Premier University, Chittagong
Department of Electrical & Electronic Engineering

Syllabus for B.Sc. in Electrical & Electronic Engineering (Batch 7th to 16)

Introduction

The modern life is inconceivable without Electrical and Electronic Engineering. From radio to cell phones, biomedical instrumentation e.g. pacemaker, computer aided tomography, X-ray imaging, MRI-save lives, microelectronics- turns sand to CPUs and memory, nanotechnology- develops new device and materials, consumer electronics- meets the entertainment and every day necessities from toast makers to shaving razors and ultimately the fuel to all these goods and systems that is electrical power generation and transmission safely to the consumers; all have been made possible by the Electrical and Electronic Engineers. However, the overwhelming demand in this field of technology is always a challenge to meet which requires a broad educational background and a long time commitment to learn and research. Considering this challenge, the Department of Electrical and Electronic Engineering at Premier University was established in January 2008. The vision of this department is to be recognized as the very best program of Electrical and Electronic Engineering education and research in this region and the mission is to provide quality education and to transfer highly skilled manpower to the community.

The department of Electrical and Electronic Engineering is facilitated with well-equipped labs on circuits and electronics, machines and power systems, communication and microprocessor as well as three well-furnished computer labs for control system, digital signal processing, microwave engineering and VLSI with necessary software and interfacing units. The curriculum of the department is mainly concentrated on three majors: Power, Communication and Electronics. The curriculum is designed heading to make the students capable of doing independent research works and skilled to bring together the theoretical concepts practically which are formulated by 1-year project/thesis works as well as industrial training/attachments. And the excellent faculty members of the department bring all these plans, visions and missions into reality with their cordial and professional cooperation.

The department of Electrical and Electronic Engineering at Premier University provides broad training to individuals would make them adaptable to the future challenge in the arena of electrical power generation, transmission and distribution, signal processing, telecommunications, sensors, microelectronics, nanotechnology and Microsystems not only across the country but also globally as technology evolve-making them successful throughout the career.

Chronology of Events

December 2007 : Electrical and Electronic Engineering (EEE) Program was launched.
July 2012 : Students of first batch of EEE program graduated.

Fact Sheet

Program : Undergraduate
Name of Degree : Bachelor of Science in Electrical and Electronic Engineering [B. Sc. Engg. in EEE]
Duration : 4 Years
Semester : 8
Total Theory Courses : 40
Total Lab Courses : 28
Project/Thesis : 1
Total Credits : 160

Course List and Code

Course Code	Course Title	Credit

CHE 101	Chemistry	3
CHE 102	Chemistry Laboratory	0.75
CSE 110	Introduction to Computer Systems (Laboratory)	2
EEE 101	Electrical Circuits I	3
EEE 102	Electrical Circuits I Laboratory	1.5
ENG 101	General English	3
MAT 105	Engineering Mathematics I	3
ME 102	Mechanical Engineering Drawing & CAD (Laboratory)	1
PHY 101	Engineering Physics I	3
ACC 101	Basic Accounting	3
EEE 103	Electrical Circuits II	3
EEE 104	Electrical Circuits II Laboratory	1.5
EEE 106	Electrical Circuit Simulation Laboratory	1.5
ENG 103	Developing English Skills	2
MAT 107	Engineering Mathematics II	3
ME 201	Basic Mechanical Engineering	3
PHY 103	Engineering Physics II	3
PHY 104	Engineering Physics II Laboratory	0.75
CE 102	Civil Engineering Drawing Laboratory	1
ECO 201	Basic Economics	3
EEE 241	Electromagnetic Fields and Waves	3
EEE 211	Electronics I	3
EEE 212	Electronics I Laboratory	1.5
EEE 221	Electrical Machines I	3
EEE 222	Electrical Machines I Laboratory	1.5
MAT 201	Engineering Mathematics III	3
CSE 301	Computational Methods for Engineering Problems	3
CSE 302	Computational Methods for Engineering Problems Laboratory	1
EEE 213	Electronics II	3
EEE 214	Electronics II Laboratory	1.5
EEE 223	Electrical Machines II	3
EEE 224	Electrical Machines II Laboratory	1.5
EEE 201	Signals & Systems	3
EEE 202	Signals & Systems Laboratory	1
MAT 203	Engineering Mathematics IV	3
EEE 302	Electronic Appliances Laboratory	1.5
EEE 309	Communication Engineering	3
EEE 310	Communication Engineering Laboratory	1.5
EEE 311	Digital Electronics	3
EEE 312	Digital Electronics Laboratory	1.5
EEE 322	Electrical Machine Design Laboratory	1
EEE 351	Transmission & Distribution of Electrical Power	3
MGT 203	Industrial and Business Management	3
MGT 251	Organizational Behavior	3
EEE 313	Measurement and Instrumentation	3
EEE 314	Measurement and Instrumentation Laboratory	1.5
EEE 315	Power System Analysis	3

EEE 316	Power System Analysis Laboratory	1.5
EEE 333	Switchgear and Protection	3
EEE 334	Switchgear and Protection Laboratory	1.5
EEE 356	Electrical and Electronic Engineering Services (Laboratory)	1.5
EEE 371	Microprocessors & Microcontrollers	3
EEE 372	Microprocessors & Microcontrollers Laboratory	1.5
EEE 373	Control Systems	3
EEE 374	Control Systems Laboratory	1.5
EEE 411	Semiconductor Physics & Devices	3
ENG 401	Technical Writing & Presentation	2.0
EEE 477	Digital Signal Processing	3
EEE 478	Digital Signal Processing Laboratory	1.5
EEE 400	Project/Thesis (Two semesters long course, i.e., for 7th & 8th semesters)	4

A Major has to be selected from the list given below with the approval of the Department:

Major in Power

EEE 431:	Computer Aided Power System Analysis	3
EEE 432:	Computer Aided Power System Analysis Laboratory	1
EEE 441:	Industrial Power Electronics	3
EEE 442:	Industrial Power Electronics Laboratory	1.5
EEE 451:	Power Plant Engineering	3
EEE 461:	High Voltage Engineering	3
EEE 462:	High Voltage Engineering Laboratory	1.5
EEE 471:	Renewable Energy	3
EEE 481:	Power System Operation and Control	3

Major in Electronics

EEE 433:	Processing and Fabrication Technology	3
OR		
EEE 403:	Microwave and Antenna Engineering	3
EEE 443:	VLSI Design	3
EEE 444:	VLSI Design Laboratory	1.5
EEE 453:	Biomedical Instrumentation	3
OR		
EEE 485:	Analog Integrated Circuit Design	3
EEE 463:	VHDL	3
OR		
EEE 441:	Industrial Power Electronics	3

EEE 464:	VHDL Laboratory	1.5
OR		
EEE 442:	Industrial Power Electronics Laboratory	1.5
EEE 473:	Optoelectronics and Optical Fiber Communication	3
EEE 474:	Optoelectronics and Optical Fiber Communication Laboratory	1
EEE 467:	Radio Electronics	3
OR		
EEE 483:	Microwave Devices, Amplifiers and Sources	3

Major in Communication

EEE 435:	Cellular Mobile Communication	3
OR		
EEE 483:	Microwave Devices, Amplifiers and Sources	3
OR		
EEE 445:	Advanced Communication Engineering	3
EEE 403:	Microwave and Antenna Engineering	3
EEE 473:	Optoelectronics and Optical Fiber Communication	3
EEE 474:	Optoelectronics and Optical Fiber Communication Laboratory	1
EEE 465:	Digital Communication	3
EEE 466:	Digital Communication Laboratory	1.5
EEE 419:	Random Process for communication	3
OR		
EEE 467:	Radio Electronics	3
EEE 420:	Random Process for communication Laboratory	1.5
OR		
EEE 468:	Radio Electronics Laboratory	1.5
EEE 455:	Satellite Communication	3
OR		
EEE 485:	Analog Integrated Circuit Design	3

Course Description

CHE 101: Chemistry
Theory: 3hours/week, 3 Credits

Structure of Atom: Atomic structure, quantum numbers, electronic configuration, periodic table. Properties and uses of noble gases. Wave nature and particle nature of electrons. Schrodinger's wave equation, Particle in one dimensional box, normalization and orthogonalization of wave functions. , Mason theory of nuclear forces, Mass defect, Properties and uses of radioactive elements.
Chemical Bonding: Different types of chemical bonds, covalent and coordinate compounds, Valence bond theory.
Classification of Elements: Structure and properties of Boron, Silicon, Germanium, Gallium, Arsenic and Antimony, Preparation of pure silicon, Intrinsic and extrinsic semiconductors, p-n junction and Application of semiconductors.
Instrumental Analysis: Radiation and matter interaction, Electromagnetic radiation, UV- VIS and IR spectroscopy, Beer-Lambert's law, Basic components of a spectrometer, Radiation sources, Wavelength selectors, Different types of radiation detectors, Signal processor, Sensitivity and noise reduction.
Reaction Dynamics: Thermo Chemistry, Chemical kinetics, chemical equilibrium, Ionization of water and pH concept.
Electrochemistry: Types of conductors of electricity, Electrolytes and non-electrolytes, Phenomena of electrolysis, Faraday's law of electrolysis, Theories of electrolytic conduction, Electrical properties of solution.
Organic Chemistry: Aliphatic and aromatic hydrocarbons, Selective organic reactions.
Polymers: Synthetic and natural polymers, Thermosetting and thermoplastic polymers, natural and synthetic rubber, Insulation properties of PVC, rubber and plastics.
Water Treatment: Specification of water, Treatment of drinking water, Iron removing plant, Distillation of water, Contamination of water caused by As, Pd, Hg and other toxicants, Removal of toxicity from polluted water, Thermal and radioactive pollution of water.
Fuel: Types of fuel, Origin of fuel, Refining of crude fuels, Characteristics of different fuels, Calorific value, Octane number, Antiknock compounds, Cracking of fuels, Nuclear fuels and Aviation fuels.

References:

- *Essentials of Physical Chemistry* by B.S. Bahl, G.D. Tuli and Arun Bahl
- *Modern Inorganic Chemistry* by R.D. Madan

CSE 110: Introduction to Computer Systems (Laboratory)
Lab: 4hours/week, 2 Credits

Introduction to computations: Early history of computing devices;
Computers: Major components of a computer;
Hardware: Processor, Memory, I/O devices, Hard Disk, Storage media, CD ROM, DVD, Printer, Scanner;
Software: Function of operating system, Discussion on different types of operating system;
Networking: Different types of networks, Network topologies, Communication media.
Language Concept: Different types of Computer Languages.

Program development stages: Flow charts; Basic programming concepts; Compiler and Interpreter, Executable and Object File.
Programming Constructs: Compilers and interpreters; Syntax and semantics; Data types and their representation; Strong typing. Static vs. dynamic typing; operators, arithmetic expressions and assignment statements; Loops and Nested Loops; Case statements; Arrays; Functions; Header files; Preprocessor; Multidimensional array; Strings; User defined data types: structures, unions, enumerations; Input and Output: standard input and output, formatted input and output, Files: file function for sequential and random I/O; Pointers: Pointers and structures; Pointer and function; Operation and Pointer; Pointer and function; Pointer and array Pointer and memory address; Operations on Bits; Variable length argument list; Command line parameters; Error Handling; Linking; Library functions.

References:

- *Computer Science* by C.S. Frence.*Computer Science* by War ford.
- *Inside PC* by Norton.
- *Introduction to Computer* by Norton
- *How Computer Works* by Ron White.

EEE 101: Electrical Circuits I
Theory: 3hours/week, 3 Credits

Circuit variables and elements: Voltage, current, power, energy, independent & dependent sources and resistance.
Basic laws: Ohm's law, Kirchhoff's current and voltage laws.
Simple resistive circuits: Series and parallel circuits, voltage and current division, wye-delta transformation.
Techniques of circuit analysis: Branch current method, Nodal and mesh analysis including supernode and supermesh. Independent and dependent sources.
Network theorems: Source transformation, Thevenin's, Norton's and superposition theorems with applications in circuits having independent and dependent sources, Maximum power transfer condition and Reciprocity theorem.
Energy storage elements: Inductors and capacitors, series parallel combination of inductors and capacitors.
Responses of RL, RC and RLC circuits: Natural and step responses. Introduction to Alternating Current (AC), sinusoidal variation, frequency and wavelength. Instantaneous voltage, current and power, impedance of AC quantities, RMS value & average value, RLC series and parallel circuits. Phasor algebra and Drawing of phasor diagram.
Magnetic quantities and variables: Flux, permeability and reluctance, magnetic field strength, magnetic potential, flux density, magnetization curve. Laws in magnetic circuits: Ohm's law and Ampere's circuital law. Magnetic circuits: series, parallel and series-parallel circuits.

References:

- *Introductory Circuit Analysis* by Robert L. Boylestad, (Prentice Hall)
- *Electrical Engineering* by Robert P. Ward
- *A text book of electrical technology* by B. L. Thereja
- *Alternating Current Circuits* by R.M. Kerchner and G.F. Corcoran (Wiley)

ENG 101: General English
Theory: 3hours/week, 3 Credits

The Basic English course enables students to progress from a broad awareness into a critically informed knowledge of English literature in its historical range and depth. Competence in textual analysis, ease in critical argument, the ability to recognize and fashion rhetorical and linguistic discourse and the manipulation of sound reasoning are among the skills, both in spoken and written form, conferred by the proper study of literature.
English phonetics: The places and manners of articulation of the English sounds; Vocabulary; English grammar: construction of sentences, some grammatical problems; Comprehension; Paragraph writing; Précis writing; Amplification;; Short stories written by some well-known classic writers.
Grammar: Tense, article, preposition, subject-verb agreement, clause, Main Verbs, Modals and Modal-related patterns, Causatives, Conditionals, Subjunctives, Infinitives, Have + Participle, Auxiliary Verbs, Pronouns, Relative Pronouns, Nouns and Adjectives, Nouns functioning as Adjectives and other Parts of Speech, Determiners, Comparatives, Prepositions and prepositional idioms, Point of View, Agreement of verbs, Introductory verbal Modifiers,
Vocabulary building: Correct and precise diction, affixes, level of appropriateness. Colloquial and standard, informal and formal. Word Choice – Vocabulary – Antonym, Synonym, Homonym, Homograph, Homophone, Wh. Questions, Punctuations: Full stop, comma, colon, semi colon, apostrophe, capital letter, hyphen, quotation marks, titles etc.
Developing reading skill: Strategies of reading – skimming, scanning, predicting, inferring; analyzing and interpreting variety of texts; practicing comprehension from literary and nonliterary texts.
Developing writing skill: Sentences and Clauses, sentence variety, generating sentences; clarity and correctness of sentences, linking sentences to form paragraphs, writing paragraphs, essays, and reports.

References:

- *English Grammar in Use* by Raymond Murphy.
- *Build Up Your English* (ELBS) by A. J. Glover.
- *Fluency in English* by L.G. Alexander.
- *General English for Technical Students* by E. Frank Candlin.
- *Words and Ideas* by Hans P. Guth.
- *From Paragraph to Essay* by Maurice Imhoof and Herman Hudson
- *A Practical English Grammar,* by A. J. Tomson, Oxford University Press
- *Cliffs Test of English as Foreign Language* by M. A. Pyle

MAT 105: Engineering Mathematics I
Theory: 3hours/week, 3 Credits

Differential Calculus: Function and its domain, range and graphical representation. Limits, continuity and differentiability of functions, differential coefficients of various types of functions, successive differentiation and Leibnitz's theorem, Rolle's theorem, Mean value theorem, Taylor's theorem in finite and infinite forms, expansion of functions, L'Hospital's rule,

partial differentiation and Euler's theorem, tangent and normal, extreme curve plotting and optimization, Curvature, asymptotes, and curve tracing.
Co-ordinate Geometry: Transformation of co-ordinate axes, pair of straight lines, equations of conics and reduction to standard forms, circles, system of circles. Rectangular co-ordinates,
Introduction of Vector Analysis.

References:

- *Differential Calculus* by Joshep Edward.
- *Differential Calculus* by Mohammed & Bhattacharjee
- *Differential Calculus* by P.K. Das & Mukherjee.
- *Two dimensional Geometry/ analytical geometry* by Askwith, J.M. Kur.
- *A treatise on three dimensional Geometry* by J.T. Bell.
- *A text book of co-ordinate geometry and vector analysis* by Rahman & Bhattacharjee.
- *Vector analysis* by M.R.Spigel.

ME 102: Mechanical Engineering Drawing & CAD (Laboratory)
Lab: 2hours/week, 1 Credits

This course contributes towards the engineering topics component of the mechanical engineering curriculum by familiarizing students with the state of the art CAD and FEA software for modeling, analyzing and designing mechanical components. This course brings into focus the Introduction, Orthographic drawings, First and third angle projections, scale drawing, sectional view, isometric views, missing line, auxiliary view, detail and assembly drawing, project on engineering drawing and CAD using AutoCAD or contemporary packages instructed by the teachers. The students also understand the requirements for good engineering drawings, and are able to apply these to their work/projects.

References:

- *AutoCAD – 2002 instant reference* by Goerge Omura & B. Robert Colloria.
- *Mastering AutoCAD* by Goerge Omura.
- *Introduction to AutoCAD* by B. Robert Colloria

PHY 101: Engineering Physics I
Theory: 3hours/week, 3 Credits

Mechanics: Kinematics, Graphical representations of displacement-time, velocity-time and acceleration-time, Motion in two and three dimensions-projectile motion, Application of Newton's laws of motion, Free body diagrams, Analysis of frames of trusses, Friction, Equilibrium forces, Work-kinetic energy theorem. Power, Conservative forces. Conservation of energy, Conservation of linear momentum for a system of particles, Center-of-mass motion, Elastic and inelastic collision in one dimension, Rotational kinematics, Angular momentum of a single particle, Conservation of Angular momentum, Moment of Inertia, Balancing of rotating masses.
Gravitation: Gravitational field. Kepler's laws.
Waves & Oscillations:

Oscillations: Simple Harmonic motion, damped simple harmonic oscillation, forced oscillations, Combination and Composition of simple harmonic motions, Lissajous figures, Transverse and Longitudinal nature of waves, traveling and standing waves, intensity of waves, energy calculation of progressive & stationary waves, Phase velocity, group velocity.
Sound waves: Velocity of Longitudinal wave in a gaseous medium, Doppler Effect.
Thermodynamics: 0^{th}, 1^{st} and 2^{nd} law of thermodynamics, Reversible and irreversible processes, Carnot cycle, Auto cycle, Diesel cycle and their efficiency; Clausius theorem, Entropy, Absolute scale of temperature. Clausius Clapeyron equation. Thermodynamic functions, Maxwell's thermodynamic relations. Problem involving thermodynamic relations and functions. Gibb's phase rule.

References:

- *Physics I* by Halliday & Resnick.
- *Waves and Oscillations* by Brijlal.
- *Heat and Thermodynamics* by Brijlal.

ACC 101: Basic Accounting
Theory: 3hours/week, 3 Credits

Accounting its origin and development, Definition of Accounting and book Keeping, used and users of financial information, transaction, assets, liabilities, the accounting cycle. Income statement, Retained earnings, statement and balance sheet. Interpretation of financial statements, use of accounting information in project evaluation and other decision making. Financial Accounting and Accounting Standards, Conceptual Framework Underlying Financial Accounting, Accounting Process, Journal entries, Preparation of Cash Book and other books, Bank Reconciliation Statement, Ledger Posting and Preparation of Trial Balance, Capital and Revenue expenditure, Adjustment entries and closing entries, Work Sheet, Provision for bad and doubtful debts, Depreciation, Inventory Valuation, Preparation of Manufacturing Account, Trading Account, Profit and Loss Account and Balance Sheet, Accounting for Incomplete Records, Bill of Exchange, Partnership Accounts – Admission and retirement of Partners – Dissolution of partnership, Acquisition and Disposition of Property, Plant, and Equipment, Intangible Assets, Current Liabilities and Contingencies, Master Budget.

References:

- *Accounting* by Meigs Williams.
- *Cost Accounting* by T. Hargren and George Foster.
- *Advance Accounting* by M. M. Khan
- *Intermediate Accounting* by W. Karrenbrock & H. Simsons
- *Financial Accounting* by R.K. Eskew and D.L Jensen

EEE 103: Electrical Circuits II
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 101: Electrical Circuits I

AC Analysis: Effective values of AC current and voltage. Average power, phasors and complex quantities, impedance, real and reactive power, power factor with sinusoidal excitatory for RLC

circuits. Analysis of non-sinusoidal waves, Analysis of single phase AC circuits: series and parallel RL, RC and RLC circuits, nodal and mesh analysis, application of network theorems in AC circuits, circuits with non-sinusoidal excitations, transients in AC circuits, passive filter.
Resonance in AC circuits: Series and parallel resonance.
Analysis of three phase circuits: Three phase supply, Analysis of balanced and unbalanced circuits, Power calculation, Phase sequence and its effects. Measurement of 3-phase power by 3-wattmeter method as well as two wattmeter method.
Miscellaneous: Magnetically coupled circuits, Application of Matrix in circuit analysis. Transient analysis for different types AC and DC circuits.

References:

- *Alternating Current Circuits* by R.M. Kerchner and G.F. Corcoran (Wiley)
- *Introductory Circuit Analysis* by Robert L Boylestad (Prentice Hall)
- *A text book of electrical technology* by B. L. Thereja

EEE 106: Electrical Circuit Simulation Laboratory
Lab: 3hours/week, 1.5 Credits
Prerequisite: EEE 101: Electrical Circuits I

Introduction to CAD & Simulation Tools, Simulation techniques of different CAD Tools;
DC Circuit simulation, AC Circuit simulation, two port network, second order circuit, Resonance, Three phase System etc.
Details concept of simulation Tools MATLAB, PSpice etc.

References:

- *System Simulation* by Geoffey Gordon.
- *The Designer's guide to Spice and Spectre* by Ken Kundert.
- *SPICE: A guide to circuit simulation and analysis using PSpice* by Paul W. Tuinenga, MicroSim Corporation

ENG 103: Developing English skills
Theory: 2hours/week, 2 Credits

Developing writing skill: Letter Writing: formal and informal, Report writing; Business communication and tenders, business letters, letters of opinion, application and CV writing, fax, e-mail, memo, etc.
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, complaints, apologies, describing people and places, narrating events.
Discussion: A group of students to be brought on the dais at a time. Other students of the class will be interrogating and likewise every student should be brought in turn and questions should be asked from the fields of literature, science, current politics, international affairs, games and sports, etc. The Instructor will act as a conductor.

References:

- *English Grammar in Use* by Raymond Murphy.
- *Build Up Your English* (ELBS) by A. J. Glover.
- *Words and Ideas* by Hans P. Guth.
- *From Paragraph to Essay* by Maurice Imhoof and Herman Hudson
- *General English for Technical Students* by E. Frank Candlin.
- *Fluency in English* by L.G. Alexander

MAT 107: Engineering Mathematics II
Theory: 3hours/week, 3 Credits
Prerequisite: MAT 105: Engineering Mathematics I

Integral Calculus: Integration of various types of functions, integration techniques, definite integrals and its properties, Wallis's formulae, Improper Integrals, Beta function and Gamma function, applications of integration, length of a curve, areas of surfaces, volume of solids/hollow solids of revolution, pedal equations.
Differential Equation: Formation of differential equations, Solution of first order and first degree differential equation, first order but higher degree differential equations, solution of linear differential equations with constant coefficients, homogeneous linear differential equations, series solution of differential equations, Bessel functions.

References:

- *Integral Calculus by* Joshep Edward.
- *Integral Calculus* by Mohammed & Bhattacharjee
- *Advanced Engineering Mathematics* by Erwin Kreyszig.
- *Advanced Engineering Mathematics* by H.K. Dass
- *Ordinary & Partial Differential Equation* by V.D. Sharma
- *Differential Equations* by Dr. S.M. Farid
- *Differential Equations* by Erinu Kresgige
- *Integral Calculas* by P.K.Das & Mokhajji

ME 201: Basic Mechanical Engineering
Theory: 3hours/week, 3 Credits

Introduction: Sources of Heat energy. Renewable and non-renewable sources and their potential; Introduction to steam generation, Steam generator: Boilers and their classification; Working principle of few common and modern boiler; Boiler mountings and accessories; Performance of boiler. Heat engines: Gas turbines, diesel engines, petrol engines, Fuel, lubrication and cooling systems of I.C engines.
Energy and First law: Systems and surroundings; Conservation of energy; Different thermodynamic processes; Energy transfer as heat for a control volume.
Entropy and Second law: Reversibility and irreversibility; Definition and corollaries of second law of thermodynamics. Entropy: its transfer and change.
Characteristics of some thermodynamic cycles: Analysis of different thermodynamic cycles, Vapor power cycles, Representation of various cycles on PV & TS planes.

Basic concepts of refrigeration systems: Vapor compression refrigeration, Absorption refrigeration, cop, Refrigerants and their classifications and properties.
Air conditioning: Introduction, Objectives and major components of air conditioning systems; Humidity; Dew point.
Robotics: Introduction to robotics, essential components of a robot & their kinematics, links, frames, spatial motions, programming robots, clocks, sensors, actuators and control.

References:

- *Engineering Thermodynamics* by P.K. Nag.
- *Heat Engineering* by V.P. Vasandani
- *A textbook of Thermal Engineering* by RS Khurmi, J.K.Gupta

PHY 103: Engineering Physics II
Theory: 3hours/week, 3 Credits
Prerequisite: PHY 101: Engineering Physics I

Electricity and Magnetism
Electromagnetism: Magnetic fields, Maxwell's equations, Ampere's law, Faraday's law, Lenz's law. Inductance: Self mutual inductance. Magnetic properties of matter: Magnetomotive force, magnetic field intensity, permeability and susceptibility, classification of magnetic materials, magnetization curve of ferromagnetic materials, magnetic circuits, magnetostriction.
Optics: Theories of light; Huygen's principles and constructions.
Interference of light: Young's double slit experiment, Fresnel bi-prism, Newton's ring, interferometers.
Diffraction and Polarization of light: Diffraction, Fresnel Fraunhoffer diffraction, Diffraction by single slit, Diffraction by double slit, Diffraction gratings, Polarization of electromagnetic waves, production and analysis of polarized light, optical activity, Optics of crystals.
Lasers and their Applications: Laser introduction, Stimulated and spontaneous radiation's coherence, Resonators Ruby, He, Ne, CO_2, N_2 and dye laser. Material processing with lasers, welding, material removal and material shaping.
Modern physics: Relativity, Michelson-Morley experiment, Lorenz-Einstein transformation, Mass energy relation, Quantum effect, Photoelectric effect, Compton Effect.
Atomic Physics: De-Broglie wave, correspondence principles, uncertainty principle, The Rutherford-Bohr model of the atom, Energy levels and spectra, atomic excitation, The Laser, Quantum theory of hydrogen atom, The Zeeman effect, Electron spin, Many electron atoms and the exclusion principle, vector atom model
Nuclear Physics: Introduction, Nuclear constituents, Nuclear binding and nuclear structure, Radioactivity, Radioactive decay, Half-life, Law of successive disintegration, Radioactive equilibrium, The nucleus, Properties of nucleus, Binding energy, Nuclear reactions, Nuclear fission and fusion, nuclear reactors.

References:

- *Physics volume II* by Halliday & Resnick.
- *Optics* by Brijlal.
- *Fundamental of optics* by Jenkine & White.

- *Modern Physics* by Beiser.
- *Nuclear Physics* by Kaplan.
- *Engineering Physics* by Theraja.

CE 102: Civil Engineering Drawing Laboratory
Lab: 2hours/week, 1 Credit
Prerequisite: ME 102: Mechanical Engineering Drawing & CAD (Laboratory)

This course develops the capability of the students with the Isometric drawing and bird's eye view of simple buildings, plan, elevation and section of one storied and two storied building. Through this course students will familiarize with the plan, elevation and section of staircase as well as detail drawing of roof truss, Project on building drawing and drawing by AUTOCAD.

ECO 201: Basic Economics
Theory: 3hours/week, 3 Credits

The Economic Problem: Want and Scarcity, opportunity cost;
The Language of economics: Economy, Production, Consumption, Exchange, Resources, What resources earn, Income and Wealth, Public and Private Sector in the Economy,
Economic System: Coping with scarcity, what how and for whom to produce, providing answers to what how and for whom, the market economy, the planned economy, the mixed economy, developed and less developed economy.
How the Economy works: The nature of economic problems and their sources. Economic goals of a society. Alternative economic systems. Circular flow of income, An Economy in Equilibrium
Demand and Supply Theory: Supply, demand and market – elementary theory of supply and demand – relationship between goods and factor markets, adjustment to changes in demand and supply, Taxes and Subsidies
Elasticity: Demand, Price, Income and Cross and supply elasticity - Measurement, importance and applications.
Consumer behavior and market demand: Utility approach vs. the indifference user approach – Individual and market demand curves - the consumer's surplus, application, Indifference curve, Budget Line;
Production and Costs Theory: What is production, The production function, the aims of firms, classification of inputs, production with one variable input – total, average and marginal product, law of diminishing returns, production with two variables input – Isoquants; constant, increasing and decreasing return to scale; technical efficiency - short run and long run - choice of inputs in the short and the long run – total fixed and variable costs – average and managerial costs.
The perfectly competitive market and its characteristics: Conditions of profit maximization - A firms short run optimal output level – firm's short run supply curve - the short run industry supply – interaction of market demand and industry supply - the equilibrium price - The long run industry supply curve.
Imperfectly competitive markets: Monopoly - optimal price – output combination - inefficiency of monopoly-Price discrimination - natural monopoly - important features of monopolistic competitive and oligopoly – cartels in oligopoly.

Basic principles of factor pricing: Derived demand for an input – income distribution - factor price differentials – causes and implications - economic rents.
Resource allocation and the market: Concepts of equity and efficiency - strength and weakness of the market mechanism in terms of equity and efficiency - the need for government intervention – tools of intervention – regulation - public ownership and taxation, Perfect competition,.
International trade: Gains from international specialization-free trade vs. protection – the World Trade Organization (WTO) and globalization - regional economic integration SAARC, EU.
Non – Renewable resources: Pricing and optimal rate of extraction.
Key macroeconomics phenomena: Output - employment- inflation - exchange rates- growth etc. – major macroeconomics ills – unemployment – inflation - slow growth. National output – concepts and measurements - interpretation of national income measures – inter temporal and international comparisons – the pitfall, Interest Rates, Balance of Payment, Exchange rate, Monetary and Fiscal Policy.
Income determination: Aggregate expenditure and equilibrium national income – a simple model. Changes in autonomous expenditures and national income – the multiplier. Government spending and taxes. Net exports – a more comprehensive measure of aggregate expenditure – equilibrium income in this context. Aggregate demand and aggregate supply – short run and long run. Determination of national income and the price level. Demand and supply stocks. Fiscal and monetary policies – Government budget – controlling deficits – various proposals. The tradeoff between inflation and unemployment – stagflation, short run and the long run Philips curves.
Balance of payments and the exchange rates: Policy changes to correct dis-equilibrium in the balance of payments.

References:

- *Modern Microeconomics* by A. Koutsoyiannis.
- *An introduction to positive economics* by R.G. Lipsey.
- *Economics* by P. A. Samuelson.
- *Microeconomics theory* by R.A. Bilas
- *Macroeconomics* by R. Dornbusch and S.Fischer.
- *Macroeconomic Theory and Policy* by William H. Branson.
- *Modern Economics* by H.L. Ahuja
- *International Trade: Theory and Policy* by M. Chacholiades

EEE 241: Electromagnetic Fields and Waves
Theory: 3hours/week, 3 Credits

Electrostatics: Coulomb's law, force, electric field intensity, electrical flux density. Gauss's theorem with application, Electrostatic potential, boundary conditions, method of images, Laplace's and Poisson's equations, energy of an electrostatic system, conductors and dielectrics.
Magnetostatics: Concept of magnetic field, Ampere's Law, Biot-Savart law, vector magnetic potential, energy of magnetostatic system, Mechanical forces and torque's in Electric and Magnetic fields, Curvilinear co-ordinates, rectangular, cylindrical and spherical co-ordinates,

solutions to static field problems. Graphical field mapping with applications, solution to Laplace equations, rectangular, cylindrical and spherical harmonics with applications.
Maxwell's equations: Their derivations, continuity of charges, concepts of displacement current, Boundary conditions for time-varying system, Potentials used with varying charge and currents, Retarded potentials, Maxwell's equations in different coordinate systems.
Relation between circuit theory and field theory: Circuit concepts and the derivation from the field equations, High frequency circuit concepts, circuit radiation resistance, Skin effect and circuit impedance, Concept of good and perfect conductors and dielectrics, Current distribution in various types of conductors, depth of penetration, internal impedance, power loss, calculation of inductance and capacitance.
Propagation and reflection of electromagnetic waves in unbounded media: Plane wave propagation, polarization, power flow and Poynting's theorem. Transmission line analogy, Smith Chart; reflection from conducting and dielectric boundary display lines ion in dielectrics, liquids and solids, plane wave propagation through the ionosphere, Introduction to radiation.

References:

- *Field and Wave Electromagnetics* by David K. Cheng.
- *Fields and Waves in Communication Electronics* by Simon Ramo, John R. Whinnery, Theodore Van Duzer.
- *Engineering Electromagnetics* by William H. Hayt. Jr
- *Antenna & Wave Propagation* by K.D. Prasad

EEE 211: Electronics I
Theory: 3hours/week, 3 Credits

P-N junction as a circuit element: Intrinsic and extrinsic semiconductors, operational principle of p-n junction, contact potential, current-voltage characteristics of a diode, simplified dc and ac diode models, dynamic resistance and capacitance.
Diode circuits: Half wave and full wave rectifiers, rectifiers with filter capacitor, characteristics of a zener diode, zener shunt regulator, clamping and clipping circuits..
Bipolar junction transistor: current components, BJT characteristics and regions of operation, BJT as an amplifier, biasing the BJT for discrete circuits, small signal equivalent circuit models, BJT as a switch. Single stage mid-band frequency BJT amplifier circuits and different type of biasing techniques. Voltage and current gain, input and output impedance of common base, common emitter and common collector amplifier circuits.
Metal-oxide-semiconductor field-effect-transistor (MOSFET): Structure and physical operation of an enhancement MOSFET, threshold voltage, Body effect, current- voltage characteristics of an enhancement MOSFET biasing discrete and integrated MOS amplifier circuits, Current Mirror: Simple CMOS current mirror, Source degenerated current mirror, high output impedance current mirror, Bipolar current mirror; Single-stage MOS amplifiers, MOSFET as a switch, CMOS inverter**.**
Noise: Statistical Characteristics of Noise, Noise Spectrum, Amplitude Distribution, Correlated and Uncorrelated Noise, Types of Noise, Thermal Noise and Flicker noise, Noise in Single stage amplifiers, Common source stage, Common gate stage, Source follower, Cascade stage; Noise in Differential Pairs, Noise Bandwidth.

Junction field-effect-transistor (JFET): Structure and physical operation of JFET, transistor characteristics, pinch-off voltage. Differential and multistage amplifiers, Description of differential amplifiers, small-signal operation, differential and common mode gains, RC coupled mid-band frequency amplifier.

References:

- *Electronics Devices and Circuit Theory* by Robert L. Boylestad & Louis Nashelsky.
- *Electronics Devices* by Thomas L. Floyd.
- *Electronics Devices* by Millmann & Halkias.
- *Design of Analog CMOS integrated circuits* by Behzad Razavi.
- *Electronic Principles* by Albert Paul Malvino.
- *Electronics Devices and Circuits* by Tocci

EEE221: Electrical Machines I
Theory: 3hours/week, 3 Credits

DC generator: construction, principle of operation classification, armature winding, voltage build up, armature reactions and commutation, performance evaluation and testing.
DC motor: Operation, types, speed-torque characteristics, starting, speed control, braking. Two and four quadrant operation of DC motor, Choice of DC motor for different application.
Single phase transformers: Construction and principle of operation, Equivalent circuit, PU systems, Phasor diagram, Efficiency, Regulation, Testing of short-circuit test and open circuit test, parallel operation, Determination of transformer constants and polarity.
Three-phase transformer: Vector group, Parallel operation and testing, Autotransformer, Harmonics of polyphase transformers.

References:
Alternating Current Machines by A.F. Puchstein and T.E. Lloyed.
Direct and Alternating Current Machinery by Jack Rosenblatt and M. Harold Friedman.
Electrical Machinery fundamental by Stephen J. Chapman.
A Textbook of Electrical technology (AC & DC machine) volume II by B.L. Theraja.

MAT 201: Engineering Mathematics III
Theory: 3hours/week, 3 Credits
Prerequisite: MAT 105: Engineering Mathematics I, MAT 107: Engineering Mathematics II

Complex Analysis: Complex number system, analytic function, limit and continuity of a function of complex variable and related theorems, complex differentiation, Cauchy's integral theorem, Cauchy's integral formula, Liouville's theorem, Taylor's theorem and Laurent's theorem, singular points, Cauchy's residue theorem, contour integration, conformal mapping;
Vector Calculus: Differentiation and integration of vectors together with elementary applications, definition of line, surface and volume integrals, gradient, divergence and curl of point functions, Gauss's theorem, Stoke's theorem, Green's theorem.
Statistics: Frequency distribution, mean, median, mode, and other measures of central tendency, standard deviation and measures of dispersion, moments, skewness, and kurtosis, elementary sampling theory, permutation, combination and rules of probability together with well-known

probability distributions such as binomial, Poisson and normal, estimation, hypothesis testing, design of experiments, chi-square test, analysis of variance, regression analysis.

References:

- *Advanced Engineering Mathematics* by Erwin Kreyszig.
- *Advanced Engineering Mathematics* by H.K. Dass.
- *Vector Integration* by Abdur Rahman.
- *Statistics* by Schaum Series.
- *Statistics* by M. Spiegel
- *Basic statistics and Probability* by S.K. Gupta
- *Probability and Statistics for engineers and scientists* by R.E.Walpole & R.H.Myres

CSE 301: Computational Methods for Engineering Problems
Theory: 3hours/week, 3 Credits
Prerequisite: MAT 201: Engineering Mathematics III

Numerical Methods: Concepts of algorithm and flowchart, errors in numerical methods, interpolation, numerical methods for the solution of simultaneous linear/nonlinear algebraic and transcendental equations, numerical integration, solution of ordinary and partial differential equations.
Queuing Theory: Stochastic processes, Discrete-parameter Markov Chains and continuous-parameter Markov Chains, Queuing models, solution of network of queues.

References:

- *Numerical Methods* by S.R.K Iyengar & R.K. Jain.
- *Numerical Methods for Engineers* by Steven C. Chapra & Raymond P. Canale.
- *Numerical Analysis* by Vasistha.
- *Advanced Engineering Mathematics by H.K. Dass.*
- *Numerical Analysis* by Richard L. Burden & J. Douglas Faires
- *Applied Numerical Analysis* by Curtis F. Gerald & Patrick O. Wheatley
- *Numerical methods for scientific and engineering computation* by Mahinder Kumar Jain, S. R. K. Iyengar, Rajendra K. Jain

EEE 213: Electronics II
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 211: Electronics I

Operational amplifiers (Op-Amp): Properties of ideal Op-Amps, non-inverting and inverting amplifiers, inverting integrators, differentiator, weighted summer and other applications of Op-Amp circuits, effects of finite open loop gain and bandwidth on circuit performance, logic signal operation of Op-Amp, dc imperfections
General purpose Op-Amp: DC analysis, small-signal analysis of different stages, gain and frequency response of 741 Op-Amp. Negative feedback: properties, basic topologies, feedback amplifiers with different topologies, stability, frequency compensation.

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.
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.
Signal generators: Basic principle of sinusoidal oscillation, Op-Amp RC oscillators, LC and crystal oscillators.
Power Amplifiers: Classification of output stages, class A, B and AB output stages. RF amplifiers, waveform generations using 555 and 8038 ICs, schmitt trigger, pulse generator, VCO.
Multivibrators: Bistable, Monostable, Astable, different types of bistable with their circuits & operating techniques.

References:

- *Electronic Principles* by Albert Paul Malvino,
- *Electronics Devices & Circuits* by C. Halkias and Jacob Millman.
- *Design of Analog CMOS integrated circuits* by Behzad Razavi.
- *Electronics Devices and Circuit Theory* by Robert L. Boylestad & Louis Nashelsky.
- *Electronics Devices* by Thomas L. Floyd.
- *Pulse, Digital & Switching waveform* by Jacob Millman.

EEE 223: Electrical Machines II
Theory: 3hours/week, 3 Credits
Prerequisite: EEE221: Electrical Machines I

Three-phase induction motor: Rotating magnetic field, equivalent circuit, vector diagram, torque-speed characteristics, effect of changing rotor resistance and reactance on torque-speed curves, motor torque and developed rotor power, no-load test, blocked rotor test, V curves, starting, braking and speed control.
Single-phase induction motor: Theory of operation, equivalent circuit, starting techniques and generalized machines.
Synchronous Generator: excitation systems, equivalent circuit, vector diagrams at different loads, factors affecting voltage regulation, synchronous impedance, synchronous impedance method of predicting voltage regulation and its limitations. Introduction to wind turbine generators.
Parallel operation of two or more generators: Necessary conditions, synchronization, circulating current and vector diagram.
Synchronous motor: Operation, effect of loading under different excitation condition, effect of changing excitation, V-curves and starting, Commutator motor.
Special purpose motors: Two value capacitor motors, permanent split and split phase capacitor motors, Reluctance motors, Hysteresis motors, Universal motors, Stepper motors, servo motors, shaded pole motors.

References:

- *Direct and Alternating Current Machinery* by Jack Rosenblatt and M. Harold Friedman.

- *Electrical Machinery fundamental* by Stephen J. Chapman
- *Alternating Current Machines* by A.F. Puchstein and T.E. Loyed
- *Fractional & sub-fractional HP Electric Motors* by Martin
- *Practical Electric Motor Handbook* by Irving M. Gottlieb.
- *Electric Machinery* by A. Fitzgerald, Kingsley
- *Electric Machines* by Kothari, Nagrath

EEE 201: Signals & Systems
Theory: 3hours/week, 3 Credits
Prerequisite: MAT 107: Engineering Mathematics II, MAT 203: Engineering Mathematics IV

Classification of signals and systems: Signals - classification, Basic operation on signals, Elementary signals, Representation of signals using impulse function; Systems – classification. Properties of Linear, Analogues system and their solution.
Time Invariant (LTI) systems: Linearity, Causality, Time invariance, Memory, Stability, Inevitability.
Time domain analysis of LTI systems: Analogues system 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, sampling theorem 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, poles and zeroes of a network. Discrete signals and z-transform methods.
Introduction to Random signals: Stationery, Ergodicity, Noise models, Correlation and power spectrum, Distribution and density functions

References:
- *Signals and Systems* by Haykin.
- *Linear System Analysis* by D.K. Cheng.
- *Signal & Systems Analysis using Transform Methods and MATLAB* by M.J. Roberts.
- *A practical approach to Signals & systems* by D. Sundararajan.

MAT 203: Engineering Mathematics IV
Theory: 3hours/week, 3 Credits
Prerequisite: MAT 105: Engineering Mathematics I, MAT 107: Engineering Mathematics II

Matrix: Algebra of matrices, adjoint and inverse of a matrix; elementary transformations of matrices, Cayley-Hamilton theorem, normal and canonical forms, solution of linear equations, eigenvalues and eigenvectors;
Linear Algebra: Field, linear space, & linear transformation, functional & dual space,

Fourier analysis: Real and complex form of Fourier series, finite transform, Fourier integral.
Special Functions: Legendre polynomials and their properties, Rules for solving Partial Differential equations.
Laplace transformation: Definition of Laplace transform and inverse Laplace transform, Laplace transform of different functions, important properties of Laplace transform and inverse Laplace transform, The Heaviside's formula, convolution property, solution of differential equations by Laplace transform.

References:

- *Advanced Engineering Mathematics* by H.K. Dass.
- *Mathematical Methods (Volume I)* by Abdur Rahman.
- *Mathematical Methods (Volume II)* by Abdur Rahman.
- *Ordinary and Partial Differential Equation* by V.D. Sharma.
- *Mathematical Methods* by Gupta, Malik
- *Fourier series and Boundary Value Problems* by Charchil
- *Laplace Transform* by M.R. Spigel

EEE 302: Electronic Appliances Laboratory
Lab: 3hours/week, 1.5 Credits
Prerequisite: EEE 211: Electronics I

Principle of operation of Electronic Appliances used in domestic places, commercial places and offices like calculator, telephone, scanner, printer etc; AM & FM Radio Receiver, Mobile phone transmitter and receiver; Audio Cassette and CD player, VCR, VCP, VCD player, DVD player, Basic principle of operation of an AM radio transmitter, FM Radio transmitter, transmitting antennas used in these cases.
TV engineering: Principles of black & white (B&W) and color TV, composite video & chrominance signals, formulation of the chrominance signal, I & Q signals, block, schematic & pictorial diagrams of TV and their characteristics, CRT, static & dynamic convergence, automatic degaussing circuits, pincushion cause & correction, raster & raster formation, different sections of B&W and color TV, VHF & UHF frequency allocations, control of all section, AFT & remote control circuits, basic troubleshooting procedures, isolating and replacing the defective stage & component, video signal & camera tubes. Introduction to LCD monitor, Flat Screen TV, 100HZ Digital TV, LED TV, Plasma TV etc.
Study of Practical circuit diagrams of the above mentioned appliances and possible troubles in these appliances.

References:

- *Television Engineering* by Arvind M Dhake
- *Making Printed Circuit Boards* by Jan Axelson
- *Monochrome and Colour Television* by R.R.Gulati.
- *Home Satellite TV installation & troubleshooting manual* by Frank Baylin (3rd edition)
- *Basic Television & Video Systems* by Bernard Grob (5th ed International Student Edition)

EEE 309: Communication Engineering

Theory: 3hours/week, 3 Credits

Introduction of communication systems: Basic principles, fundamental elements, system limitations.
Information Theory: Information and system capacity, Information transmission, Entropy, Continuous channel capacity, Transmission through electrical network.
Analog communication: AM, FM, PM, DSB, SSB, VSB, ISB.
Digital communication: Introduction, Nyquist sampling theorem, Quantization of analog system, Quantization noise, PAM, PWM, PPM, PCM, LOGPCM, and systems, Digital modulations, ASK, FSK, PSK, DPSK, MSK, M-array digital modulation, QAM, QPSK, Delta modulation, Multi carrier modulation, line coding, Frame construction, Error Probability. Introduction to Radar and Satellite Communication. ISDN, B-ISDN, SONET, SDH
Multiplexing: Space division multiplexing, frequency division multiplexing, time division multiplexing, and code division multiplexing.
Noise: Physical sources of noise, types of noise, calculation of noise, SNR & noise figure, and calculation of noise figure, noise temperature, equivalent noise resistance.

References:

- *Electronic Communication System* by George Kennedy.
- *Modern Digital & Analog Communication Systems* by B.P. Lathi.
- *Communication System* by Simon Haykin.
- *Principles of Communication Systems* by Herbert Taub and Donald L. Schilling.
- *Information Transmission, Modulation and Noise*, 4th edition by Mischa Schwartz.
- *Packet Switching* by James Martin.
- *Digital Communication System* by Valaney.
- *Digital and analog communication system* by Leon W. Couchii.
- *An introduction to Analog and Digital communications* by Simon Haykin.
- *Digital communications* by Simon Haykin

EEE 311: Digital Electronics
Theory: 3hours/week, 3 Credits

Number systems: Representation of numbers in different bases, Addition and subtraction in different bases, Complement: Subtraction using complements, Binary multiplication & division.
Binary codes: Different coding system, Boolean algebra, various gates, Sum of products and product of sums, Standard and canonical forms and other logical operations.
Simplification of Boolean functions: Karnaugh map method, Tabular method of simplification; Implementation of logic circuit using various gates, Universal gates.
Combinational logic circuit: Design procedure: Adder, Subtractor, Code converters, Parity bit checker and magnitude comparator, Analysis of different combinational circuits, Encoder, decoder, Multiplexer, Demultiplexer, ROM, PLA and their applications.
Flip-flops: SR, JK, Master slave, T and D type flip-flops and their characteristic tables & equations; Triggering of flip-flops, Flipflop, Excitation table.
Sequential circuits: Introduction to sequential circuits, Analysis and synthesis of synchronous and asynchronous sequential circuits.

Counters: Classifications, Synchronous and asynchronous counter design and analysis, Ring counter, Johnson counters, Ripple counter and counter with parallel load.
Registers: Classification, Shift registers, Circular registers and their applications and registers with parallel load. Basic Concept of Application Specific IC (ASIC) design.
Digital IC logic families: Brief description of TTL, DTL, RTL, ECL, I2L, MOS and CMOS logic and their characteristics, principles of operation and application.
Memory Units: Various memory devices and their interfacing.
Converters: Digital to Analog (D/A), Analog to Digital (A/D) converters, and their applications.

References:

- *Digital logic and Computer design* by M. Moris Mano.
- *Modern Digital Electronics* by R.P. Jain.
- *Microelectronic Circuits* by Adel S. Sedra and Kenneth E. Smith.
- *Fundamental of Digital Logic with VHDL Design* by Stephen Brown & Zvonko Vranesic
- *Digital Electronics* by Tocci

EEE 322: Electrical Machine Design Laboratory
Lab: 2hours/week, 1 Credit
Prerequisite: EEE221: Electrical Machines I

Design principles of Electrical Machines, Equipment, Device involving electric and magnetic circuit. Design of Electric Power Transformers, Transformers for Electronics (AF & RF) circuits. Design of Electric Ceiling Fan, Pedestal Fan and table fan. Design of Electric motors for small pumps. Design of Electric Autotransformers. Design of Electric Welding Transformer.

References:

- *Electrical Machine Design* by A.K. Sawhney.
- *Machine Design* by M.G. Say.
- *Spotlight on Modern Transformer Design* by Pavlos S. Georgilakis.
- *Design and Testing of Electrical Machines* by M.V. Deshpande.

EEE 351: Transmission & Distribution of Electrical Power
Theory: 3hours/week, 3 Credits

Inductance of transmission lines: Flux linkage, Inductance due to internal flux, Inductance of single-phase two wire lines, Flux linkage of one conductor in a group, Inductance of composite conductor lines.
GMD examples: Three-phase lines with equilateral spacing and unsymmetrical spacing, Parallel circuit 3 phase lines, Use of tables.
Electrical field: Potential difference between points due to a charge, Capacitance of a two-wire line, Group of charged conductors, Capacitances of 3 phase lines with equilateral and with unsymmetrical spacing, Effect of earth, parallel circuit lines.
Resistance and skin effect: Resistance and temperature, Skin effects, Influence on resistance, use of table, Current and voltage relation on a transmission line, T- and pi-representation, exact solution. Equivalent circuit of a long line.

Mechanical characteristics of transmission line: Sag and stress analysis; Wind and ice loading, supports at different elevation conditions at erection; effect of temperature changes. **Generalized line constant:** General line equation in terms of A, B, C, D constants. Relation between constant, charts of line constants, constants of combined networks, measurement of line constants.
Circle diagrams: Receiving end and sending end power circle diagrams.
Voltage and power factor control in transmission systems: Tap changing Transformers; on load tap changing. Inductance regulators. Moving coil regulators, Boosting transformers, Power factor control; static condensers; synchronous condenser.
Cable: Insulators for overhead lines; types of insulators, their construction and performance. Potential distribution in a string of insulators, string efficiency. Methods of equalizing potential distribution; special types of insulators, testing of insulators. Insulated cables, cables versus overhead lines, insulating materials. Electrostatic stress grading. Three core cables; dielectric losses and heating. Modern development; oil filled and gas filled cables. Measurement of capacitance. Cable testing. Introduction to transmission line protection: over current relay and time grading, reverse power relays.
Protection: Differential protection Distant relays. Distribution: Distributor calculation, ring mains and interconnections.

References:

- *Power System Analysis,* by W.D. Stevenson JR, John J. Grainger
- *Elements of Power System Analysis,* by W.D. Stevenson.
- *Principles of Power System* by V.K. Mehta & Rohit Mehta.
- *Electrical Power system analysis* by Ashfaq Husain.
- *The transmission and Distribution of Electrical Energy* by H.W. Cotton and H. Barber
- *Generation, Transmission and Utilization of Electrical Power* by A.T. Starr.
- *Electric Power Transmission System Engineering- Analysis and Design* by Turan Gonen
- *Power Transmission & Distribution* by Anthony J. Pansini.
- *Electrical Transmission and Distribution Reference book* by Central Station Engineers of the Westinghouse Electric Corporation.

MGT 203: Industrial and Business Management
Theory: 3hours/week, 3 Credits

Introduction: Scope of industrial management, functions of management, duties and responsibilities of a manager, Brief discussions about Tailor's scientific management, theory and contributions of Henry Fayol-Elton- Mayo and Gilbreth, Modern concepts of management.
Organization: Growth of organization authority, responsibility, relationships, span of control, principles of organization, administration-management and organization relationship, committee and task force, Manpower planning
Personnel management: Scope, Importance, Need hierarchy, Functions of personnel manager, wages and salary, wage-incentive plan, job evaluation and merit rating, Training, Performance appraisal, moral and motivation, leadership, industrial disputes, collective bargaining agent, health and safety measures, Informal groups, Organizational change and conflict.

Financial management: Elements of costs, break-even analysis, depreciation calculation, budgets, budgetary control, introduction to time value of money and benefit/cost ratio, Cost planning and control, Development planning process.
Marketing: Modern concept of marketing, marketing department, sales promotion, inventory and inventory control, CPM, plant layout and location, use of computer in management and office business, management information systems, Patent laws.
Technology Management: Management of innovation and changes; Technology life cycle; Case studies.

References:

- *Productions and Operations Management* by James B. Dilworth.
- *Management* by Ricky W. Griffin.
- *Management* by Heinz Weihrich & Harold Koontz.

MGT 251: Organizational Behavior
Theory: 3hours/week, 3 Credits

Study of organizational behavior (OB): OB follows the principles of human behavior, organizations are social systems, and multiples factors shape OB, Structure and process effect OB and the emergent culture.
Model of managing Organizations: Behavior, Structure and Processes: Organization environment, behavior within organization, structure and design of the organization, the processes of organization;
The Individual: Biological characteristics, Ability, Learning, Values, Attitudes, Job Satisfaction, Personality, Emotion, Perception, Individual Decision Making, Motivation,
The Group: Definition and Classification, Stages of Group Development, Roles, Status and Norms, Composition, Cohesiveness, Group Decision Making, Team, Creating effective team, Leadership – the emerging concepts, Power and Politics, Conflict and Negotiation,
Contemporary Issues: Organizational Change, Stress Management. Organizational culture

References:

- *Essentials of Organizational Behavior. 9th ed. New Jersey(2008): Pearson/Prentice Hall* by Robbins, S. & Judge T.A
- *Organizational Behavior: An Introductory Text, 6th ed., Harlow: FT/Prentice Hall*(2007) by Huczynski, A. & Buchanan D
- *Management and Organizational Behavior 8th ed. FT/Prentice Hall* by Lauries J. Mullins (2007)
- *Organizations: behavior, structure, processes. 12th ed. McGraw Hill(2006)* by Gibson, J., Ivanchevich, J., Donnelly, J. & Konopaske R
- *Organizational Behavior: key concepts, skills, & best practices.2nd ed. McGraw Hill (2006)* by Kinicki A. & Kreitner R.
- *Essentials of organizational behavior. Harlow: Prentice hall(2006)* by Mullins, L
- *Organizational Behavior: Foundations, Realities & Challenges 5th ed. Thomson South-Western* by Nelson D & Quick J.
- *Principles of organizational behavior. 4th ed. Oxford: Oxford University Press(2005)* by Fincham R & Rhodes P.

- *Organizational behavior. (10th ed.) McGraw Hill (2005)* by Luthans F.
- *Social Psychology. 8th ed. Boston: McGraw Hill* (2005) by Irwin Myers D
- *Organizational Behavior: Concepts, Controversies and Applications. 11th Ed. New Jersey: Prentice Hall (2005)* by Robbins S.
- *Divisions of Labor. Pearson Custom Publications (2005)* by Scott P.
- *Organizational Behavior: An Introductory Text, 5th ed., Harlow: FT/Prentice Hall (2004)* by Buchanan D & Huczynski A.
- *Workplaces of the Future. Palgrave Macmillan (2003)* by Thompson P & Warhurst C
- *Management and Organizational Behaviour.6th ed. FT/Prentice Hall (2002)* by Mullins L
- *Work Organizations: a critical Introduction. 3rd ed. Palgrave (2002)* by Thompson P. & McHugh D
- *Organizational Behavior: An Introductory Text, 4th ed., Harlow: FT/Prentice Hall (2001)* by Huczynski A & Buchanan D

EEE 313: Measurement and Instrumentation
Theory: 3hours/week, 3 Credits

Measurement: Measurement of resistance, inductance and capacitance, balancing procedure for A.C bridges, cable faults and localization of cable faults, magnetic measurement, ballistic galvanometers, flux meter, separation of iron losses, high voltage measurement.
Measuring instruments: Classification, operating principle of ammeters, voltmeters, wattmeter and watt-hour meters.
Introduction to instrumentation Error: Classification of error, normal law of error, guarantee of error.
Transducer: Resistive, strain gauges, thermal, magnetic, LVDT, capacitive, piezoelectric, optical, current and potential transformers.
Electronic measuring instruments: Oscilloscope, DMM, VTVM, TVM.
Computer based instrumentation: PC-based data acquisition, filtering by moving average, Instrumentation for process control, data conditioning.
Mechanical measurement: Measurement of speed, frequency, pressure, temperature, flow force, weight level detector, shaft encoder.
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. Mechanical, electrical and optical transducer, sample and hold circuits.

References:

- *Electrical & Electronics Measurement and Measuring Instruments* by A.K. Sawhney & Puneet Sawhney
- *Electrical Measurements & Measuring Instruments* by E.W. Golding & F.C. Widdis.
- *Electrical Measurements*, Wiley Eastern by F.K. Harris
- *Modern Electronic Instrumentation and Measurement Techniques*, Prentice–Hall India by A.D. Helfrick & W.D. Cooper
- *Transducers and Instrumentation*, Prentice- Hall India by D V S Murty.

EEE 315: Power System Analysis

Theory: 3hours/week, 3 Credits
Prerequisite: EEE 223: Electrical Machines II

System modeling: Review of synchronous machine, the effect of synchronous machine excitation, per unit quantities, changing the base of per unit quantities, per unit impedance in single phase transformer and three phase transformer circuits, per unit impedance of three winding transformers, one-line diagram, impedance and reactance diagram, per unit and percentage method of calculations, advantages and disadvantages of per unit computations.
Network calculations: Node equation, matrix partitioning, node elimination by matrix algebra, bus admittance and impedance matrices, modification of an existing bus impedance matrix, direct determination of a bus impedance matrix.
Load flow solution and control: Classification of buses, specification of bus voltage-power etc, Gauss-Seidel method and Newton-Raphson method of load flow solutions, some principles of load flow control.
Symmetrical three phase faults: Short circuit currents and the reactance of synchronous machines, internal voltages of loaded machines under transient conditions, bus impedance matrix in fault calculations, bus impedance matrix equivalent network, percentage reactance and short-circuit MVA, reactor control of short-circuit currents and location of reactors and their advantages and disadvantages.
Symmetrical components: Symmetrical components of unsymmetrical phasors, sequence impedance and sequence networks, sequence network of unloaded generators, positive and negative sequence networks, zero-sequence networks.
Unsymmetrical faults: Unsymmetrical short-circuits on an unloaded generator, single line-to-ground fault, line-to-line fault, double line-to-ground fault, unsymmetrical faults of power systems, faults through impedance, unsymmetrical open circuits and series impedances.
Power system stability: The stability problem of power system, swing equation, power-angle equation, equal area criterion of stability.
Multi-machine stability studies: Classical representation, step-by-step solution of the swing curve, factors affecting stability, techniques for improving stability

References:

- *Elements of Power System Analysis* by William D. Stevenson Jr.
- *Power System Analysis* by W.D. Stevenson JR, John J. Grainger
- *Electrical Power system* by Ashfaq Husain.
- *Modern power system analysis* By Nagrath Kothari.
- *Power system Analysis* by Hadi Saadat
- *Electrical Power system* by Debapriya Das.
- *Power system analysis & Design (5th edition)* by Glover, Sharma, Overbye
- *Electrical Transmission and Distribution Reference book* by Central station engineers of Westinghouse Electric Corporation.

EEE 333: Switchgear and Protection
Theory: 3hours/week, 3 Credits

Protection issues: Purpose of power system protection, Introduction to circuit interruption and protection. Terminologies and general characteristics of relays and breakers.

Circuit breakers: control systems, arc extinction, recovery voltage. Air, oil, air blast, vacuum, SF6 and high voltage DC circuit breakers. Selection criteria, testing of circuit breakers.
Relays: Introduction to Analogue and Digital static relays. Static over-current, differential and distance protection. Microprocessor based relays, over-current, directional, sequence, pilot-wire and carrier current protection, power and impedance relays, balanced current relaying of parallel line, ground fault relaying.
Bus-bar arrangement, grounding, reactors, lightning arrestors, surge absorbers, ground wire, generators grounding.
Unit protection: generator, motor, transformer, bus and line protection.

References:

- *Switch Gear and Protection* by Sunil S. Rao.
- *Modern Power System Analysis* by Nagrath Kothari.
- *Power System Protection and switchgear* by B. Ravindranath, M. Chander
- *Switchgear and Power System Protection* by Ravindra P. Singh
- *Switch Gear and Protection* by U. A. Bakshi

EEE 356: Electrical & Electronic Engineering Services (Laboratory)
Lab: 3hours/week, 1.5 Credits
Prerequisite: CE 102: Civil Engineering Drawing Laboratory, EEE 101: Electrical Circuits I

Designing LT Electrical distribution buildings, for low rise office buildings, for industrial buildings, for multipurpose buildings. Selection of cable size, circuit breaker size, busbar size. Typical lighting design inside a domestic building, office building and an industry. Choice of luminaries for various applications.
Introduction to modern Lifts and their installation. Installation of a PABX for domestic building, office building and industrial compound. Designing routing and layout of indoor and underground telephone and fiber optic cables. Designing routing and layout of UTP data cables and fiber optic cables for LAN.
Introduction to IEE Wiring Regulation 16th (BS7671: 2001) incorporating Amendments 1& 2, 2004. Safety regulations, various types of cables for indoor wiring and electrical distribution in buildings. Distribution boards, MCB, MCCB. Earthing requirements, various earthing systems. Conductors for outdoor distribution through poles. Single line diagram of a typical 11 KV/0.4 KV 500 KVA Substation and 200 KVA pole mounted transformer. Bus-bar trunking system for various applications.
Introduction to CCTV, Fire Detection and Alarm system, Fire fighting system, Burglar Alarm system.

References:

- *Based on 2011 National Electrical code: Electrical Wiring: Residential* – Ray C. Mullin & Phill Simmons
- *Electrical Wiring: Domestic by* Brain Scaddan.
- *Electrical Wiring, Estimating & Costing* by S.L Uppal.
- *Handbook of Electrical Design details by* Neil Sclater, John E. Traister BS7671:2001 incorporating Amendments 1 & 2, 2004, (IEE Wiring Regulation 16th edition), IET, U.K. (Including more supporting documents from IET London, U.K.)

EEE 371: Microprocessors & Microcontrollers
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 311: Digital Electronics

Introduction to different type of microprocessors: 8 bit, 16 bit, 32 bit and their architectures; pin diagram & junction; Intel series microprocessor and Co-processor; RISK & CISK processor;
Assembly Language: Basic Instruction Sets and Assembly language Programming based on 8086 microprocessor.
Microprocessor peripherals: Introduction to some available microprocessor peripherals IC's and their application such as 8251, 8253, 8254, 8255, 8257, 8259, 8279, A/D and D/A converter interfacing, Timing Diagram, Interrupts, I/O systems, DMA-based data transfer, memory interfacing. MMX and SIMD technologies. The above peripheral is based on 8085 and 8086 processor.
Digital Interfacing Introduction, interfacing to microprocessor to keyboards, alphanumeric displays. Introduction to microcomputers and interfacing to microcomputer ports to high power devices.
Analog Interfacing: Introduction, Sensor, Transducer, industrial process control system, developoing of prototype of a microcomputer based instrument.
Micro controller: Introduction of microcontroller; embedded system design; microcontroller programming environment; Architecture of different microcontroller such as PIC, MSP, ARM etc. Real time application design based on microcontroller

References:

- *Architecture Programming and Application with the 8085* by Ramesh Gaonkar.
- *The Intel Microprocessors 8086/8088 : Architecture Programming and Interfacing* by Barry B. Brey
- *Microprocessor and Interfacing* by D.V. Hall.
- *Advanced PIC Microcontroller Projects in C* by Dogan Ibrahim
- *Assembly Language Programming and Organization of the IBM-PC* by Ytha Yu & Charles Marut.

EEE 373: Control Systems
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 201: Signals & Systems

Introduction: Introduction to modern and basic control system.
Mathematical Model: State space representation/transfer function/zero-pole of control system design; state space representation; solution of state equation.
Block diagram approach; signal flow graph; block diagram theory; block diagram reduction method;
Classical Control System: Analysis methods such as: Nyquist stability criterion, root locus, routh's criteria; classical design using frequency domain methods, phase lead and lag controllers, PID controllers, relay auto tuning, controllability and observability, Linear control system design using state feedback, LQR design, pole placement, use of observers,

Modern Control System: introduction to robotics, Transducers, actuators and the basic concept of intelligent control system, application of eigen value, state variable analysis, canonical forms
Controller Design: P, I, PI and PID types.
Intelligent Control System: Introduction to Artificial neural network; Definition: neuron, perceptron etc. Different types of algorithm: back-propagation, newton's algorithm; introduction to Fuzzy logic, Crisp set, fuzzy set, fuzzy addition, multiplication, subtraction, division, alpha cut, fuzzy set reprenstation.
Introduction to PLC, PLC specification, functional description of PLC, Different programming languages for PLC. (**Will be implemented on Control Systems Lab: EEE-374**)

References:

- *Control System* by J.J.D. Azzo & C.H. Houpis
- *Modern Control Systems*, eighth edition, Addison-Wesley Longman Inc, by R.C. Dorf and R.H. Bishop
- *Modern Control Engineering*, by Katsuhiko Ogata.
- *Fuzzy Logic: A Practical Approach* by F. Martin McNeill, Ellen Thro
- *Neural Networks: A Comprehensive Foundation* by Simon Haykin

EEE 411: Semiconductor Physics & Devices
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 211: Electronics I

Electron & Hole statistics in semiconductors. Transport properties, Charge carrier recombination, Diffusion of electron & hole, Equation of continuity, Carrier injection, p-n Junction, Types of p-n junction, Current-Voltage characteristics, Physical model of a p-n junction, Junction capacitance and Width, Breakdown phenomena, Bipolar junction transistors: Basic principle of PNP and NPN transistors, emitter efficiency, base transport factor and current gain, diffusion equation in the base, Ebers-Moll equations and circuit synthesis. Metal-Semiconductor Junction: Energy band diagram of metal semiconductor junctions, Rectification at metal-semiconductor Junction, MOS structure: MOS capacitor, energy band diagrams and flat band voltage and control of threshold voltage. Schottky-diffusion theory, Principle of operation of FET, qualitative theory of MOSFET operation, body effect and current–voltage relationship of a MOSFET. Junction field-effect-transistor. Photovoltaic effect, LED.

References:

- *Physics of Semiconductor Devices*, by Michael Shur
- *Physics of Semiconductor Devices*, 2nd edition, by S.M. Sze
- *Solid State Electronic Devices* by Ben Streetman & Sanjay Banerjee.
- *Electrical Engineering Materials* by A.J.Dekker
- *Principles of electronic materials and devices* by S.O.Kasap

ENG 401: Technical Writing & Presentation
Theory: 2hours/week, 2 Credits
Prerequisite: ENG 101: General English

This course is designed to help students to develop writing and oral skills needed by Electrical and Electronic Engineering professionals. The scope of this course includes not only general guidelines for technical writing, including word choice, sentence structure, and paragraph development, but also discipline-specific technical writing that conforms to IEEE standards. The course includes oral presentation skills and the effective use of graphic and design elements.

1. Beginning to Write
   a) Making sensible sentences.
   b) Joining and expanding sentences.
   c) Contracting sentences.
   d) Logical development of sentences in context using an idea.
   e) Clear and effective communication of information.

2. Reading for Writing
   Students will be required to comprehend modern prose-passages drawn from different disciplines with attention to their (a) context, (b) vocabulary, and (c) syntax, and deliver feedback in the form of précis, summaries, and comprehension answers. They will also be required to present their writings before the class for discussion and reactions by the peers.

3. Expanding Writing
   a) Writing paragraphs on technical aspects.
   b) Writing short, free and guided compositions.
   c) Developing essays on technical issues.
   d) Writing reports, memos and business letters.
   e) Editing compositions for clarity and effectiveness.

References:

- *Engineer's Guide to Technical Writing* by Kenneth G. Budinski
- *Thinking on Paper* by Thinking on Paper.

EEE 477: Digital Signal Processing
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 201: Signals & Systems

Introduction to Digital Signal Processing (DSP): Digital signals and systems: Operations in digital signal processing, the scope of DSP, analog to digital conversion, frequency Domain Effects of Sampling: Periodic repetitions in frequency domain due to sampling in time domain, recovery of continuous-time signal from its samples (reconstruction), role of anti-aliasing and reconstruction filters, examples of aliased signals (show how waveform is distorted), impulse response, finite impulse response (FIR) and infinite impulse response (IIR) of discrete-time systems, difference equation.
Discrete Transformations: Discrete Fourier series, the Discrete-Time Fourier Transform, discrete Fourier transform (DFT) and fast Fourier transform (FFT): Forward and inverse transforms; coefficient ordering; time and frequency resolution; periodic extension, zero padding and modulo-M reduction; properties of the DFT, circular convolution; Cooley-Tukey decomposition, recursive application, radix-2 FFTs , time and frequency decimation, computational complexity.

Z-Transforms: regions of convergence, convolution property and graphical interpretation of the convolution operation, z-transforms of cascaded systems, stability and causality,
Realization and frequency Response: Frequency response (Magnitude and Phase), representation of LTI systems with rational polynomials, block-form implementations of a rational polynomial transfer function
Digital Filters: FIR filters- linear phase filters, specifications, design using window, optimal and frequency sampling methods; IIR filters- specifications, design using impulse invariant, bi-linear z-transformation, least-square methods, linear phase, Butterworth, Chebychev , Inverse Chebychev , Bessel and elliptic filters, finite precision effects in implementing digital filters.
Implementing Digital Filters: Block-diagram representations; direct forms; cascade forms, first and second-order factors; parallel forms; feedback loops transposed forms; linear-phase FIR structures.
Wavelets: Short time Fourier transform; fundamentals of wavelets, wavelet transform (continuous and discrete), time – frequency density and orthogonal bases.

References:

- *Signal Processing for Communication* by Paolo Prandoni & Martin Vetterli.
- *Digital Signal Processing: Principles, Algorithms & Applications* by John G. Proakis & Dimitirs G. Manolakis.
- *Theory and Application of Digital Signal Processing* by Lawrence R. , Gold, Bernard Rabiner
- *Digital Signal Processing: Fundamentals and Applications* by Li Tan

EEE 431: Computer Aided Power System Analysis
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 315: Power System Analysis

Symmetrical components and applications; sequence impedance and their representation; evaluation of faults levels; general review of network and matrix theories; algorithms for formation of network matrices and their modifications for analysis by different iterative methods; acceleration of convergence; MVA mismatch considerations; terminal constants.

References:

- *Modern Power System Analysis* by D.P Kothari & I. J. Nagrath.
- *Computer: Computer Aided Power System Analysis* by George Kusic

EEE 441: Industrial Power Electronics
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 211: Electronics I, EEE221: Electrical Machines I

Industrial Devices Based on Semiconductor: SCRs; TRIACS; Power MOSFET; IGBT;
AC-AC converter: Thyristor converter, characteristics, commutation, dc motor speed control, harmonics, power factor and cycloconverter.

DC-AC converter: characteristics and operation; dc motor speed control; switching converter and power supplies;
DC-AC converter: Three phase and single phase voltage source and current source inverters; voltage, frequency and harmonic control; PWM inverters and SVM inverters.
Introduction to power electronic control of motor: Scalar and vector control of poly phase induction motors; rotor power control; synchronous motor and PMSM motor control; DC motor braking and plugging circuits; transistor dynamic braking circuit; emergency stop plugging circuit. Switch mode power supply.

References:

- *Power Electronics Handbook* by Muhammad Harunur Rashid.
- *Modern Power Electronics and AC Drives* by Bose
- *Industrial Electronics and Robotics*, Tata McGraw-Hill, Singapore by Schuler & McNamee.
- *Power Electronics*, Tata McGraw-Hill publishing Company Ltd, 1987(1994) New Delhi, India by P. C. Sen.
- *Power Electronics*, McGraw-Hill publishing Company, (UK), London, 1981 by Cyril W. Lander.

EEE 451: Power Plant Engineering
Theory: 3hours/week, 3 Credits

Planning of power Plant: Generating capacity and selection of plants, types of load and their effects.
Plant location: Site selection for different plants, plant performance.
Station performance: Efficiency, heat rate and incremental rate, load division between generating units for economy.
Generation scheduling: deterministic and probabilistic.
Conventional power plant: Hydro and thermal power plant, generating cost.
Nuclear power plant: Nuclear fission and fusion; energy release; moderation, control, cooling and shielding aspects; Nuclear power station of different types.
Non-conventional power generation: Microhydel power plant; Wind, magneto hydrodynamic and photovoltaic power generation.
Reliability concepts: Failure rate, outage, mean time of failure, series and parallel systems and redundancy, Reliability evaluation techniques of single area system.

References:

- *Power Plant Engineering* by G.R Nagpal
- *Power Station Engineering & Economy* by Bernhardt G.A. Skrotzki and William A. Vopat
- *Elements of Electrical Power Station Design* by M.V.Deshpande.

EEE 461: High Voltage Engineering
Theory: 3hours/week, 3 Credits
EEE 223: Electrical Machines II, EEE 333: Switchgear and Protection

High voltage supplies: AC: Cascaded Transformers, Tesla coils. DC: Valve Rectifier circuits, Cascaded Rectifiers, Electrostatic generators, Graff generators.
Impulse Generators: Impulse voltage wave shapes, Mathematical analysis and design consideration of impulse generators. Triggering of impulse generators. Measurement of high voltages: Sphere gap and uniform gap methods.
Corona: Power loss calculation, Break down of solid, liquid and gaseous dielectrics.Insulation testing, standard specifications; High voltage DC. Transmission, merits and demerits over AC transmission; Bridge arrangement. Mathematical analysis of the bridge circuit, Regulation, Reactive power, artificial commutation.
Protection against lighting and Insulation co-ordination: Lighting phenomena, Direct and indirect lighting, Transmission line design based on Direct strokes, ground wire; Protective devices: lightning arrestors and protector tubes; Insulation co-ordination and transformer insulation protection; Selection of lighting arrester, BIL.

References:

- *High Voltage Engineering* by C.L. Wadhwa.
- *High Voltage Engineering* by M.S. Naidu & V. Kaamaraju.

EEE 471: Renewable Energy
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 211: Electronics I

Importance of renewable energy sources, Statistics regarding solar radiation and wind speed. Insulation: geographical distribution, atmospheric factors, measurements. Solar cell: Principle of operation, spectral response, factors effecting conversion efficiency, I-V characteristics, maximum power output. PV modules and arrays: stationary and tracking. PV systems: stand alone, battery storage, inverter interfaces with grid. Wind turbine generators: types, operational characteristics, cut-in and cut-out speed control, grid interfacings, AC-DC-AC link.

References:

- *Renewable Energy* by Boyle.
- *Fundamentals of Renewable Energy Processes* by Aldo Vieira Da Rosa
- *Advanced Renewable Energy Sources* by G.N.Tiwari, R.K.Mishra

EEE 481: Power System Operation and Control
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 373: Control Systems

The principles of symmetrical components and sequence networks, different kinds of faults, art of designing protective circuits, choosing of circuit breakers, relays, and instrumentation devices CT's and VT's, controlling active and reactive power in a power system, Turbine-Governor Control, the Automatic Load-Frequency Control (ALFC), the Automatic Voltage Regulator (AVR). The Economic Dispatch, introduction to the nature of transmission-line transients, swing equation of a generator, and the equal-area stability criterion. Different evaluation processes the stability of a multi-machine power system also.

References:

- *Power System Operation & Control* by S. Sivanagaraju.
- *Power Generation, Operation & Control* by Alien J. Wood & Bruce F. Wollbenberg

EEE 433: Processing and Fabrication Technology
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 411: Semiconductor Physics & Devices

The basics of silicon processing for the fabrication of the various silicon-based components utilized in Microsystems technology. Processing of substrate materials and their crystallography, thin film deposition methods, thick film sensors, rapid prototyping and micro ECM and EDM are covered, Silicon fabrication processes, Silicon micromachining (wet), Dry etching technologies for metals, semiconductors and insulators, Microsystems fabrication techniques, Manufacturing issues in MST, Clean room technology and practice, Analytical models for MST

References:

- *Fundamentals of Semiconductors Fabrication* by Gary S. May & Simon M. Sze
- *Microchip Fabrication: A Practical Guide to Semiconductor Processing* by Peter Van Zant

EEE 403: Microwave and Antenna Engineering
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 241: Electromagnetic Fields and Waves

The introduction of Microwave Engineering; HF transmission line; Microwave device; Microwave system; Microwave units of measure; Transit time effect; velocity modulation, Smith Chart; Impedance Matching Technique and Application; EM propagation; Reflection & Refraction; Microwave coaxial connectors, Different kind Wave Guide: Microwave Cavities; Microwave Hybrid Circuits; Waveguide components; Rectangular and circular waveguide; Microwave cavity resonator, Different kinds of Microwave Tube: (O-type & M-type); Klystrons; Multi-cavity klystron amplifier; Reflex klystron oscillator; Backward wave oscillator; Magnetron; Traveling wave tube; The basic of Antenna Concepts; The origin of first antenna; Definition; Patterns; Beam area; Radiation intensity; Beam efficiency; Directivity-gain-resolution; Different types of aperture; Friis transmission formula; Duality of antenna; Antenna field zone, Radiation Patterns and Gain; Phase scanning of Antennas Arrays; Array of Point Source: Introduction to point source; Power pattern; A power theorem and its application to an isotropic source; Radiation intensity; Source with hemispheric power pattern; Field pattern and phase pattern; Arrays of two isotropic point source; The Electric Dipole Antenna and The Thin Layer Antenna; Small Current Element Antenna; Long Straight Antenna; The loop Antenna; Helical Antenna; Cylindrical Antenna; Reflector Antenna; Slot & Horn Antenna; Broadband and Frequency Independent Antenna; Patch or Micro-strip Antenna; Log Periodic Antenna, Yagi-Uda antenna.

References:

- *Antenna & Wave Propagation* by K.D. Prasad
- *Fields and Waves in Communication Electronics* by Simon Ramo, John R. Whinnery, Theodore Van Duzer
- *Microwave Engineering*, Wiley Text Books; 2nd edition, ISBN: 0471170968 by David M. Pozar.
- *Electromagnetic Waves and Radiating Systems*, Prentice-Hall Inc. N.Y. 1968 by E.C. Jordan and K.G. Balmain
- *Microwave Devices and Circuits*, Prentice Hall Inc., New Jersey, USA by S.Y. Liao
- *Engineering Electromagnetic Fields and Waves,* Wiley Eastern Limited, New Delhi by C. T. A Johnk.
- *Microwave and Radar Engineering* by V.S.Bagad
- *Electromagnetics, Microwave Circuit and Antenna Design for Communications Engineering* by Peter Russer
- *Antenna Engineering Handbook* by John Volakis

EEE 443: VLSI Design
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 211: Electronics I

VLSI design methodology: top-down design approach, Technology trends.
Introduction to microelectronics and MOS technology; basic electrical properties and circuit design processes of MOS and Bi-CMOS circuits; scaling of MOS circuits; sub-system design processes.
Brief overview fabrication process: NMOS, CMOS, Bi-CMOS process.
layout; Analog and digital layout. Stick diagram.
Computational elements; Design of ALU subsystem, adder, multipliers, memory, registers and aspects of system timing, practical aspects of design tools and test-ability; CMOS design: Behavioral description; structural description; physical description and design verification; Complex CMOS gates, CMOS building block: multiplexer, barrel shifter, adder, counter, multipliers: Data Path and memory structures it also give concept of GaAs technology & Ultra-fast VLSI circuits and systems.
FPGA and PLD design; Introduction to HDL; Basic digital design using VHDL.

References:

- *Design of Analog CMOS Integrated Circuits* by Behzad Razavi.
- *Design of VLSI System* by Linda E.M. Brackendury.
- *CMOS VLSI Design: A Circuits and Systems Perspective* by Neil Weste & David Harris
- *Fundamentals of Semiconductors Fabrication* by Gary S. May & Simon M. Sze
- *The Art of Analog Layout* by Alan Hastings
- *MOS Device* by Yannis Tsividis

EEE 453: Biomedical Instrumentation
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 211: Electronics I

The Human body, Bioelectricity, Bioelectric amplifier, Electrocardiograph, Blood pressure measurement, Blood flow measurement, Phonocardiography, Measurement of human brain parameters, Electroencephalogram, Tomography, Ultra sonogram, ICU/CCU central monitoring system. Action potential, ECG, EEG, and EMG signals, their origin and applications in medical diagnosis. Electrodes for recording ECG, EEG and EMG signals, instrumentation amplifiers, signal Conditioners, A/D and D/A converter interfaces to PC, computerized Automatic Analysis, Biotelemetry, monitoring biological parameters from distance. Transducer for physiological parameter reading, their characteristics, measurement of body temperature, blood pressure and heart beat. Diagnostic methods, ultrasound, CT and MRT, merits of these methods, surgical diathermy machines, defibrillators, pacemakers, and ventilators, intensive care Units. Lasers and applications of Lasers in medical diagnostics and therapy, Prosthesis and Prosthetic devices, patient Safety, electrical shock hazards, incorporation of safety aspects in biomedical instrumentation.

References:

- *Principles of Medical Electronics & Biomedical Instrumentation* by C.S.Raja Rao, S.K.Guha
- *Biomedical Instrumentation and Measurements* by Leslie Cromwell, Fred J. Weibell,
- Erich A. Pfeiffer
- *Handbook of Biomedical Instrumentation* by Khandpur
- *Biomedical Instrumentation and Measurements* by R. Anandanatarajan

EEE 485: Analog Integrated Circuit Design
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 213: Electronics II, EEE 311: Digital Electronics

Integrated-Circuit Devices and Modeling of MOS transistor, Advanced MOS Modeling, Bi-polar Junction Transistor, Device Model Summary, Spice-Model Parameters; Basic Current Mirrors & Single-Phase Amplifier; Noise Analysis and Modeling; Time-domain analysis; frequency domain analysis; Noise models for circuit elements; noise analysis examples; Advanced current mirror; Performance of Sample-Hold circuit; MOS sample and hold basics; Basic building blocks, operation and analysis of Switch capacitor circuit;
Data converter. This part includes D/A & A/D converter; Quantization noise; Performance limitation; Nyquist rate D/A & A/D converter; Successive Approximation Converter; Flash Converter; Two-Step converter; Basic idea about oversampled and Sigma-delta converter;

References:

- *Analysis and Design of Analog Integrated Circuits* by Paul R. Gray, Paul J. Hurst, Stephen H. Lewis & Robert G. Meyer
- *Analog Integrated Circuit Design* by David A. Johns & Ken Martin

EEE 463: VHDL (Virtual Hardware Description Language)
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 311: Digital Electronics

Fundamental Concepts: Modeling digital system, Domains and level of modeling, Modeling concepts;
Scalar data types and operation: Types and types classification;
Sequential Statement: Different type of sequential statement;Composite data type and operation, Basic modeling construction, Packages, Aliases, Resolved signals, Generic Constants, Generate Statements, Components and Configuration, Guards and blocks; Access types; Files and I/O; status; Components and configuration;
VHDL Synthesis, High level design flow and top level system design; RTL simulation;

References:

- *The Designer's guide to VHDL* by Peter J. Ashenden
- *VHDL Programming by Example* by Douglas L. Perry
- *Fundamentals of Digital logic with VHDL Design* by Stephen Brown & Zvonko Vranesic

EEE 473: Optoelectronics and Optical Fiber Communication
Theory: 3hours/week, 3 Credits
Prerequisite: PHY 103: Engineering Physics II, EEE 211: Electronics I

Optical fibers: Luminescence and quantum efficiency in radiation, Properties of light, modes of propagation, transmission characteristics, and Waveguide analysis. Optical sources: light emitting diode (LED) and semiconductor laser diode (SLD), Materials and principles of visible and infrared LED, Operational principles, characteristic curves: optical transmitter design using LED/SLD. Optical amplifiers: LASERs and fibre amplifiers. Photodetectors: P-I-N and avalanche photodetectors (APD), noise sources. Optical modulation and detection schemes. Direct and coherent detection receivers: configuration. Operation. Noise sources. Sensitivity calculation. Performance curves. Design of analogue and digital receivers, Modulation of light.
Transmission link analysis: point-to-point and point-to-multi-point links, system configuration, link power budget, rise time budget, line coding schemes, transmission system limitations. Design of fiber-optic systems. Optical data buses, optical networks, fiber distributed data interface (FDDI) and synchronous optical network (SONET). Optical frequency division multiplexing (OFDM) and wavelength division multiplexing (WDM) transmission systems. Frequency division multiplexing, DWDM, co-channel interference, optical CDMA.
System design: Transmitter and receiver design; Fiber optic networks: SONET, SDH, Telephone and computer networks, Cable TV

Introduction to optoelectronic integrated circuits.

References:

- *Understanding Optical Communication* by Harry J. R. Dutton
- *Optical Fiber Communication: Principles & Practice* by John M. Senior
- *Optoelectronics: Introductory Theory & Experiments* by Cardinale.

EEE 467: Radio Electronics
Theory: 3hours/week, 3 Credits

Prerequisite: EEE 213: Electronics II, EEE 309: Communication Engineering

Introduction of the Radio system and radio building blocks. Basic Concept in RF Design: nonlinearity and time variance; intersymbol interference; random process and noise; Modulation & Detection Techniques: AM, FM, PM; binary and quadrature modulation; power efficiency of modulation scheme; Multiple Access Techniques: TDMA; FDMA; CDMA; Transceiver Architecture: heterodyne receiver; homodyne receiver; image-reject receiver; digital IF receiver; sub-sampling receiver; direct-conversion transmitter; two-step transmitter; transceiver performance test; LNA: bipolar LNA; CMOS LNA; Mixer: Down-conversion Mixer; noise in mixer; Oscillator: bipolar and CMOS oscillator; negative-Gm oscillator; interpolative oscillator; monolithic oscillator; Frequency Synthesizers: PLL; charge-pump PLL; type I & type II PLLS; noise in PLLs;

References:

- *RF Microelectronics* by Behzad Razavi.
- *Electronic and Radio Engineering (Electrical and Electronic Engineering)* by F.E.Terman
- *Practical Radio Engineering and Telemetry for Industry* by David Bailey

EEE 483: Microwave Devices, Amplifiers and Sources
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 213: Electronics II

Microwave frequency ranges, waveguides, special waveguide types, cavities and resonators, microwave networks, antennas and radiation, radiation pattern, antenna arrays and their design; Transit time effect. Microwave Tubes, Multicavity Klystron Amplifier, Reflex Klystron Oscillator, Backward Wave Oscillator, Traveling Wave Tube.
Introduction to Microwave Solid State Devices: Microwave FET amplifier, Gunn Oscillator, FET & DR Oscillator, YIG Oscillator, PIN diode modulator, MESFET amplifier.

References:

- *Microwave Devices & Circuits,* Prentice-Hall Inc, New Jersey, USA by S. Y. Liao
- *Electronic and Radio Engineering (Electrical and Electronic Engineering)* by F.E.Terman
- *Radio Engineering* By G.K.Mithal
- *Microwave and Radar Engineering* by V.S.Bagad

EEE 435: Cellular Mobile Communication
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 309: Communication Engineering

Cellular Communication: Introduction: Concept, Evolution and Fundamentals; Cellular traffic, **Cell Planning:** Introduction of cells; Cell planning process; Frequency reuse; Co-channel interference; Adjacent channel interference; Clusters; Cell splitting and components;

Channel Concept: Introduction of physical and logical channel, Classification of channels, Mathematical modeling of fading channels, Control channel; Logical channel, Different types of bursts, Relationship between bursts and frames; Mapping of logical channels onto physical channels; Sample traffic case (Call to an MS); Co-channel and adjacent channel interference
Mobile Radio Propagation: Propagation Characteristics; Models for radio Propagation;
Hand off and Dropped calls: Reason and types; Forced hand-off; Mobile assisted hand-off and dropped call rate;
Diversity Techniques: Concept of diversity branch and signal paths; Carrier interference ration performance; Diversity schemes and combining techniques
GSM: Introduction of GSM; GSM system networks; Base station system (BSS), Switching systems (SS), Operation and support system (OSS), General packet radio service (GPRS), Mobile intelligent network (MIN), Service center (SC), Billing gateway (BG), Service order gateway (SOG);
GSM identities: Mobile station ISDN number (MSISDN), International mobile subscriber identity (IMSI), Temporary mobile subscriber identity (TMSI), Mobile station roaming number (MSRN), International mobile equipment identity (IMEI) and Software version number (IMEISV), Location area identity (LAI), Cell global identity (CGI);
GSM system architecture: SS implementation, BSS implementation, OMC and NMC implementation;
Base Station System: Introduction of Base station system; Transcoder controller (TRC); Base station controller (BSC); Radio base station (RBS).
Mobile Stations: Introduction to Mobile station; Mobile station functions; Mobile station classes; Subscriber identity module (SIM); Subscriber data stored in the mobile equipment; Features and evolution of mobile stations;
Brief Discussion of CDMA, 3G & 4G Communication, EDGE, GPRS, FDMA systems,
TDMA systems.

References:

- *Wireless Communications: Principles and Practice* by Theodore S. Rappaport
- *Mobile Communications* by Jochen Schiller
- *Cellular Communications Explained: From Basics to 3G* by Ian Poole
- *GSM Networks: Protocols, Terminology and Implementation* by Gunnar Heine
- *Mobile Wireless Communications* by Mischa Schwartz
- *GSM System Survey* by Ericsson publishers
- *Cellular and Mobile Communications* by V.Jeyasri Arokiamary
- *Mobile Cellular Communication* by Gottapu Sasibhushana Rao
- *Wireless and Cellular Communications* by William C. Y. Lee

EEE 445: Advanced Communication Engineering
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 309: Communication Engineering

Detection and Estimation techniques: Introduction: Review of Gaussian variables and processes, Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules. Detection of Deterministic signals, Detection of random signals, Nonparametric Detection, Estimation of signal parameters, Signal Estimation in Discrete-Time.

Spread spectrum techniques-spreading techniques; PN-Sequences-DSSS, RHSS-use of spread spectrum with CDMA.

Coding Techniques:

Coding Algebra, Block codes, Cyclic codes, Convolutional codes, Turbo codes, Low density parity codes. Non-binary parity codes, Trellis Code Modulation, Modulation codes for storage systems, Coding for recording, channels, Constrained codes, Iterative coding, Turbo coding for multi track recording channels.

Different kind of protocol and standard: Basic cellular system-performance criteria-operation of cellular system-cell splitting-interfacing GSM, GPRS, Blue-tooth link controller, the link manager, the host controller interface, LLCAP, WLL, Multiple Access Techniques.

ATM's postiotn in OSL model-B-ISDN protocol reference model ATM functions and layer-ATM signaling principles, TM operation and maintenance, ATM protocol stack: lower layers, fiber based networks and its advantages, ATM physical layer media.

ISDN standards, ISDN interface and function, UNI ISDN protocol architecture, ISDN physical layer, ISDN dataline layer-network interface.

Multiple Access in satellite communication, Link budget overview, Broadcast satellite service, Fixed satellite service, Mobile satellite service.

Introduction to Software define radio,

References:

- *Mobile Cellular Telecommunication System* by William C.Y.Lee
- *Telecommunication System Engineering* by Roger L. Freeman

EEE 465: Digital Communication
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 309: Communication Engineering

Introduction, Nyquist sampling theorem, quantization of Analog system, quantization of noise, PAM, PWM, PPM, PCM, LOGPCM, TDM, FDM systems, Digital modulation, ASK, FSK, PSK, DPSK, MSK, M-array digital modulation, QAM, QPSK, delta modulation, line coding, frame construction, error probability.

Telephony: Introduction to telephone system, principles, microphone, receiver, elements of telephone.

Exchange: Introduction to switching systems, Strowger and crossber exchange, digital exchange, signaling and switching technique, traffic theory, PABX system, Telephone/Exchange tariff measurement.

Formatting analog information, Sources of corruption, Baseband modulation, Baseband demodulation/detection, Matched filter, Equalizer, Digital band pass modulation and demodulation, Error performance of binary systems, Source coding, Channel coding, Synchronization, Multiplexing and multiple access, Spread spectrum techniques.

References:

- *Digital communications* by John G. Proakis
- *Modern Digital & Analog Communication Systems* by B.P. Lathi.
- *Digital Communication System* by Valaney
- *Digital and analog communication system* by Leon W. Couchii.

- *An introduction to Analog and Digital communications* by Simon Haykin.
- *Digital communications* by Simon Haykin
- *Digital communications* by J.S.Chitode
- *Principles of Digital Communication and Coding* by Andrew J. Viterbi & Jim K. Omura

EEE 419: Random Process for Communication
Theory: 3hours/week, 3 Credits
Prerequisite: MAT 201: Engineering Mathematics III

The basics of probability, Concepts of random variables, Basic concepts of convergence, law of large numbers, Central limit theorem, Stationarity, Cyclo-stationarity, auto-correlation sequences and power spectrum, Random walks, Markov chains, Gaussian Processes and Poisson processes, Power spectral density representation and estimation, Application in communication.

References:

- *Probability, Random Processes and Statistical Analysis: Applications to communications, signal processing, Queueing Theory and Mathematical finance* by Hisashi Kobayashi, Brian L. Mark, William Turin
- *Communication Systems and Random Process Theory* by J.K.Skwirzynski, Sijthoff & Noordhoff
- *Probability and Random Processes: With applications to signal processing and communications* by S. Miller
- *Probability and Random Processes for Electrical and Computer Engineers* by John A. Gubner
- *Introduction to Random Processes in Engineering* by A. V. Balakrishnan
- *Probability and Random Processes for Electrical Engineering* by Alberto Leon-Garcia

EEE 455: Satellite Communication
Theory: 3hours/week, 3 Credits
Prerequisite: EEE 309: Communication Engineering

The brief history of satellite communication, Types of satellite, Basic satellite operation, Orbit consideration, Frequency Issues, Aspects of propagation and antennas, Multiple Access in satellite communication, Link budget overview, Broadcast satellite service, Fixed satellite service, Mobile satellite service.
Satellite Communications Systems and Applications
Communication satellite subsystems, earth station, regenerative satellite systems, broadcasting by satellites and satellite link analysis.
INTELSAT systems; VSAT networks; GPS; GEO, MEO and LEO mobile communications, INMARSAT systems, Iridium, Globalstar, Odyssey; Broadband and Multimedia Systems, Spaceway, Teledesic;
RADAR: Introduction to radar system, principal, RADAR equation, LORAN, SONAR, ILS, GCA radar beacon, CW radar, TR, ATR tubes duplexer and application of radar.

References:

- *Satellite Communication* by D.C.Agarwal
- *Satellite Communication* by Dennis Roddy
- *Radar Cross-section* by Eugene F. Knott, John Shaeffer, Michael Tuley
- *Radar Engineering and Fundamentals of Navigational Aids* by G.S.N. Raju
- *Introduction to Radar Systems* by Merrill I. Skolnik
- *Microwave and Radar Engineering* by V.S.Bagad

Lab courses

Each of the lab courses are designed to enable the students to acquire the practical knowledge so that they can implement their understanding in professional environment and also for the research purpose. The stuffs of the courses are based on the corresponding theory courses so that students can have a clean understanding of the full course.