-requisite Course(s)	None

Section B: Course Details

20.87.5 Course Content (As approved by the Academic Council)

- *Reviews of Compound semiconductor:* Zinc-blend crystal structures, growth techniques, alloys, band gap, basic opto-electronic properties, density of carriers in intrinsic and doped compound semiconductors.
- *Introduction to Physics of Hetero-Junctions:* Band alignment, band offset, Anderson's rule, single and double sided hetero-junctions, quantum wells and quantization effects, lattice mismatch and strain and common hetero-structure material systems.
- *Hetero-Junction diode:* Band banding, carrier transport and I-V characteristics.
- *Hetero-junction field effect transistor:* Structure and principle, band structure, carrier transport and I-V characteristics. Nonideal effects, frequency response, high electron mobility transistor.
- *Hetero-structure bipolar transistor (HBT):* Structure and operating principle, quasi-static analysis, extended Gummel-Poon model, Ebers-Moll model, secondary effects and band diagram of a graded alloy base HBT.
- *Resonant Tunnelling diodes:* physics and operation.
- *Resonant Tunnelling Transistors:* device physics, operation and characteristics

20.87.6 Course Objectives

- To deliver knowledge of the physics and properties of compound semiconductors.
- To provide fundamental understanding of compound semiconductor-based heterostructure devices such as heterojunction diode, heterojunction bipolar transistor, resonant tunnelling diode and transistor.

- To develop ability to analysis and design electronic devices based on compound semiconductors.

20.87.7 Knowledge required

Fundamental understanding of concepts of the engineering electromagnetics and the physics of electronic materials and devices.

20.87.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**implement** the physics-based knowledge to solve problems relevant to compound semiconductor materials and heterostructure devices	PO(a)	C3	Lectures, Interaction with students	Assignment, Class test, Final exam
2	**analyse** the operation of heterostructure devices based on the operational principle	PO(b)	C4	Lectures, Interaction with students	Assignment, Class test, Final exam
3	**design** electronic devices based on compound semiconductors	PO(c)	C6	Lectures, Design problem solving sessions, Interactive discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.87.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
				√	√		√	√	√	√					√	√	√		

20.87.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Reviews of Compound semiconductor:* Zinc-blend crystal structures, growth techniques, alloys, band gap
2	4-6	*Reviews of Compound semiconductor:* Basic opto-electronic properties, density of carriers in intrinsic and doped compound semiconductors
3	7-9	*Introduction to Physics of Hetero-Junctions:* Band alignment, band offset, Anderson’s rule, single and double sided hetero-junctions, quantum wells and quantization effects
4	10-12	*Introduction to Physics of Hetero-Junctions:* Lattice mismatch and strain and common hetero-structure material systems

Week	Lectures	Topic
5	13-15	*Hetero-Junction diode:* Band banding, carrier transport and I-V characteristics
6	16-18	*Hetero-junction field effect transistor:* Structure and principle, band structure, carrier transport and I-V characteristics
7	19-21	*Hetero-junction field effect transistor:* Nonideal effects, frequency response, high electron mobility transistor
8	20-24	*Hetero-structure bipolar transistor (HBT):* Structure and operating principle
9	25-27	*Hetero-structure bipolar transistor (HBT):* Quasi-static analysis, extended Gummel-Poon model, Ebers-Moll model
10	28-30	*Hetero-structure bipolar transistor (HBT): S*econdary effects and band diagram of a graded alloy base HBT
11	31-33	*Resonant Tunnelling diodes:* physics and operation
12	34-36	*Resonant Tunnelling Transistors:* device physics, operation and characteristics

20.87.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.87.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.87.13 Textbook/References

- Principles of Electronic Materials and Devices by Safa Kasap (3rd edition)
- Semiconductor Optoelectronic Devices by Pallab Bhattacharya (2nd edition)
- Semiconductor Device Physics and Design by Umesh K. Mishra and Jasprit Singh
- Physics of Semiconductor Devices by Michael Shur

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.88 Description of course EEE 459

Section A: General Information

20.88.1 Course Title	Optoelectronics
20.88.2 Type of Course	Optional, Theory
20.88.3 Offered to	EEE
20.88.4 Pre-requisite Course(s)	None

Section B: Course Details

20.88.5 Course Content (As approved by the Academic Council)

- *Optical properties in semiconductor*: Direct and indirect band-gap materials, basic transitions in semiconductors, radiative and non-radiative recombination, optical absorption, photo-generated excess carriers, minority carrier life time, luminescence and quantum efficiency in radiation.
- *Properties of light*: Particle and wave nature of light, polarization, interference, diffraction and blackbody radiation.
- *Light emitting diode (LED)*: Principles, materials for visible and infrared LED, internal and external efficiency, loss mechanism, structure and coupling to optical fibers. Double-Heterostructure (DH) LEDs, Characteristics, Surface and Edge emitting LEDs.
- *Stimulated emission and light amplification*: Spontaneous and stimulated emission, Einstein relations, population inversion, absorption of radiation, optical feedback and threshold conditions.
- *Semiconductor Lasers*: Population inversion in degenerate semiconductors, laser cavity, operating wavelength, threshold current density, power output, elementary laser diode characteristics, hetero-junction lasers, optical and electrical confinement. single frequency solid state lasers-distributed Bragg reflector (DBR), distributed feedback (DFB) laser.
- Introduction to quantum well lasers. Introduction to quantum well lasers, Vertical Cavity Surface Emitting Lasers (VCSELs), optical laser amplifiers.
- *Photo-detectors*: Photoconductors, junction photo-detectors, PIN detectors, avalanche photodiodes, hetero-junction photodiodes, Schottky photo-diodes and phototransistors. Noise in photo-detectors. PIN and APD. Photo-detector design issues.
- *Solar cells*: Solar energy and spectrum, silicon and Schottkey solar cells.
- *Modulation of light*: Phase and amplitude modulation, electro-optic effect, acousto-optic effect and magneto-optic devices. Introduction to integrated optics.

20.88.6 Course Objectives

- To provide a physics-based understanding of optical properties of materials and electrical and optical characteristics of devices such as, LED, LASER, Photodetectors, Photovoltaic Solar Cells, Electro-Optic Modulators.
- To establish the theoretical foundation required for designing optoelectronic devices so that those can be applied for practical optoelectronic electronic applications

20.88.7 Knowledge required

Fundamental understanding of concepts of the physics of solid-state devices and engineering electromagnetics

20.88.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the physics-based knowledge to solve problems relevant the operation of optoelectronic devices	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse** the operation of Optoelectronic devices based on the underlying physics	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**design** Optoelectronic devices such that specified performance characteristics are attained	PO(c)	C6	Lectures, Discussions	Assignment, Class test, Final exam

4	**present** designed optoelectronic devices/systems	PO(j)	A3	Interactive discussions	Assignment and Presentation

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.88.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
				√	√		√	√	√	√					√	√	√		

20.88.10 Lecture Plan

Week	Lectures	Topic
1	1-3	*Optical properties in semiconductor*: Direct and indirect band-gap materials, basic transitions in semiconductors, radiative and non-radiative recombination.
2	4-6	*Optical properties in semiconductor*: Optical absorption, photo-generated excess carriers, minority carrier life time, luminescence and quantum efficiency in radiation.
3	7-9	*Carrier transport processes and excess carriers:* Drift and diffusion, generation and recombination of excess carriers, built-in-field, recombination-generation SRH formula
4	10-12	*Light emitting diode (LED):* Principles, materials for visible and infrared LED, internal and external efficiency.
5	13-15	*Light emitting diode (LED):* Loss mechanism, structure and coupling to optical fibers.
6	16-18	*Light emitting diode (LED):* Double-Heterostructure (DH) LEDs, Characteristics, Surface and Edge emitting LEDs.
7	19-21	*Stimulated emission and light amplification*: Spontaneous and stimulated emission, Einstein relations, population inversion, absorption of radiation, optical feedback and threshold conditions.
8	20-24	*Semiconductor Lasers*: Population inversion in degenerate semiconductors.
9	25-27	*Semiconductor Lasers*: Laser cavity, operating wavelength, threshold current density, power output, elementary laser diode characteristics.
10	28-30	*Semiconductor Lasers*: Hetero-junction lasers, optical and electrical confinement. single frequency solid state lasers-distributed Bragg reflector (DBR), distributed feedback (DFB) laser.
11	31-33	*Photo-detectors*: Photoconductors, junction photo-detectors, PIN detectors, avalanche photodiodes, hetero-junction photodiodes,

Week	Lectures	Topic
		Schottky photo-diodes and phototransistors. Noise in photo-detectors. PIN and APD. Photo-detector design issues.
12	34-36	*Solar cells*: Solar energy and spectrum, silicon and Schottkey solar cells.
13	37-39	*Modulation of light*: Phase and amplitude modulation, electro-optic effect, acousto-optic effect and magneto-optic devices. Introduction to integrated optics.

20.88.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.88.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.88.13 Textbook/References

- Optoelectronics and Photonics: Principles and Practices by Safa Kasap (3rd edition)
- Reference Textbooks and relevant resources
- Semiconductor Optoelectronic Devices by Pallab Bhattacharya
- Physics of Semiconductor Devices by Sze & Ng, Wiley (3rd edition)
- Optoelectronics, an introduction by Wilson & Hawkes, PHI (3rd edition)

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.89 Description of course EEE 460

Section A: General Information

20.89.1 Course Title	Optoelectronics Laboratory
20.89.2 Type of Course	Optional, Sessional
20.89.3 Offered to	EEE
20.89.4 Pre-requisite Course(s)	None

Section B: Course Details

20.89.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 459: Optoelectronics

20.89.6 Course Objectives

- To provide hands-on training on numerical analysis of photonic properties of materials and electrical and optical characteristics of devices used for optoelectronic applications

- To provide hands-on training on experimental techniques used for characterization of optoelectronic devices

20.89.7 Knowledge required

Fundamental understanding of concepts of the physics of solid-state devices and engineering electromagnetics

20.89.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** modern tools to solve problems relevant to optoelectronic materials and devices	PO(e)	C3, P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests
2	**compare** theoretical and experimental results of optoelectronic properties of devices and materials	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	**design** optoelectronic devices/systems so that specific performance characteristics are attained	PO(c)	C6	Lectures, interactive discussions	Report, Project demonstration
4	**present** designed optoelectronic devices/systems	PO(j)	A3	Interactive discussions	Project demonstration and Presentation
5	demonstrate effective **individual and team-working skills**	PO(i)	A3		Peer and instructor assessment

***** Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.89.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
				√	√		√	√	√	√					√	√	√		

20.85.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	Light Absorption and Emission Properties of Materials
3	2(a)	Reflection and Transmission of Light in Semiconductors

Week	Experiment no.	Topic
4	2(b)	Radiative and Non-Radiative Recombination of Light in Semiconductors
5	3	Characterization of Light Emitting Diodes (LEDs). Calculation of (i) output spectrum, (ii) output optical power (L) -current (I) characteristics, and (iii) I-V characteristics of LED
6	4	Study of the gain and threshold characteristics of lasers
7	5	Study of Ideal and Practical Solar Cells
8	-	Project Proposal submission and discussion
9	-	Laboratory test 1
10	-	Presentation on project updates
11	-	Laboratory test 2
12	-	Final project demonstration and presentation
13	-	Final project demonstration and presentation

20.89.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design of optoelectronic devices/systems has to be completed by the end of this course. A project report has to be submitted and the project has to demonstrated and presented in the class.

20.89.12 Distribution of Marks

To be decided by course instructor(s)

20.89.13 Textbook/References

- Optoelectronics and Photonics: Principles and Practices by Safa Kasap (2nd edition)
- Semiconductor Optoelectronic Devices by Pallab Bhattacharya
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.90 Description of course EEE 461

Section A: General Information

20.90.1 Course Title	Semiconductor and Nano Device
20.90.2 Type of Course	Optional, Theory
20.90.3 Offered to	EEE
20.90.4 Pre-requisite Course(s)	None

Section B: Course Details

20.90.5 Course Content (As approved by the Academic Council)

- *Lattice vibration*: Simple harmonic model, dispersion relation, acoustic and optical phonons.
- *Free electron model*: Electrical conductivity.

- *Band structure*: Isotropic and anisotropic crystals, band diagrams and effective masses of different semiconductors and alloys.
- *Scattering theory*: Perturbation theory, Fermi-Golden rule for static and oscillating potentials, scattering rates for impurity and phonons, inter-band and inter-sub-band optical absorption, mobility.
- *Quantum mechanical model of carrier transport*: Tunneling transport, current and conductance, resonant tunneling, resonant tunneling diodes, super-lattices and mini-bands.
- Introduction to inter subband transition devices.

20.90.6 Course Objectives

- To provide a physics-based understanding of the electrical behavior of semiconductor and nano devices.
- To establish the theoretical foundation required for calculating charge carrier transport through semiconductor and nano-scale devices.
- The course gives a foundation for further studies in nano devices and related research.

20.90.7 Knowledge required

Fundamental understanding of concepts of semiconductor physics as taught in EEE 307.

20.90.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**apply** the physics-based knowledge to solve problems relevant to the electrical properties of materials	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse** the charge carrier transport through semiconductor and nano devices based on the underlying physics	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**design** electronic and opto-electronic devices such that specified performance characteristics are attained	PO(c)	C6	Lectures, Discussions	Assignment, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.90.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.90.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Lattice vibration: Simple harmonic model
2	4-6	Lattice vibration: Dispersion relations
3	7-9	Lattice vibration: Acoustic and optical phonons
4	10-12	Free electron model: Electrical conductivity
5	13-15	Band structure: Isotropic and anisotropic crystals, band diagrams
6	16-18	Band structure: Effective masses of different semiconductors and alloys
7	19-21	Band structure: Effective masses of different semiconductors and alloys
8	22-24	Scattering theory: Perturbation theory, Fermi-Golden rule for static and oscillating potentials
9	25-27	Scattering theory: Scattering rates for impurity and phonons.
10	28-30	Scattering theory: Inter-band and inter-sub-band optical absorption, mobility.
11	31-33	Quantum mechanical model of carrier transport: Tunneling transport, current and conductance.
12	34-36	Quantum mechanical model of carrier transport: Resonant tunneling diodes, super-lattices and mini-bands.
13	37-39	Introduction to inter subband transition devices

20.90.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.90.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.90.13 Textbook/References

- Solid State Physics: For Engineering and Materials Science" by John P. McKelvey
- "Introduction to Solid State Physics" by Charles Kittel
- "The Physics of Low-Dimensional Semiconductors" by John H. Davies

20.91 Description of course EEE 463

Section A: General Information

20.91.1 Course Title	Introduction to Nanotechnology and Nanoelectronics
20.91.2 Type of Course	Optional, Theory
20.91.3 Offered to	EEE
20.91.4 Pre-requisite Course(s)	None

Section B: Course Details

20.91.5 Course Content (As approved by the Academic Council)

Why Nanotechnology: importance, size scales, quantum size effects, revolutionary applications, potentials. Nanotools: scanning tunneling microscope, atomic force microscope, electron microscope, measurement techniques based on fluorescence, other techniques. Basics of Fabrication: fabrication and processing industry, wafer manufacturing, deposition techniques: evaporation, sputtering, chemical vapor deposition, epitaxy; Wet and dry etching techniques; photolithography, electron beam lithography, stamp technology. Bottom-up processes: chemical and organic synthesis techniques, self-assembly, other techniques. Nanoelectronics: overview of quantum mechanics, Schrodinger equation, particle in a box. Band theory of solids. Importance of nanoelectronics, Moore's law, ITRS roadmap. Tunneling devices: quantum tunneling, resonant tunneling diodes. Single electron transistor: Coulomb blockade. Quantum confinement: wires and dots, carbon nanotubes, graphenes. Brief introductions on Molecular electronics and nanobiology.

20.91.6 Course Objectives

- To familiarize the nano-realm and its non-conventional non-bulk behaviour to students.
- To explain the working principles of nano tools, characterization techniques, nano-devices.
- To understand nanoelectronic theories and principles for quantum tunnelling, and other nano-devices.

20.91.7 Knowledge required

Fundamental understanding of concepts of quantum theory, device theory and electronic materials.

20.91.8 Course Outcomes

20 CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**explain** the theories of nano dimension, nano tools, top-down and bottom-up processes and operation of some nano-devices.	PO(a), PO(e)	C2, C5	Lectures, Discussions	Assignment, Class test, Final exam
2	**analyse nano**-electronic processes, tools, and devices by applying concepts of nano principles.	PO(a), PO(d)	C3	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.91.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.91.10 Lecture Plan

Week	Lectures	Topic
1-2	1-6	**Why** Nanotechnology: importance, size scales, **quantum size effects**, revolutionary applications, potentials.
3-4	7-12	**Nanotools:** scanning tunneling microscope, atomic force microscope, electron microscope, measurement techniques based on fluorescence, other techniques.
5-6	13-18	Basics of Fabrication: **fabrication and processing** industry, wafer manufacturing, deposition techniques: evaporation, sputtering, chemical vapor deposition, epitaxy; Wet and dry etching techniques; photolithography, electron beam lithography, stamp technology.
7-8	19-24	**Bottom-up processes**: chemical and organic synthesis techniques, self-assembly, other techniques.
9-10	25-30	**Nanoelectronics:** overview of quantum mechanics, Schrodinger equation, particle in a box. Band theory of solids. Importance of nanoelectronics, Moore's law, ITRS roadmap.
11-13	31-39	**Tunneling devices:** quantum tunneling, resonant tunneling diodes. **Single electron transistor:** Coulomb blockade. Quantum confinement: wires and dots, carbon nanotubes, graphenes.

20.91.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.91.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.91.13 Textbook/References

- Introduction to Nanoscience and Nanotechnology, by Hornyak, Tibbals, Dutta & Moore .
- **Nanoelectronic Devices** by Byung-Gook Park, Sung Woo Hwang and Young June Park, CRC Press 2012.
- **Introduction to Nanoscience**, by Professor **S. M. Lindsay**.
- **Transport in Nanostructures** 2nd ed, by David K. Ferry, Stephen M. Goodnick and Jonathan Bird , Cambridge University Press 2009.
- **Quantum Mechanics:** An Introduction for Device Physicists and Electrical Engineers, 3rd Edition, David K. Ferry, CRC Press 2021
- Online resources or supplementary reading materials will be shared with the class and MS Teams.

Besides going through relevant topics of the textbooks, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.92 Description of EEE 465

Section A: General Information

20.92.1 Course Title	Analog Integrated Circuits and Design
20.92.2 Type of Course	Optional, Theory
20.92.3 Offered to	EEE
20.92.4 Pre-requisite Course(s)	None

Section B: Course Details

20.92.5 Course Content (As approved by the Academic Council)

- *Analog IC Design:* Bipolar, MOS and BiCMOS IC technology and its impact, eggshell analogy, application areas and the future of analog IC design.
- *Review of transistors :* Large and small signal models of MOS transistors. Basic CMOS Amplifiers with passive and active loads and cascode stages.
- Fabrication : Integrated circuit fabrication techniques. Photolithography steps. Fabrication sequences of CMOS circuits.
- *Differential pairs:* Differential vs. single-ended operations of simple amplifiers, differential and common mode voltages, common mode rejection ratio (CMRR), input common mode range (ICMR), transfer characteristics, small signal analysis, and frequency response of differential pairs.
- *Current source/sinks :* Multiple current sources/sinks using Bipolar and FET technologies. Current mirrors: Basic, cascode and active current mirrors; influence of channel modulation, mismatched transistors and error in aspect ratios. Wilson current mirror.
- *Constant current or voltage references:* Supply voltage and temperature independent biasing, band-gap references; constant-Gm biasing. Widlar band-gap voltage reference.
- *High-gain amplifiers:* Design and analysis of operational amplifiers (Op Amps) using MOSFETs, hierarchy in analog integrated circuits for an Op-Amps, internal structure of IC Op-Amps, high-performance Op-Amps.
- *Switch capacitor circuits:* Equivalent resistance of a switched capacitor, unity gain buffers, charge amplifiers and integrators. Sampling switches: Charge injection, clock feed-through, charge feed-through; quantized model and remedy of charge injection. Switched capacitor filters.
- *Phase Lock Loop :* Design of different sub-circuit of a frequency synthesizer and design of a PLL circuit.
- *Noise :* Origin of internally developed noises in ICs; shot, thermal, flicker, burst and avalanche noises in a device. Representation of noises in circuits, noises in single stage and differential amplifiers, noise bandwidth.

20.92.6 Course Objectives

- The objective of this course is to master the design techniques of Analog Integrated Circuit emphasizing fundamentals as well as new paradigms that need to master in today's industry.
- The first objective is to develop the intuition first which will tell the designer where to touch to achieve the required specification. It is accomplished by the development of a solid foundation and learn the methods of analysing circuits by inspection so that the student learn what approximations can be made in which circuits and how much error to expect in each approximation.
- In depth analysis of Analog integrated circuits is developed for each circuit whenever possible and discussion on simulation techniques are also discussed.

20.92.7 Knowledge required

Fundamental understanding of concepts of Electronic Circuits I is required for this course.

20.92.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)

CO1	**Apply** the physics-based knowledge of Semiconductor device to design circuit to process Analog signals to do useful operation.	PO(a)	C3	Lectures, Discussions	Assignment, Class test, Final exam
CO2	**Analyse** the operation of integrated circuits (ICs) based on the underlying physics and control theory.	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
CO3	**Design** solid-state integrated circuits such that specified performance characteristics are attained.	PO(c)	C5	Lectures, Discussions	Assignment, Final exam
CO4	**Apply** circuit simulation tools to verify theoretical prediction of circuit performance using very complex but realistic device model	PO(e)	C6	Lectures, Discussion	Assignment, Home work

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.92.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.92.10 Lecture Plan

Week	Lectures	Topic
1-3	1-9	Introduction to Analog Design. Review of Basic MOS Device Physics. CMOS technology. MOS device Modelling for circuit simulation : DC and AC parameters modelling. Photolithography and CMOS Fabrication Sequences.
4-6	10-18	Review of MOS amplifiers. Conflicting nature of performance parameters. Common source (CS) stage, CS stage with diode connected load, CS stage with current source and triode load, CS stage with source degeneration, Source follower, Common Gate stage. Cascode stage.
7-8	19-25	Differential pairs: Differential vs. single-ended operations of simple amplifiers, differential and common mode voltages, transfer characteristics and voltage gain of differential pair. common mode rejection ratio (CMRR), input common mode range (ICMR), common mode to differential conversion, Gilbert Cell.
9	26-27	Current sink and sources, Current Mirrors. Basic, cascode and active current mirrors; influence of channel modulation, mismatched transistors and error in aspect ratios. Wilson current mirror.

Week	Lectures	Topic
10	28-30	Constant current or voltage references: Supply voltage and temperature independent biasing, band-gap references; constant-Gm biasing. Widlar band-gap voltage reference.
11	31-33	Frequency response of amplifiers: Frequency response of Common source, source follower, common gate, cascade stage and differential pairs.
12	34-36	Operational amplifiers (op-Amps): General considerations. One stage and two stage op-Amps. Gain boosting and common mode feedback.
13	37-39	Phase lock loops (PLL) : Basic PLL topology. Basic charge pump PLL.
14	40-42	Introduction to switch capacitor circuits. MOSFET as switches. Switch capacitor amplifiers. Switch capacitor integrators.

20.92.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.92.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.92.13 Textbook/References

- Design of Analog CMOS Integrated Circuits. McGraw Hill International Edition 2001
- CMOS Analog Circuit Design by Phillip E Allen and Douglas R Holberg, Oxford University Press, 2nd Edition

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.93 Description of EEE 466

Section A: General Information

20.93.1 Course Title	Analog Integrated Circuits and Design Laboratory
20.93.2 Type of Course	Optional, Sessional
20.93.3 Offered to	EEE
20.93.4 Pre-requisite Course(s)	None

Section B: Course Details

20.93.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 465: Analog Integrated Circuits and Design.

20.93.6 Course Objectives

- To provide hands-on training on design techniques of Analog Integrated Circuit emphasizing fundamentals as well as new paradigms that need to master in today's industry
- To provide hands-on training on simulation techniques used for schematics and layout design.

20.93.7 Knowledge required

Fundamental understanding of concepts of Electronic Circuits I is required for this course.

20.93.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Apply** the physics-based knowledge of Semiconductor device to design circuit to process Analog signals to do useful operation.	PO(a)	C3	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests
CO2	**Analyse** the operation of integrated circuits (ICs) based on the underlying physics and control theory.	PO(b)	C4, P4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment
CO3	**Design** solid-state integrated circuits such that specified performance characteristics are attained.	PO(c)	C6	Lectures, Discussions	Report, Project demonstration
CO4	**Use** circuit simulation tools to verify theoretical prediction of circuit performance using very complex but realistic device model	PO(e)	C5	Lab demonstrations, Discussion	Lab-tasks, Assignment, Lab-tests
CO5	**Demonstrate** effective individual and team-working skills	PO(i)	A3		Peer and instructor assessment
CO6	**Present** designed Analog Integrated Devices/Systems	PO(j)	A3	Interactive discussions	Project demonstration and Presentation

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.93.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.93.10 Lecture Plan

Week	Experiment No.	Topic
1	-	Introductory class and overview of the course
2	1	Study of the basic current-versus voltage curve, threshold voltage, transconductance and figure of merit of the MOS transistor in the process technology library (pdk)
3-4	2	Study of Single Stage Common Source CMOS Amplifier Design
5-6	3	Layout design and verification of Single Stage amplifier with Cadence Virtuoso Layout Suite L Editor
7	-	Project Topic Assignment and Discussion
8	4	Study of Bandgap Reference Voltage Circuit
9	5	Design of a Two Stage CMOS Operational Amplifier and study of its dc and ac characteristics using Cadence Virtuoso
10	-	Laboratory Test
11	-	Project update presentation, discussion, and feedback
12	-	Final project demonstration and presentation
13	-	Final project demonstration and presentation

20.93.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests and report writing.
- A group project on the design of analog integrated circuits has to be completed by the end of this course. A project report has to be submitted and the project has to be demonstrated and presented in the class.

20.93.12 Distribution of Marks

To be decided by course instructor(s)

20.93.13 Textbook/References

- Design of Analog CMOS Integrated Circuits by Behzad Razavi. McGraw Hill International Edition 2001
- Supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.94 Description of course EEE 467

Section A: General Information

20.94.1 Course Title	VLSI Circuits and Design
20.94.2 Type of Course	Optional, Theory
20.94.3 Offered to	EEE
20.94.4 Pre-requisite Course(s)	None

Section B: Course Details

20.94.5 Course Content (As approved by the Academic Council)

- Integrated circuit trends, choice of technology, Design approaches. MOS device : structure, operation, threshold voltage and characteristics equation for NMOS and PMOS devices. Principles of inverters :

NMOS inverters design with resistive and NMOS enhancement transistor load. Ratioed and ratioless design.

- The CMOS inverter : operation, transfer characteristics(TC). Propagation delay, rise time, fall time and power consumption estimation of CMOS inverter. Design for equal rise and fall time. Noise Margin. Variation of TC with respect to Wn and Wp. NMOS pass transistor, CMOS pass gate. Electro migration, and Latch-up in CMOS circuits.
- Basic logic gates in CMOS. Synthesis of arbitrary combinational logic in CMOS, pseudo-NMOS, dynamic CMOS, clocked CMOS and CMOS domino logic.
- Delay estimation, Elemore delay model, transistor sizing for minimum delay. Buffer chain design to drive large capacitive load. Logical efforts of path and the best number of stages.
- Integrated circuit fabrication technology: photolithography, CMOS nanometer process flow.
- Scaling of MOS transistor and secondary effects on device characteristics. Scaling of interconnect: RC delay modeling, repeaters and cascaded drives. Buffer chain design to drive large capacitive load. Logical efforts of paths and the best number of stages.
- Integrated circuit fabrication technology: photolithography, Advanced CMOS nanometer process flow and enhancement of CMOS process, technology related CAD issues and manufacturing issues, design margin and PVT corners. Reliability issues: Latch-up, electro-migration.
- High speed digital circuit design techniques, circuit families. Architecture for high speed design: Carry select, carry skip, carry look ahead and tree adders. Wallace tree multiplication.
- Sequential circuit design: sequencing methods, maximum and minimum delay constrains, clock skew. Design of latches and flip-flops, clock Generation and synchronization, High-speed clock generation and distribution.
- Memory elements design: SRAM and DRAM design. System timing consideration, static and dynamic CMOS memory array.
- Finite State Machine design: Design of Moore Type and Mealy type FSM. Digital system design using Verilog. Functional verification of digital system using system Verilog, verification coverage, random test pattern generation and UVM.
- Synthesis of Combinational and Sequential Logic (RTL). Postsynthesis Design Validation: timing verification by static timing analysis. Timing closure.
- ASIC Cell based design, standard cell place and route design, timing directed placement design. Floor planning, power distribution and I/O cell placement.

20.94.6 Course Objectives

- The objective of this course is to master the design techniques of Very Large Scale Integrated Circuits emphasizing fundamentals as well as new paradigms that need to master in today's industry. Hence the course covers basic as well as advanced aspects of the design of Very Large Scale Integrated (VLSI) circuit from design to verification and testing.
- By the end of the course it is expected that the students will be able to design moderately complex digital VLSI chip, verify performance of the system and optimize the system for high speed and low power.

20.94.7 Knowledge required

Fundamental understanding of concepts of Electronic Circuits I is required for this course.

20.94.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Apply** the physics-based mathematical models of Semiconductor device to design digital circuit to do useful operation.	PO(a)	C2, C3	Lectures, Discussions	Assignment, Class test, Final exam

CO2	**Synthesis Digital** circuits based on specific operational requirements.	PO(b)	C4, C6	Lectures, Discussions	Assignment, Class test, Final exam
CO3	**Design** digital system based on specific requirements and design constraints such as power, speed, size etc.	PO(c), PO(d)	C4, C6	Lectures, Discussions	Assignment, Final exam
CO4	**Apply** circuit simulation tools to verify theoretical prediction of circuit performance using very complex but realistic device model.	PO(e)	C5, C6	Lectures, Discussion	Assignment, Home work

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.94.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
√	√	√	√	√	√			√	√	√						√	√		√

20.94.10 Lecture Plan

Week	**Lectures**	**Topic**
1	1-3	Finite State Machine design: Design of Moore Type and Mealy type FSM. Digital system design using Verilog
2-3	4-9	Functional verification of digital system using system Verilog: Flat and layered test benches, verification coverage, random test pattern generation and UVM.
4	10-12	Synthesis of Combinational and Sequential Logic (RTL). Postsynthesis Design Validation: timing verification by static timing analysis. Timing closure.
5-6	13-18	Integrated circuit trends, choice of technology, Design approaches. MOS device : structure, operation, threshold voltage and characteristics equation for NMOS and PMOS devices. Principles of inverters : NMOS inverters design with resistive and NMOS enhancement transistor load. Ratioed and ratioless design. The CMOS inverter : operation, transfer characteristics(TC). Propagation delay, rise time, fall time and power consumption estimation of CMOS inverter. Design for equal rise and fall time. Noise Margin. Variation of TC with respect to Wn and Wp. NMOS pass transistor, CMOS pass gate. Electro migration, and Latch-up in CMOS circuits.
7	19-21	Basic logic gates in CMOS. Synthesis of arbitrary combinational logic in CMOS, pseudo-NMOS, dynamic CMOS, clocked CMOS and CMOS domino logic.
8	22-24	Delay estimation, Elemore delay model, transistor sizing for minimum delay. Buffer chain design to drive large capacitive load. Logical efforts of path and the best number of stages.

Week	Lectures	Topic
9	25-27	Integrated circuit fabrication technology: photolithography, CMOS nanometer process flow.
10-12	28-36	High speed digital circuit design techniques : circuit families, architecture for high speed design, Carry select, carry skip, carry look ahead and tree adders. Wallace tree multiplication. Sequential circuit design: sequencing methods, maximum and minimum delay constrains, clock skew. Design of latches and flip-flops, clock Generation and synchronization, High-speed clock generation and distribution.
13	37-39	Memory elements design: SRAM and DRAM design. System timing consideration, static and dynamic CMOS memory array.
14	40-42	ASIC Cell based design, standard cell place and route design, timing directed placement design. Floor planning, power distribution and I/O cell placement.

20.94.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.94.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.94.13 Textbook/References

- *CMOS VLSI design: A Circuit and System Perspective* by Neil H. E. **Weste**, David Harris & Ayan Banerjee, Pearson Education, 4th Edition.
- CMOS VLSI design - A Circuits and Systems Perspective, 4th edition by Neil H. E. Weste and David Money Harris, Publisher : Addison Wesley.
- *Advanced Digtial Design with the Verilog HDL*, Michael D. **Ciletti**, Prentice Hall of India Private Limited, 2005
- System Verilog for Verification 3rd Edition Chris Spear and Greg Tumbush, Springer
- Static Timing Analysis for Nanometer Designs – A practical Approach R. J Bhasker and Rakesh Chadha, Springer
- Computer Organization and Design RISC-V Edition by David A. Patterson and John L. Hennessy, ELSEVIER

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.95 Description of course EEE 468

Section A: General Information

20.95.1 Course Title	VLSI Circuits and Design Laboratory
20.95.2 Type of Course	Optional, Sessional
20.95.3 Offered to	EEE
20.95.4 Pre-requisite Course(s)	None

Section B: Course Details

20.95.5 Course Content (As approved by the Academic Council)

- Laboratory experiments and Industry level projects based on the theory course EEE 467

20.95.6 Course Objectives

- The objective of this course is to master the design techniques of Very Large Scale Integrated Circuits emphasizing fundamentals as well as new paradigms that need to master in today's industry. Hence the course covers basic as well as advanced aspects of the design of Very Large Scale Integrated (VLSI) circuit from design to verification and testing.
- By the end of the course, it is expected that the students will be able to design moderately complex digital VLSI chip, verify performance of the system and optimize the system for high speed and low power.

20.95.7 Knowledge required

Fundamental understanding of concepts of "Electronic Circuits I" and "Digital Circuit Design" is required for this course.

20.95.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Apply** the physics-based mathematical models of Semiconductor device to design digital circuit to do useful operation.	PO(a)	C2, C3	Lectures, Discussions, Lab work	Lab Report, Lab Test
CO2	**Synthesis** Digital circuits based on specific operational requirements.	PO(b)	C4, C6	Lectures, Discussions, Lab work	Lab Report, Lab Test
CO3	**Design** digital system based on specific requirements and design constraints such as power, speed, size etc.	PO(c), PO(d)	C4, C6	Lectures, Discussions	Lab Report, Lab Test
CO4	**Apply** circuit simulation tools to verify theoretical prediction of circuit performance using very complex but realistic device model.	PO(e)	C5, C6	Lectures, Discussion Lab work	Lab Report, Lab Test
CO5	**Work as a team member** in a group of 4 in a Comprehensive industry standard project in collaboration with Neural Semiconductor Ltd., a leading VLSI design company in Bangladesh	PO(i)	C3, C4, C6, A3	Lectures, Discussion Lab work	Project Report, Project Presentation
CO6	**Communicate effectively** with the team member and perform the design by dividing it into a number of subsystem to be completely by each member.	PO(j)	C3, C4, C6, A3	Lectures, Discussion Lab work	Project Report, Project Presentation
CO7	**To design** the system cost effectively so that the cost of the chip become competitive.	PO(k)	C3, C4, C6, A3	Lectures, Discussion Lab work	Project Report,

					Project Presentation

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.95.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
√	√	√	√	√	√			√	√	√						√	√		√

20.95.10 Lecture Plan

Week	**Lectures**	**Topic**
1	1	Introduction of overall rules, regulations, assessment methods and project related guidelines for EEE 468 Sessional Course
2	2	Expt-1: ASIC Front End Design: Directed Testing of a digital sub-system using Cadence NCsim.
3	3	Expt-2: ASIC Front End Design: Layered Verification of a digital sub-system
4	4	Expt-3 : RTL design of a digital sub-system and System level validation using CADENCE IUS
7	5	Expt-4: RTL Logic Synthesis with Cadence Genus(TM) Synthesis Solution
8	6	Expt-5: Physical Design of an arithmetic logic unit in Cadence Innovus.
8	7	Lab Test
8-12	8	32 bit RISC – V Core processor design with all six types of instructions execution capability with a Memory Wrapper and a communication protocol such as APB or I2C. The students has to design and verify the processor with physical design in Cadence environment with generalized pdk.
13	9	Students will give power point presentation on their project performance in front of the faculties and industry experts.

20.95.11 Assessment Strategy

- Attendance will be recorded in every class
- Report on each laboratory experiment will be evaluated
- Continuous assessment will be done in the form of in-class lab performance.
- A lab test will be conducted at the end of the laboratory experiments.
- A Comprehensive industry standard project will be given to the student in collaboration with Neural Semiconductor Ltd., a leading VLSI design company in Bangladesh, at 6th week of the course. The progress and evaluation of the project will be jointly evaluated by faculty and industry expert. The project

will take 7 weeks to complete and at the end of the project the students have to present their outcome in front of the faculty and industry experts.

20.95.12 Distribution of Marks

Class Participation	10%
Report writing	20%
Regular Lab Performance	10%
Lab Test	20%
Project performance and presentation	40%
Total	100%

20.95.13 Textbook/References

- CMOS VLSI design - A Circuits and Systems Perspective, 4th edition by Neil H. E. Weste and David Money Harris, Publisher : Addison Wesley.
- *Advanced Digtial Design with the Verilog HDL*, Michael D. **Ciletti**, Prentice Hall of India Private Limited, 2005
- System Verilog for Verification 3rd Edition Chris Spear and Greg Tumbush, Springer
- Static Timing Analysis for Nanometer Designs – A practical Approach R. J Bhasker and Rakesh Chadha, Springer
- Computer Organization and Design RISC-V Edition by David A. Patterson and John L. Hennessy, ELSEVIER

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

Power group

20.96 Description of course EEE 411

Section A: General Information

20.96.1 Course Title	Power System II
20.96.2 Type of Course	Optional, Theory
20.96.3 Offered to	EEE
20.96.4 Pre-requisite Course(s)	None

Section B: Course Details

20.96.5 Course Content (As approved by the Academic Council)

- Definition and classification of stability, two axis model of synchronous machine, loading capability, rotor angle stability - swing equation, power-angle equation, synchronizing power coefficients, equal area criterion, multi-machine stability studies, step-by-step solution of the swing curve, factors affecting transient stability. Frequency and voltage stability.
- Economic Operation within and among plants, transmission-loss equation, dispatch with losses.
- Flexible AC transmission system (FACTS) - introduction, shunt compensation (SVC, STATCOM), series compensation (SSSC, TCSC, TCSR, TCPST), series-shunt compensation (UPFC).
- Power quality- voltage sag and swell, surges, harmonics, flicker, grounding problems; IEEE/IEC standards, mitigation techniques.

20.96.6 Course Objectives

- To understand the concept and classification of stability, two axis model of synchronous machine, loading capability, rotor angle stability.

- To analyse swing equation and demonstrate its application for developing synchronizing power coefficients and equal area criterion.
- To understand multi-machine stability and factors affecting transient stability, voltage stability and frequency stability.
- To analyse the economic operation of power system.
- To understand the operation of FACTS devices.
- To demonstrate the application of FACTS devices.
- To be familiar with power quality and its improvement techniques.

20.96.7 Knowledge required

Fundamental concepts of Power System I, Energy Conversion II and Energy Conversion I.

20.96.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Explain** the transient stability, voltage stability and frequency stability by **applying** the knowledge of power system and rotor dynamics.	PO(a)	C2, C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**Analyse** the techniques economic operation of power system with and without transmission loss.	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	At the end of the course the students will be able to **design** a stability cogitated power system by satisfying necessary requirements	PO(c)	C6	Lectures, Discussions	Assignment, Final exam
4	At the end of the course the students will be able to **investigate** the techniques for voltage improvement, power system augmentation and power quality improvement.	PO(d)	C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.96.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.96.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Definition and classification of stability, two axis model of synchronous machine.
2	4-6	Loading capability, rotor angle stability.
3	7-9	Swing equation, power-angle equation, synchronizing power coefficients.
4	10-12	Equal area criterion and its application.
5	13-15	Multi-machine stability studies, step-by-step solution of the swing curve, factors affecting transient stability.
6	16-18	Frequency stability.
7	19-21	Voltage stability.
8	20-24	Economic Operation within and among plants.
9	25-27	Transmission-loss equation, dispatch with losses.
10	28-30	Flexible AC transmission system (FACTS) - introduction, shunt compensation (SVC, STATCOM).
11	31-33	Series compensation (SSSC, TCSC, TCSR, TCPST), series-shunt compensation (UPFC).
12	34-36	Power quality- voltage sag and swell, surges, harmonics, flicker.
13	37-39	Grounding problems; IEEE/IEC standards, mitigation techniques.
14	40-42	Summary review.

20.96.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.96.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.96.13 Textbook/References

- Power System Analysis by Stephen John J. Grainger and William D. Stevenson, McGraw-Hill, 1994.
- Smart Grid Technology and Application, Janaka Ekanayake et al., Wiley, 2012.
- Electrical Power Systems Quality, Roger C. Dugan et al. McGraw-Hill.
- Online resources or supplementary materials will be shared with the class on a need basis.

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.97 Description of course EEE 412

Section A: General Information

20.97.1 Course Title	Power System II Laboratory
20.97.2 Type of Course	Optional, Sessional
20.97.3 Offered to	EEE
20.97.4 Pre-requisite Course(s)	None

Section B: Course Details

20.97.5 Course Content (As approved by the Academic Council)

This course consists of two parts*:* In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 411. In the second part, student will design systems or apply the concept learned in EEE 411 to deduce a new conclusion in perspective of stability or something related to power system.

Familiarization with grounding concept and grounding resistance, importance of grounding, understanding how grounding reduces imbalance.

Introduction with transient stability, Dependency of transient stability on fault type, circuit network and understanding the concept of fault clearing time.

Definition of frequency and stability, Inherent features to maintain desired frequency response, concept of designing an UFLS.

Classification of load model, introduction with LFR, determination of load type from provided data.

20.97.6 Course Objectives

- To provide practical knowledge of grounding and its importance
- To provide understanding of transient stability and its depending parameters
- To provide hands on knowledge of using simulation software tools for frequency stability and ability to design a load-shedding scheme to achieve desired response.
- To provide knowledge about load model and type determination from post-fault data.

20.97.7 Knowledge required

The full knowledge of Power System II course

20.97.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Investigate** the power quality in the presence of grounding and determination of grounding resistance	PO(a), PO(d)	C4	Lectures, Laboratory Experiments	Report Writing, Viva Voce, Final Quiz
2	**Use power system analysis tools** like PSAF to check transient stability following a disturbance	PO(b)	C5	Hands on experience simulation tools, Discussions	Assignment, Final Quiz
3	**Finding** dependent parameters of transient stability and its improvement	PO(b)	C3, C4	Hands on experience simulation tools, Discussions	Report Writing, Viva Voce, Final Quiz
4	**Introduction with** frequency stability and system's inherent features to maintain a desired response.	PO(e)	C4, P4	Hands on experience simulation tools, Discussions	Assignment, Lab Test

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
5	**Design** a load-shedding scheme to arrest frequency excursion	PO(c)	C6	Hands on experience simulation tools, Discussions	Assignment, Lab Test
6	**Deducing** load type i.e. its dependency on V & f from post fault data	PO(b)	C3	Hands on experience simulation tools, Discussions	Report Writing, Viva Voce
7	**Use necessary tools to investigate** the impact on power system while some part of it is modified, and **design** necessary system upgradation	PO(c)	C4, C6	Hands on work using simulation tools, Discussions	Project presentation

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.97.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.97.10 Lecture Plan

Sl#	**Week/Class**	**Topic**
1	1	Experiment-1: Observation of power quality
2	2-3	Experiment-2: Study of transient stability
3	4-5	Experiment-3: Study of frequency stability
4	6	Experiment-4: Estimation of load model parameters
5	7-10	Project discussion and update
6	11	Viva voce
7	12	Final presentation

20.97.11 Assessment Strategy

- Attendance will be recorded in every class.
- Report on each laboratory experiment/work will be evaluated.
- Assignment will be given on stability study of power system and will be evaluated. These assignments will be simple design based.
- A viva voce examination on all the classes will be evaluated.

20.97.12 Distribution of Marks

Class Participation	5%
Lab Reports	10%
Viva Voce	10%
Project	35%

Final Examination	40%
Total	100%

20.97.13 Textbook/References

- John J. Grainger and William D. Stevenson, Jr. "Power System Analysis", McGraw-Hill, 1994
- J. Duncan Glover, Mulukutla S. Sarma, and Thomas J. Overbye, "Power System Analysis and Design", 5^{th} Ed.
- William D. Stevension, Jr., "Elements of Power System Analysis", 4^{th} Ed.
- Supplied Labsheets
- Any other contemporary books and URLs may be used
- *It is strongly advised that the students will follow the class lectures and discussions regularly for a thorough understanding of the topics.*

20.98 Description of course EEE 471

Section A: General Information

20.98.1 Course Title	Energy Conversion III
20.98.2 Type of Course	Optional, Theory
20.98.3 Offered to	EEE
20.98.4 Pre-requisite Course(s)	None

Section B: Course Details

20.98.5 Course Content (As approved by the Academic Council)

Basic principles of energy conversion: electromagnetic, electrostatic, thermoelectric, electrochemical, and electromechanical.

Acyclic machines: generators, conduction pump and induction pump.

Nonconventional energy conversion: solar-photovoltaic, solar-thermal, wind, geothermal, wave and tidal energy, MHD (Magneto Hydrodynamic) systems.

Motors and drives: series universal motor, permanent magnet DC motor, brushless DC motor (BLDC), stepper motor, reluctance motor, switched reluctance motor, hysteresis motor, repulsion motor, permanent magnet synchronous motor, linear induction motor, electro static motor.

20.98.6 Course Objectives

- To understand the basic principles of electromagnetic, electrostatic, thermoelectric, electrochemical, and electromechanical energy conversion
- To understand the construction and operations of acyclic machines
- To familiarize and understand nonconventional energy conversion
- To understand the construction and operations of special purpose motors and drives and their applications

20.98.7 Knowledge required

Electrical Circuits I and II, and Energy Conversion I and II courses

20.98.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools

CO1	**Understand** the basic principles of electromagnetic, electrostatic, thermoelectric, electrochemical, and electromechanical energy conversion	PO(a), PO(b)	C1, C2	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO2	**Understand** the construction of and **explain** the operations of acyclic machines: generators, conduction pump and induction pump	PO(a), PO(b)	C1, C2	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO3	**Apply** basic energy conversion principles to **explain** the operation of various nonconventional energy conversion systems	PO(a), PO(b)	C1, C2, C3	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO4	**Apply** the knowledge of electrical circuits, electronic devices, and basic energy conversion principles to **explain** the construction and operation of special purpose motors and drives and their applications	PO(a), PO(b), PO(c)	C1, C2, C3	Lectures, Tutorials, Homework	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.98.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.94.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-9	1-3	Basic principles of energy conversion: electromagnetic, electrostatic, thermoelectric, electrochemical, and electromechanical	CO1
10-12	4	Acyclic machines: generators, conduction pump and induction pump	CO2
13-24	5-8	Nonconventional energy conversion: solar-photovoltaic, solar-thermal, wind, geothermal, wave and tidal energy, MHD (Magneto Hydrodynamic) systems	CO1, CO3
25-39	9-13	Motors and drives: series universal motor, permanent magnet DC motor, brushless DC motor (BLDC), stepper motor, reluctance motor, switched reluctance motor, hysteresis motor, repulsion motor, permanent magnet synchronous motor, linear induction motor, electro static motor	CO1, CO4
40-42	14	Review	CO1, CO2, CO3, CO4

20.98.11 Assessment Strategy

- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.98.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.98.13 Textbook/References

- Edward M. *Walsh*, "*Energy Conversion* - Electromechanical, Direct, Nuclear,"
- Stephen J. Chapman, "Electric Machinery Fundamentals," 5th ed., McGraw Hill, 2012
- William H. Yeadon, Alan W. Yeadon, "Handbook of Small Electric Motors," McGraw Hill, 2001
- Alroza Khaligh, Omar G. Onar, "Energy Harvesting - Solar, Wind, and Ocean Energy Conversion Systems," CRC Press, 2010
- P. C. Sen, "Principles of Electric Machines and Power Electronics, 3rd ed., John Wiley & Sons, 2013
- A F Puchstein, T C Lioyd, "Alternating-Current Machines," John Wiley & Sons, 1988
- Takashi Kenjo, Akira Sugawara, "Stepping Motors and Their Microprocessor Controls," Clarendon Press, 1994
- Jacek F. Gieras, Zbigniew J. Piech, "Linear Synchronous Motors,", CRC Press, 2000
- Jacek F. Gieras, "Advancements in Electric Machines," Springer, 2008

20.99 Description of course EEE 473

Section A: General Information

20.99.1 Course Title	Renewable Energy
20.99.2 Type of Course	Optional, Theory
20.99.3 Offered to	EEE
20.99.4 Pre-requisite Course(s)	None

Section B: Course Details

20.99.5 Course Content (As approved by the Academic Council)

- **Renewable energy sources**: Solar, wind, mini-hydro, geothermal, biomass, wave and tides.
- **Solar Photovoltaic:** Characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, sun tracking systems, Maximum Power Point Tracking (MPPT): chopper, inverter. Sizing the PV panel and battery pack in stand-alone PV applications. Modern solar energy applications (residential, electric vehicle, naval, and space). Solar power plants connected to grid.
- **Solar thermal:** principles of concentration, solar tower, parabolic dish, receiver, storage, steam turbine and generator.
- **Wind turbines:** Wind turbine types and their comparison, power limitation, Betz's law; Control mechanism: pitch, yaw, speed. Couplings between the turbine and the electric generator, Wind turbine generator - DC, synchronous, self excited induction generator and doubly fed induction generator. Grid interconnection: active and reactive power control.
- **Biomass and biogas electricity generation**.

20.99.6 Course Objectives

- To provide the students with the basic knowledge of diverse green energy sources, their conversion into electricity and utilization in various areas of human life.

- To enable the students to formulate mathematical models for solving various aspects of electricity generation using variable renewable energy and for learning control strategies.

20.99.7 Knowledge required

Fundamental understanding of concepts of Energy Conversion I and II, and Power System I.

20.99.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(ies)	Assessment Tool(s)
1	Apply mathematics and relevant engineering to model the components associated with conversion of renewable energy into electricity.	PO(a), PO(b)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	Devise the techniques for maximum power extraction from and intermittency compensation of renewable sources using power electronics and flexible loads like electric vehicles, energy storage devices.	PO(c), PO(d), PO(e)	C2,C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
3	Identify the requirements to integrate distributed renewable energy sources in a non-renewable based centralized and traditional power system.	PO(g), PO(i), PO(j), PO(l)	C2,C3,C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.99.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.99.10 Lecture Plan

Week	**Lectures**	**Topic**
1-2	1-6	**Renewable energy sources**: Solar, wind, mini-hydro, geothermal, biomass, wave and tides
3-7	7-21	**Solar Photovoltaic:** Characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, sun tracking systems, Maximum Power Point Tracking (MPPT): chopper, inverter. Sizing the PV panel and battery pack in stand-alone PV applications. Modern solar energy applications (residential, electric vehicle, naval, and space). Solar power plants connected to grid
8-9	22-27	**Solar thermal:** principles of concentration, solar tower, parabolic dish, receiver, storage, steam turbine and generator

Week	Lectures	Topic
10-13	28-39	**Wind turbines:** Wind turbine types and their comparison, power limitation, Betz's law; Control mechanism: pitch, yaw, speed. Couplings between the turbine and the electric generator, Wind turbine generator - DC, synchronous, self excited induction generator and doubly fed induction generator. Grid interconnection: active and reactive power control
14	40-42	**Biomass and biogas electricity generation**

20.99.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of BUET Academic Council.

20.99.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.99.13 Textbook/References

- N.S. Rathore and N.L. Panwar., "Fundamentals of Renewable Energy," CRC Press, 1st edition, 2021
- Kirk Hagen, "Introduction to Renewable Energy for Engineers", Pearson, 1st edition, 2015
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the text/reference book, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.100 Description of course EEE 475

Section A: General Information

20.100.1 Course Title	Power Plant Engineering
20.100.2 Type of Course	Optional, Theory
20.100.3 Offered to	EEE
20.100.4 Pre-requisite Course(s)	None

Section B: Course Details

20.100.5 Course Content (As approved by the Academic Council)

- **Load forecasting, Load curve**: demand factor, diversity factor, load duration curve, energy load curve, load factor, capacity factor, utilization factor.
- **Thermal power station**: heat rate, incremental heat rate, efficiency, capacity scheduling, load division.
- **Principles of power plants:** steam, gas, diesel, combined cycle, hydro and nuclear. Captive power plant and cogeneration.
- **Power plant auxiliaries and instrumentation**.
- **Power evacuation and switchyard**.
- **Selection of location**: technical, economical and environmental factors.
- **Generation scheduling**.

20.100.6 Course Objectives

- To provide the students with the basic knowledge of forecasting the demand for electricity which is influenced by weather, human behaviour, societal and national needs, and the basic knowledge of how to make various thermal and non-thermal power plants operate in an environmentally compliant manner to cater to the demand.
- To understand the indispensability of traditional fuel based large power plants not only in normal scenarios but also in crisis periods and in serving as back up for the intermittent and variable renewable energy generation.
- To enable the students to formulate mathematical models for solving various aspects of power plant operation and for learning control strategies.

20.100.7 Knowledge required

Fundamental understanding of concepts of Energy Conversion I and II, and Power System I.

20.100.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(ies)	Assessment Tool(s)
1	Apply mathematics and relevant engineering to forecast the demand for electricity and selection of sites for locating various types of power plants.	PO(a), PO(b), PO(f), ,PO(g)	C3,C4	Lectures, Discussions	Assignment, Class test, Final exam
2	Familiarization with the principles, control, protection and instrumentations deployed in various types of conventional fuel based power plants to make them operate as environment compliant.	PO(c), PO(e),PO(g)	C2,C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
3	Devise the techniques for balancing generation with demand in an economic and/or optimal way.	PO(b), PO(c)	C2,C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
4	Learning the control strategies of power plants both in grid connected and isolated mode.	PO(i), PO(j), PO(l)	C2,C3,C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.100.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.100.10 Lecture Plan

Week	Lectures	Topic
1-2	1-6	**Load forecasting, Load curve**: demand factor, diversity factor, load duration curve, energy load curve, load factor, capacity factor, utilization factor
3-4	7-12	**Thermal power station**: heat rate, incremental heat rate, efficiency, capacity scheduling, load division
5-9	13-27	**Principles of power plants:** steam, gas, diesel, combined cycle, hydro and nuclear. Captive power plant and cogeneration
10-11	28-33	**Power plant auxiliaries and instrumentation**
12	33-36	**Power evacuation and switchyard**
13	37-39	**Selection of location**: technical, economical and environmental factors
14	40-42	**Generation scheduling**

20.100.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of BUET Academic Council.

20.100.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.100.13 Textbook/References

- Farshid Zabihian., “Power Plant Engineering,” CRC Press, 1st Edition, 2021
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the text/reference book, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.101 Description of course EEE 477

Section A: General Information

20.101.1 Course Title	Power System Protection
20.101.2 Type of Course	Optional, Theory
20.101.3 Offered to	EEE
20.10.4 Pre-requisite Course(s)	None

Section B: Course Details

20.101.5 Course Content (As approved by the Academic Council)

Electric arcs, arc extinction mechanism, transient recovery voltage. Circuit breakers: operating mechanisms, construction and operation of miniature circuit breaker (MCB), Molded Case circuit breaker (MCCB), air circuit breaker (ACB), air blast circuit breaker (ABCB), vacuum circuit breaker (VCB), oil circuit breaker (OCB), minimum oil circuit breaker (MOCB), sulfur hexafluoride (SF6) circuit breaker. High rupturing capacity (HRC) fuse, drop out fuse (DOF), load break switches, contactors, isolators, earthing switch, lightning arresters. CT, PT: wound type and CCVT (capacitor coupled voltage transformer), MOCT (magneto optical current transducer). Fundamental of protective relaying. Classical relays (electromagnetic attraction type, induction type); numerical relays. Inverse definite minimum time (IDMT) relays, directional relays, differential and percentage differential relays, distance relays, pilot relays (wire pilot, carrier). Protection of generators, motors, transformers, transmission lines, HVDC system and feeders.

20.101.6 Course Objectives

- The main objective of this course is to introduce the fundamentals of power system protection including the fundamental philosophy of protective relaying, relay operating principles and functional characteristics, circuit breaker operating principles and functional characteristics, unit and systems protection relaying schemes.
- The course aims to familiarize students with different types of relays and circuit breakers, current and voltage transformers, and the basics of transmission line, transformer, rotating machinery, bus protection schemes.
- The course aims for building the theoretical foundation required for understanding and solving power system protective relaying problems.

20.101.7 Knowledge required

Electrical and electronic circuits, electrical machines, power systems and its operation.

20.101.8 Course Outcomes

COs	CO Statements	Corresponding Pos	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
CO1	**Understand** the fundamental philosophy of protective relaying, **explain** the relay and circuit breaker operating principles and functional characteristics.	PO(a)	C1, C2	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO2	**Understand** the different origins of power system equipment faults and **analyze** the equipment fault characteristics.	PO(a), PO(b)	C1, C2, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO3	**Understand** the characteristics of current and voltage transformers and **solve** the problems of measurement errors in protective relaying.	PO(a), PO(b), PO(c)	C1, C2, C3, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO4	**Design** basic protection schemes for transformer, rotating machinery, transmission line and **specify** their protection requirements.	PO(b), PO(c), PO(d)	C1, C3, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.101.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.101.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-6	2	Fundamental of protective relaying.	CO1
7-15	3-5	Classical relays (electromagnetic attraction type, induction type); numerical relays. Inverse Definite Minimum Time (IDMT) relays, directional relays, differential and percentage differential relays, distance relays, pilot relays (wire pilot, carrier)	CO1
16-21	6-7	Electric arcs, arc extinction mechanism, transient recovery voltage. Circuit breakers: operating mechanisms, construction and operation of miniature circuit breaker (MCB), molded Case circuit breaker (MCCB), air circuit breaker (ACB), air blast circuit breaker (ABCB), vacuum circuit breaker (VCB), oil circuit breaker (OCB), minimum oil circuit breaker (MOCB), sulfur hexafluoride (SF6) circuit breaker.	CO1
22-24	8	High rupturing capacity (HRC) fuse, drop out fuse (DOF), load break switches, contactors, isolators, earthing switch; lightning arresters.	CO1
25-27	9	CT, PT: wound type and CCVT (capacitor coupled voltage transformer), MOCT (magneto optical current transducer).	CO3, CO4
28-39	10-13	Protection of generators, motors, transformers, transmission lines, HVDC system and feeders.	CO1, CO2, CO3, CO4
40-42	14	Review	CO1, CO4

20.101.11 Assessment Strategy

- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.101.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%

Final Examination	70%
Total	100%

20.101.13 Textbook/References

- Lewis Blackburn, and Thomas J. Domin, “Protective Relaying - Principles and Applications,” 3rd ed., CRC Press, 2007
- C. Russell Mason, “The Art & Science of Protective Relaying,” Wiley, 1967
- Stanley H. Horowitz, and Arun G. Phadke, “Power System Relaying,” 3rd ed., John Wiley & Sons, 2008
- Sunil S. Rao, “Switchgear Protection and Power System,” Khanna Publishers, 2010
- Other Resources (Online Resources or Others, if any).

20.102 Description of course EEE 478

Section A: General Information

20.102.1 Course Title	Power System Protection Laboratory
20.102.2 Type of Course	Optional, Sessional
20.102.3 Offered to	EEE
20.102.4 Pre-requisite Course(s)	None

Section B: Course Details

20.102.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 477: Power System Protection

20.102.6 Course Objectives

- To provide hands-on training on operation of different types of protective devices such as fuses and circuit breakers
- To provide hands-on training on programming different types of relays

20.102.7 Knowledge required

Fundamental understanding of concepts of the power system

20.102.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Identify** different types of protective devices used in generation transmission and distribution of power system	PO(a)	C1	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests
2	**Compare** Different types of circuit breakers and relays	PO(b)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	**Investigate** the programming the relays according to the requirement of the system	PO(e)	C4	Lectures, interactive discussions	Lab-tasks, Report, Assignment, Lab-tests
4	**Apply** the knowledge earned in the course to	PO(l)	C3	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests

	solve real power system contingencies				
5	demonstrate effective individual and team-working skills	PO(i)	A3	Lectures, interactive discussions	Peer and instructor assessment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.102.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
								√		√	√	√					√		

20.102.10 Lecture Plan

Week	**Experiment no.**	**Topic**
1	-	Introductory class and overview of the course
2	1	Operation of Fuses, HRC Fuse, drop out fuse,
3	2	Operating mechanisms, construction and operation of Miniature Circuit Breaker (MCB), Molded Case Circuit Breaker (MCCB)
4	3	Different parts of switchgear and operation of Vacuum circuit breaker (VCB)
5	4	Study of Low Tension Switchegar and Air Circuit breaker
6	5	Study of Sf6 Circuit breaker
7	6	Study of Classical relays electromagnetic attraction type, induction type); numerical relays. Inverse Definite Minimum Time (IDMT directional relays
8	-	Study the operation of over voltage and undervolatge relay and programing in De Lorenzo software
9	-	Study differential and percentage differential relays, distance relays, over-voltage and under voltage relay, and programming the relays in De Lorenzo software
10	-	
11	-	Viva
12	-	
13	-	Quiz

20.102.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of report writing and viva.
- A central quiz will be held at the the end of this course.

20.102.12 Distribution of Marks

Attendance	10%
Report	15%
Viva	30%
Quiz	45%
Total	100%

20.102.13 Textbook/References

- Sunil S Rao, "**Switchgear Protection & Power Systems**", Khanna Publishers, 2008.
- Online resources or supplementary materials will be shared with the class

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.103 Description of course EEE 479

Section A: General Infromation

20.103.1 Course Title	Power System Reliability
20.103.2 Type of Course	Optional, Theory
20.103.3 Offered to	EEE
20.103.4 Pre-requisite Course(s)	None

Section B: Course Details

20.103.5 Course Content (As approved by the Academic Council)

Review of probability concepts. Probability distribution: Binomial, Poisson, and Normal. Reliability concepts: Failure rate, outage, mean time to failure, series and parallel systems and redundancy. Markov process. Probabilistic generation and load models. Reliability indices: Loss of load probability and loss of energy probability. Frequency and duration. Reliability evaluation techniques of single area system. Interconnected system: tie line and evaluation of reliability indices.

20.103.6 Course Objectives

- To introduce the fundamentals of power system reliability.
- To familiarize and understand reliability concepts, reliability modelling of generator, load and power system equipment, reliability indices, and reliability evaluation techniques for such systems.
- To build the theoretical foundation required for reliability modelling and evaluation of power system.

20.103.7 Knowledge required

Basic probability and statistics, power systems.

20.103.8 Course Outcomes

COs	CO Statements	Corresponding POs	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
CO1	**Understand** the fundamentals of engineering system reliability	PO(a), PO(b)	C1, C2	Lectures, Tutorials, Homework	Assignment, Class test, Final exam

CO2	**Formulate** reliability indices for engineering systems, **Model and analyze** generator, load and power system equipment for reliability evaluation	PO(a), PO(b)	C1, C2, C3	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO3	**Evaluate** power generation capacity reliability for planning purposes, and transmission line and substation reliability	PO(a), PO(b), PO(c), PO(d)	C3, C4, C6	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO4	**Evaluate** interconnected system reliability, **determine** tie line capacities and **formulate** strategies for power exchanges between interconnected power systems	PO(a), PO(b), PO(c), PO(d)	C3, C4, C5, C6	Lectures, Tutorials, Homework	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.103.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.103.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-6	1-2	Review of probability concepts, probability distribution	CO1
7-12	3-4	Reliability concepts: Failure rate, outage, mean time to failure, series and parallel systems and redundancy	CO1
13-15	5	Markov process	CO1, CO2
16-21	6-7	Probabilistic generation and load models	CO1, CO2
22-27	8-9	Reliability indices: Loss of load probability and loss of energy probability	CO2, CO3
28-30	10	Frequency and duration	CO2, CO3
31-33	11	Reliability evaluation techniques of single area system	CO3, CO4
34-39	12-13	Interconnected system: tie line and evaluation of reliability indices	CO3, CO4
40-42	14	Review	CO1, CO2, CO3, CO4

20.103.11 Assessment Strategy

- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.

- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.103.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.103.13 Textbook/References

- Roy Billinton, Ronald N Allan, "Reliability Evaluation of Engineering Systems: Concepts and Techniques," 2nd ed., Springer Science+Business Media, LLC, 1992
- Roy Billinton, Ronald N Allan, "Reliability Evaluation of Power Systems," 2nd ed., Springer Science+Business Media, LLC, 1996

20.104 Description of course EEE 481

Section A: General Information

20.104.1 Course Title	Power System Operation and Control
20.104.2 Type of Course	Optional, Theory
20.104.3 Offered to	EEE
20.104.4 Pre-requisite Course(s)	None

Section B: Course Details

20.104.5 Course Content (As approved by the Academic Council)

- **Overview:** vertically integrated vs. deregulated power system. Real-time operation: SCADA; EMS (energy management system); various data acquisition devices - RTU, IED, PMU, DFDR, WAMPAC (wide area monitoring, protection and control).
- **Application functions:** state estimation; short term load forecasting; unit commitment (UC); economic dispatch (ED); optimal power flow (OPF).
- **Frequency control:** generation and turbine governors, droop, frequency sensitivity of loads, ACE (area control error), AGC (Automatic Generation Control) and coordination with UC and ED; frequency collapse and emergency load shed.
- **Power system security:** static and dynamic; security constrained OPF.
- **Electricity market operation:** GenCos, ISO, DisCos, bidding, spot market, social welfare, market clearing price (MCP), locational marginal price (LMP), bilateral contracts and forward market, hedging.
- **Demand side control:** DMS (distribution management system), DSM (demand side management), smart grid concept.

20.104.6 Course Objectives

- To provide the students with the basic knowledge of monitoring and control of a power system in which demand for electricity and hence generation is influenced by weather, human behaviour, societal and national needs.
- To enable the students to formulate mathematical models for solving various aspects of power system operation and learning control strategies.

20.104.7 Knowledge required

Fundamental understanding of concepts of Energy Conversion I and II, and Power System I.

20.104.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(ies)	Assessment Tool(s)
1	Apply mathematics and relevant engineering to model the components associated with power system operation and control.	PO(a), PO(b)	C3	Lectures, Discussions	Assignment, Class test, Final exam
2	Identify the emerging means for monitoring a power system and filtering error of digitally acquired and transmitted data in a power system.	PO(a), PO(b), PO(d), PO(l)	C4, C5, C6	Lectures, Discussions	Assignment, Class test, Final exam
3	Devise the techniques for balancing generation with demand in an economic and/or optimal way and for controlling frequency in normal or abnormal situation.	PO(c), PO(f), PO(g)	C2,C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
4	Analyse the impacts of contingencies on power system operation and identify the preventive or corrective means to reduce those considering various constraints.	PO(a), PO(e)	C4,C5,C6	Lectures, Discussions	Assignment, Class test, Final exam
5	Identify the barriers and requirements in implementing electricity market i.e. offering to the bulk consumers or distribution entities the flexibility in choice of electricity supplier and availing of competitive tariff.	PO(h), PO(i), PO(j), PO(k), PO(l)	C2,C3,C5	Lectures, Discussions	Assignment, Class test, Final exam
6	Identify the requirements in transforming traditional power system into a smart grid.	PO(h), PO(i), PO(j), PO(k), PO(l)	C2,C3,C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.104.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.104.10 Lecture Plan

Week	Lectures	Topic
1-2	1-6	**Overview:** vertically integrated vs. deregulated power system. Real-time operation: SCADA; EMS (energy management system); various data acquisition devices - RTU, IED, PMU, DFDR, WAMPAC (wide area monitoring, protection and control)
3	7-8	**Demand side control:** DMS (distribution management system), DSM (demand side management), smart grid concept
3-4	9-12	**Application functions:** state estimation;
5-7	13-19	**Application functions:** short term load forecasting; unit commitment (UC); economic dispatch (ED);
7-8	20-24	**Frequency control:** generation and turbine governors, droop, frequency sensitivity of loads, ACE (area control error), AGC (Automatic Generation Control) and coordination with UC and ED; frequency collapse and emergency load shed.
9-10	25-30	**Electricity market operation:** GenCos, ISO, DisCos, bidding, spot market, social welfare, market clearing price (MCP), locational marginal price (LMP), bilateral contracts and forward market, hedging.
11-12	31-36	**Application functions:** optimal power flow (OPF).
13-14	37-42	**Power system security:** static and dynamic; security constrained OPF

20.104.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of BUET Academic Council.

20.104.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.104.13 Textbook/References

- A. J. Wood , B. F. Wollenberg and Gerald B. Sheble., “Power Generation, Operation and Control,” John Wiley, NY, 3rd Edition, 2014
- Antonio Gomez-Expostio, Antonio J. Conejo and Claudio Canizares, “Electric Energy Systems Analysis and Operation”, CRC Presss, New York, 2018
- Jan Machowski, Janusz W. Bialek and James R. Bumby: Power System Dynamics Stability and Control, John Wiley & Sons, Ltd, UK, 2020.
- Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, *Smart Grid: Technology and Applications*, John Wiley & Sons, Ltd., UK
- John J. Grainger, William D. Stevenson, Jr. "Power System Analysis“, McGraw-Hill, Singapore
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the text/reference book, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.105 Description of course EEE 483

Section A: General Information

20.105.1 Course Title	High Voltage Engineering
20.105.2 Type of Course	Optional, Theory
20.105.3 Offered to	EEE
20.105.4 Pre-requisite Course(s)	None

Section B: Course Details

20.105.5 Course Content (As approved by the Academic Council)

High voltage DC generation: rectifier circuits, ripple minimization, voltage multipliers, Van-deGraaf and electrostatic generators; applications. High voltage AC generation: Tesla coils, cascaded transformers and resonance transformers. Impulse voltage generation: Shapes, mathematical analysis, codes and standards, single and multistage impulse generators, tripping and control of impulse generators. Breakdown in gas, liquid and solid dielectric materials, applications of gas and solid dielectrics in transformer. Corona. High voltage measurements and testing: IEC and IEEE standards, sphere gap, electrostatic voltmeter, potential divider, Schering bridge, Megaohm meter, HV current and voltage transducers: contact and noncontact. Over-voltage phenomenon and insulation coordination. Lightning and switching surges, basic insulation level (EV, EHV and UHV systems), surge diverters and arresters.

20.105.6 Course Objectives

- The main objective of this course is to introduce the fundamentals of high voltage engineering including high-voltage generation and measurement, voltage stress, the physics of materials breakdown under high voltages, testing with various types of voltage, over-voltage phenomenon and insulation coordination.
- The course aims to familiarize students with high-voltage generation, measurement and testing equipment and the basics of high voltage laboratory techniques.
- The course aims for building the theoretical foundation required for understanding and solving high-voltage problems in power system network and equipment and develop basic skills for high voltage insulation and protection design.

20.105.7 Knowledge required

Electrical circuits, basics of material physics, and statistical techniques.

20.105.8 Course Outcomes

COs	CO Statements	Corresponding Pos	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
CO1	**Understand** the requirements and standards and **employ** electrical and electronic circuits for high voltage generation.	PO(a), PO(b)	C1, C2, C3	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO2	**Apply** the physical laws to **explain** the high voltage breakdown of gas, liquid and solid dielectrics. **Solve** the problem of non-uniform field and varying breakdown strength of dielectrics.	PO(a), PO(b)	C1, C2, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam

CO3	**Design** high voltage measurement devices and **analyze** their characteristics; **set-up** laboratory procedures for high voltage measurements.	PO(a), PO(b), PO(c)	C1, C2, C3, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO4	**Understand** statistical approach to insulation coordination and **employ** this to correlate insulation and protection level.	PO(a), PO(b)	C1, C3, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO5	**Identify** high voltage phenomena relevant to engineering systems and **specify** the requirements and standards for systems protection.	PO(a), PO(b), PO(d)	C1, C4, C5	Lectures, Tutorials, Homework	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.105.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.105.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-9	1-3	High voltage DC generation: rectifier circuits, ripple minimization, voltage multipliers, Van-deGraaf and electrostatic generators; applications. High voltage AC generation: Tesla coils, cascaded transformers and resonance transformers. Impulse voltage generation: Shapes, mathematical analysis, codes and standards, single and multistage impulse generators, tripping and control of impulse generators.	CO1
10-24	4-8	Electrical breakdown in gas, liquid and solid dielectric materials.	CO1, CO2
25-27	9	Applications of gas and solid dielectrics in transformers; Corona.	CO1, CO3

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
28-33	10-11	High voltage measurements and testing: IEC and IEEE standards, sphere gap, electrostatic voltmeter, potential divider, Schering bridge, Megaohm meter, HV current and voltage transducers: contact and noncontact.	CO1, CO2, CO3
34-39	12-13	Over-voltage phenomenon and insulation coordination. Lightning and switching surges, basic insulation level (EV, EHV and UHV systems), surge diverters and arresters.	CO4, CO5
40-42	14	Review	CO5

20.105.11 Assessment Strategy

- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.105.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.105.13 Textbook/References

- E. Kuffel, W.S. Zaengl, and J. Kuffel "High Voltage Engineering Fundamentals", 2nd ed., Butterworth-Heinemann, 2000
- Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, Roshdy Radwan, "High-Voltage Engineering: Theory and Practice," 2nd ed., Marcel Dekker, 2000
- Dieter Kind, "An Introduction to High-Voltage Experimental Technique," Vieweg, 1978
- R. Reid, "High voltage resonant testing," IEEE PES Winter Meeting 1974, Conf. Paper C74038-6
- F H Airey, "An inexpensive high-voltage AC source for laboratory use," *Meas. Sci. Technol*. 1 (1990) 1297-1300
- Sanborn F. Philp, "The Vacuum-Insulated, Varying-Capacitance Machine," *IEEE Transactions on Electrical Insulation*, vol. EI-12, No. 2, April 1977, pp. 130-136
- Michael F. Wolff, "Van De Graaff's Generator," IEEE Spectrum, July 1990

20.106 Description of course EEE 484

Section A: General Information

20.106.1 Course Title	High Voltage Engineering Laboratory
20.106.2 Type of Course	Optional, Sessional
20.106.3 Offered to	EEE
20.106.4 Pre-requisite Course(s)	None

Section B: Course Details

20.106.5 Course Content (As approved by the Academic Council)

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE 483. In the second part, students will design simple systems using the principles learned in EEE 483.

20.106.6 Course Objectives

- To provide hands-on training on determining dielectric strength of solid, liquid and gaseous insulating materials
- To provide hands-on training on using earth tester to determine earth resistance
- To introduce Megger and electrostatic voltmeter

To design and present simple high voltage system

20.106.7 Knowledge required

Fundamental understanding of concepts of the high voltage engineering

20.106.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**use** modern tools to solve problems relevant to high voltage systems	PO(e)	P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests
2	**measure** dielectric strength of solid, liquid, gaseous insulating materials	PO(d)	C5	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	**design** simple high voltage system so that specific performance characteristics are attained	PO(c)	C6	Lectures, interactive discussions	Report, Project demonstration
4	**present** designed high voltage system	PO(j)	A3	Interactive discussions	Project demonstration and Presentation
5	demonstrate effective **individual and team-working skills**	PO(i)	A3		Peer and instructor assessment

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.106.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
					√	√		√		√	√	√	√	√	√				

20.106.10 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	Determination of dielectric (E) strength of gaseous insulating material
3	2	Determination of dielectric strength of liquid insulating material

Week	Experiment no.	Topic
4	3	Determination of dielectric strength of solid insulating material
5	4	Determination of dielectric strength of gas by high voltage testing set with spherical electrodes
6	5	Determination of earth resistance using earth tester
7	6	Introduction of Megger and electrostatic voltmeter
8	-	Design simple high voltage system so that specific performance characteristics are attained
9	-	
10	-	Present designed high voltage system
11	-	Viva
12	-	
13	-	Quiz

20.106.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of report writing and viva.
- A design project will be given and presentation has to be done.
- A central quiz will be held at the end of this course.

20.106.12 Distribution of Marks

Items	Percentage
Attendance	10%
Report	15%
Design Project	20%
Presentation	15%
Viva	20%
Quiz	20%
Total	100%

20.106.13 Textbook/References

- High Voltage Engineering – M S Naidu & V Kamaraju
- Online resources or supplementary materials will be shared with the class

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.107 Description of course EEE 485

Section A: General Information

20.107.1 Course Title	Power Transmission and Distribution
20.107.2 Type of Course	Optiuonal, theory
20.107.3 Offered to	EEE
20.107.4 Pre-requisite Course(s)	None

Section B: Course Details

20.107.5 Course Content (As approved by the Academic Council)

Transmission line parameters: Inductance - inductance due to internal flux, flux linkages between points external to an isolated conductor, flux linkages of one conductor in a group, single-phase two-wire line, composite-conductor lines, three-phase lines with equilateral/ unsymmetrical spacing, double circuits, bundled conductors; Capacitance - electric field of a long straight conductor, potential difference between points due to a charge, capacitance of a two-wire line, capacitance of three-phase line with equilateral/ unsymmetrical spacing, effect of Earth on transmission line capacitance, bundled conductor, parallel-circuit three-phase lines.

Sag of overhead lines. Types of insulators and electrical stress analysis.

Underground cables: Types and construction; oil filled, gas insulated and XLPE cables; electrical characteristics - electrical stress, capacitance, charging current, insulation resistance, dielectric power factor and dielectric loss, skin effect, proximity effect; identification of fault location.

HVDC transmission: Comparison of AC and DC transmission, HVDC transmission system components, monopolar and bipolar HVDC transmission, power converters: CSC (Current source converter) and VSC (Voltage source converter), operation and control of HVDC transmission link.

Substations: Substation equipment, bus bar arrangements, substation earthing, neutral grounding, substation automation, GIS substation.

Distribution systems: Primary and secondary distribution - radial, ring main, and interconnected system, distribution losses and feeder reconfiguration.

20.107.6 Course Objectives

- The main objective of this course is to introduce the fundamentals of power transmission line inductance and capacitance, the basics of overhead transmission line sag and insulators, underground cables, HVDC transmission system and its operation, substation and distribution systems.
- The course aims to familiarize students with power transmission and distribution systems, overhead and underground cable systems and the basics of HVDC system operation.
- The course aims for building the theoretical foundation and engineering knowledge required for understanding the design and specifications of power transmission and distribution systems.

20.107.7 Knowledge required

Electrical and electronic circuits, power systems.

20.107.8 Course Outcomes-

COs	CO Statements	Corresponding Pos	Learning Domain and Taxonomy Levels	Delivery Methods and Activities	Assessment Tools
CO1	**Understand** the fundamentals of overhead and underground transmission line parameters, **calculate** transmission line parameter based on line design.	PO(a), PO(b)	C1, C2	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO2	**Understand** and **analyze** the electrical and mechanical stresses on transmission line conductors and insulators, and **solve** basic design problems of transmission line.	PO(a), PO(b), PO(c)	C1, C3, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO3	**Understand** the basics of HVDC transmission systems, and **explain** its operation	PO(a)	C1, C2		
CO4	**Understand** the topological design of substation, and substation grounding.	PO(a)	C1, C2	Lectures, Tutorials, Homework	Assignment, Class test, Final exam
CO5	**Understand** the basics of distribution systems losses and **propose** loss reduction strategies.	PO(a), PO(c)	C1, C3, C4	Lectures, Tutorials, Homework	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.107.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.107.10 Lecture Plan

Lectures	Weeks	Topics (According to syllabus)	Mapping with COs
1-9	3	Transmission line parameters: inductance and capacitance	CO1, CO2
10-12	4	Sag of overhead lines	CO2
13-15	5	Types of insulators and electrical stress analysis	CO2
16-21	6-7	Underground cables: Types and construction; oil filled, gas insulated and XLPE cables; electrical characteristics - electrical stress, capacitance, charging current, insulation resistance, dielectric power factor and dielectric loss, skin effect, proximity effect; identification of fault location	CO1, CO2
22-27	8-9	HVDC transmission: comparison of AC and DC transmission, HVDC transmission system components, monopolar and bipolar HVDC transmission, power converters: CSC (Current source converter) and VSC (Voltage source converter), operation and control of HVDC transmission link	CO3
28-33	10-11	Substations: substation equipment, bus bar arrangements, substation earthing, neutral grounding, substation automation, GIS substation	CO4
34-39	12-13	Distribution systems: primary and secondary distribution - radial, ring main, and interconnected system, distribution losses and feeder reconfiguration	CO5
40-42	14	Review	CO1, CO2, CO3, CO4, CO5

20.107.11 Assessment Strategy

- Four nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 3 nos. will be counted.
- A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

20.107.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.107.13 Textbook/References

- John J. Grainger, and William D. Stevenson, Jr., “Power System Analysis,” McGraw Hill, 1994
  - Turan Gönen, “Electrical Power Transmission System Engineering - Analysis and Design,” 3rd ed., CRC Press
  - “EPRI AC Transmission Line Reference Book—200 kV and Above,” 3rd ed., Electric Power Research Institute, 2005
  - Leonard L. Grigsby ed., “Electric Power Generation Transmission and Distribution,” CRC Press, 2007

20.108 Description of course EEE 487

Section A: General Information

20.108.1 Course Title	Nuclear Power Engineering
20.108.2 Type of Course	Optional, Theory
20.108.3 Offered to	EEE
20.108.4 Pre-requisite Course(s)	None

Section B: Course Details

20.108.5 Course Content (As approved by the Academic Council)

- **Basic concepts**: nuclear energy, atoms and nuclei, radioactivity, nuclear processes, fission, fusion.
- **Nuclear systems**: particle accelerator, isotope separators, neutron chain reaction, reactor types, power generation.
- **Layout of nuclear power plant (NPP).**
- **Nuclear power plant reactors** : pressurized water reactor, boiling water reactor, CANDU reactor, gas cooled reactor, liquid metal cooled reactor, breeder reactor.
- **Auxiliaries, instrumentation and control**.
- **Grid interconnection issues**: effects of frequency and voltage changes on NPP operation.
- **Advanced and next generation nuclear plants;** very high temperature reactors.
- **Biological effects, reactor safety and security**; Three Mile island case; Chernobyl case; Fukushima case
- **Fuel cycle; radioactive waste disposal.**

20.108.6 Course Objectives

- To provide the students with the fundamental knowledge on the important features of nuclear power engineering covering chain reaction and reactor fundamentals, electricity generation, control and instrumentation, safety, fuel cycle and radioactive waste disposal.
- To enable the students to build the basic foundation required for pursuing a career on research, development and applications of nuclear power for the benefits of mankind.

20.108.7 Knowledge required

Fundamental understanding of concepts of Physics, Energy Conversion I and II, and Power System I.

20.108.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(ies)	Assessment Tool(s)
1	Understand the basic principles of extracting nuclear energy.	PO(a), PO(b)	C2,C4	Lectures, Discussions	Assignment, Class test, Final exam
2	Understand the basics of a nuclear power plant (NPP).	PO(a), PO(b), PO(d)	C2, C3, C5	Lectures, Discussions	Assignment, Class test, Final exam
3	Know about various types of existing and emerging reactors and their role in hydrogen economy.	PO(c), PO(f), PO(g),PO(j),PO(l)	C2,C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
4	Identify the reinforcements required in a grid system for accommodating and operating a NPP.	PO(a), PO(e)	C4,C5,C6	Lectures, Discussions	Assignment, Class test, Final exam
5	Understand the causes of major accidents ever occurred involving NPP and their remedies.	PO(h), PO(i), PO(j), PO(l)	C2,C4,C5	Lectures, Discussions	Assignment, Class test, Final exam

6	Know the basics of nuclear safety practices and fuel cycle	PO(h), PO(i), PO(k), PO(l)	C2,C3,C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.108.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.108.10 Lecture Plan

Week	Lectures	Topic
1-2	1-6	Basic concepts: nuclear energy, atoms and nuclei, radioactivity, nuclear processes, fission, fusion.
3	7-9	Nuclear systems: particle accelerator, isotope separators, neutron chain reaction, reactor types, power generation.
4	10-12	Layout of nuclear power plant (NPP).
5-7	13-19	Nuclear power plant reactors: pressurized water reactor, VVER reactor (“Vodo-Vodyanoi Energetichesky Reactors” *meaning* water-cooled, water moderated energy *reactor)* boiling water reactor, CANDU (**Canada Deuterium Uranium)** reactor, gas cooled reactor, liquid metal cooled reactor, breeder reactor.
7-8	20-24	Auxiliaries, instrumentation and control
9-10	25-30	Grid interconnection issues: effects of frequency and voltage changes on NPP operation.
11	31-32	Advanced and next generation nuclear plants; very high temperature reactors.
11-13	33-39	Biological effects, reactor safety and security; Three Mile island case; Chernobyl case; Fukushima case.
14	40-42	Fuel cycle; radioactive waste disposal

20.108.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.

Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of BUET Academic Council

20.108.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.108.13 Textbook/References

- Raymond L. Murray and Keith E. Holbert, Nuclear Energy : An Introduction to the Concepts, Systems, and Applications of Nuclear Processes; Elsevier, NY, 2020 (Eighth Edition).
- International Atomic Energy Agency, Electric Grid Reliability and Interface with Nuclear Power Plants; Vienna, 2012.
- Kenneth D. Kok (editor), Nuclear Engineering Handbook, CRC Press, USA, 2017
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the text/reference book, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

20.109 Description of course EEE 489

Section A: General Information

20.109.1 Course Title	Smart Grid
20.109.2 Type of Course	Optional, Theory
20.109.3 Offered to	EEE
20.109.4 Pre-requisite Course(s)	None

Section B: Course Details

20.109.5 Course Content (As approved by the Academic Council)

- **Smart grid:** two way communication; distributed energy resources (DERs) - DG (distributed generation) and ES (energy storage); high power density batteries, EV (electric vehicles) and PHEV (plug-in hybrid electric vehicles); smart sensors, meters and appliances at demand side.
- **Data communication channels;** protocols; TCP/IP; IEEE 802 series wireless LANs: bluetooth, Zigbee, WiMax; wired LANs- Ethernet, PSTN, PLC (Power Line Carrier); cyber security.
- **Smart meters and AMI (advanced metering infrastructure):** construction; standards for information exchange- Modbus, DNP3 and IEC61850; interfacing with HAN, NAN, WAN.
- **Power electronic interfaces between grid and DERs.**
- **Demand side integration (DSI):** DSM; real time pricing; ancillary markets; DR (demand response) for load shaping, frequency and voltage control, energy efficiency.
- **Microgrids, self healing and restoration**.

20.109.6 Course Objectives

- To provide the students with the knowledge on the important features of emerging power systems.
- To enable the students to build up concepts for integrating distributed energy resources including renewable energy sources, storage devices including electric vehicles, interfacing those with conventional grid, considering consumers' real time feedback, forming micro grids during system disturbances.

20.109.7 Knowledge required

Fundamental understanding of concepts of Power electronics, Digital communication, and Power System I.

20.109.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(ies)	Assessment Tool(s)
1	Understand the motives behind smart grid	PO(a), PO(b)	C2,C4	Lectures, Discussions	Assignment, Class test, Final exam
2	Identify the needs and features of a smart grid	PO(a), PO(b), PO(d)	C2, C3, C5	Lectures, Discussions	Assignment, Class test, Final exam
3	Learn the way a conventional power system (grid system) can be transformed into a smart grid	PO(c), PO(f), PO(g),PO(j),PO(l)	C2,C3, C4	Lectures, Discussions	Assignment, Class test, Final exam
4	Know smart grid gadgets	PO(a), PO(e)	C4,C5,C6	Lectures, Discussions	Assignment, Class test, Final exam
5	Know the operational strategies of smart grid	PO(h), PO(i), PO(j), PO(l)	C2,C4,C5	Lectures, Discussions	Assignment, Class test, Final exam
6	Learn how the demand can be shaped to match available generation	PO(f), PO(h), PO(i), PO(k), PO(l)	C2,C3,C5,C6	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

20.109.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

20.109.10 Lecture Plan

Week	Lectures	Topic
1	1-3	Smart grid concept; traditional vs. smart features in power generation, transmission, distribution and control.
2-3	4-9	Two way communication, DERS, DGs, ESS, EV, PHEV, smart appliances, sensors and meters; smart meters, AMI (advanced metering infrastructure)..
4	10-12	Some emerging concepts: grid resilience, grid hardening, prosumers, transactive energy.
5-7	13-19	Power electronic interfaces between grid and DERS such as PV, wind power generators.
7-8	20-24	Demand side integration (DSI): DSM; real time pricing; ancillary markets; DR (demand response) for load shaping, frequency and voltage control; energy efficiency.

Week	Lectures	Topic
9-10	25-29	Microgrids, self-healing and restoration.
10-12	30-36	Communication in smart grid: protocols; TCP/IP; HAN, NAN, WAN, IEEE 802 series wireless LANs: bluetooth, Zigbee, WiMax; wired LANs- Ethernet, PSTN, PLC (Power Line Carrier); cyber security.
13	37-39	Standards for information exchange: Modbus, DNP3 and IEC61850.
14	40-42	Interfacing smart meters with HAN, NAN, WAN, DCU and server

20.109.11 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of BUET Academic Council.

20.109.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

20.109.13 Textbook/References

- Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, **Smart Grid: Technology and Applications,** John Wiley & Sons, Ltd., UK, 2012.
- Nouredine Hadjsaïd and Jean-Claude Sabonnadière, **Smart Grids**, ISTE Ltd., UK and John Wiley & Sons, Inc., USA, 2012.
- Ersan Kabalci and Yasin Kabalci, **From Smart Grid to Internet of Energy,** Academic Press (Elsevier), UK, 2019.

- Online resources or supplementary materials will be shared with the class on a need basis

- Besides going through relevant topics of the text/reference book, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

Annex A: Definition of Terms

Term	**Definition**
PEO	Program Educational Objectives
PO	Program Outcomes
CGPA	Cumulative Grade Point Average
CO	Course Outcome
EEE	Electrical and Electronic Engineering
OBE	Outcome Based Education
COs	Course Outcomes
Ph.D	Doctor of Philosophy
OBA	Outcome-Based Accreditation

Annex B: List of Program Outcomes

The teaching methods in the department revolve around the program outcome set by the department. The department follows the following program outcomes for its undergraduate programs:

PO(a)- Engineering knowledge: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.

PO(b)-Problem analysis: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.(K1 to K4)

PO(c)- Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns. (K5)

PO(d)- Investigation: Conduct investigations of complex problems, using research-based knowledge (K8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PO(e)-Modern tool usage: Create, select and apply appropriate techniques, resources and modem engineering and IT tools, including prediction and modeling, to complex engineering problem, with an understanding of the limitations. (K6)

PO(f)-The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (K7)

PO(g)-Environment and sustainability: Understand and evaluate the sustainability and impact of professional engineering solutions of complex engineering Problem in societal and environmental contexts. (K7)

PO(h)-Ethics: Apply ethical principles and commit to the professional ethics, responsibilities and the norms of engineering practice. (K)

PO(i)-Individual work and teamwork: Function effectively as an individual, and as a member or leader of diverse teams and in multidisciplinary settings.

PO(j)- Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO(k)-Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and economic decision-manage projects and in multidisciplinary environments.

PO(l)-Life-long learning: Recognize the need for and have the preparation and ability to engage in independent, and life-long learning in the broadest context of technological change.

In addition to incorporating the above-listed POs (graduate attributes), the educational institution may include additional outcomes in its learning programs. An engineering program that aims to attain the abovementioned POs must ensure that its curriculum encompasses all the attributes of the Knowledge Profile (K1 – K8) as presented in Table 4.1 and as included in the PO statements. The ranges of Complex Problem Solving (P1 – P7) and Complex Engineering activities (A1 -A5) are given in Tables 4.2 and 4.3, respectively.

Table A.1: Knowledge Profile

	Attribute
K1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
K5	Knowledge that supports engineering design in a practice area
K6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer’s professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability
K8	Engagement with selected knowledge in the research literature of the discipline

Table A.2: Range of Complex Engineering Problem Solving

Attribute	**Complex Engineering Problem** have characteristic P1 and some or all of P2 to P7:
Depth of knowledge required	P1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach
Range of conflicting requirements	P2: Involve wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	P3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	P4: Involve infrequently encountered issues
Extent of applicable codes	P5: Are ouside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting requirements	P6: Involve diverse groups of stakeholders with widely varying needs
Interdependence	P7: are high-level problem including many component parts or sub-problems

Table A.3: Range of Complex Engineering Activities

Attribute	**Complex activities** means (engineering) activities or projects that have some or all of the following characteristics:
Range of resources	A1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies)
Level of interaction	A2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	A3: Involve creative use of engineering principles and research-based knowledge in novel ways
Consequences for society and the environment	A4: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	A5: Can extend beyond previous experiences by applying principles-based approaches

Annex C: Domains and Taxonomy Level

Taxonomy	**Level**
C	Cognitive
C1	Knowledge
C2	Comprehension
C3	Application
C4	Analysis
C5	Synthesis
C6	Evaluation
A	Affective
A1	Receiving
A2	Responding
A3	Valuing
A4	Organizing
A5	Characterizing
P	Psychomotor
P1	Perception
P2	Set
P3	Guided Response
P4	Mechanism
P5	Complex Overt Response
P6	Adaptation
P7	Organization

Annex D: Format of the Course Outline

1.1 Description of Course ABC 111

Section A: General Information

1.1.1 Course Title Insert your course title her

1.1.2 Type of Course Insert course type (Core/Optional/Session/Non-departmental)

1.1.3 Offered to Insert the name of the Department

1.1.4 Pre-requisite Course(s) Insert course numbers if applicable

Section B: Course Details

1.1.5 Course Content (As approved by the Academic Council)

Insert course content here

1.1.6 Course Objectives

• Objective 1

• Objective 2

1.1.7 Knowledge required

Insert previous knowledge requirements

1.1.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(ies)	Assessment Tool(s)
1	CO1 Statement	e.g., PO(a)	e.g.,C2	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
2	CO2 Statement				
3	CO3 Statement				
4	CO4 Statement				
5	CO5 Statement				

1.1.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5

1.1.10 Lecture Plan

Class No.	Topics	References	Corresponding CO(s)
1			
2			
3			
.....			
.....			
4			

1.1.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

1.1.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

1.1.13 Textbook/References

1. Reference 1

2. Reference 2