PART C: DESCRIPTION OF THE COURSES OF THE PROGRAM

CORE COURSES (EEE)

0713-111: Electrical Circuits I

Course Code : 0713-111 **Course Title** : Electrical Circuits I
Credit : 3 **Contact Hours** : 3 Hours/ week **Pre-requisite** : None

Course Rationale:
This course is designed to help students to apply laws and theorems in solving linear electrical circuits analysis which is essential to electrical engineers. A detailed analysis process will be covered for DC circuits and there will be an introduction to magnetic circuits which will be continued in the 0713-121 course more elaborately.

Course Objectives:
The objectives of this course are to –

- Introduce the circuit variables, laws, and theorems to solve DC circuit analysis.
- Enable students to understand the basic working principle of various energy storage devices like capacitors and inductors used in electrical circuits.
- Prepare students to analyze magnetic circuits and differentiate the parameters between electrical and magnetic circuits.

Course Contents:
Circuit Variables, Circuit Elements and Basic Laws: Definitions, symbols and units of voltage, current, power, energy, voltage and current dependent and independent sources, resistance, inductance, capacitance, Ohm's law and Kirchhoff's laws.
Electrical Circuit Analysis: Series-parallel resistance circuits and their equivalents, solution of simple circuits with both dependent and independent sources, voltage and current divider circuits, Delta-Wye equivalent circuits, introduction and application of nodal analysis and mesh analysis methods to solve circuits, introduction and application of source transformations, Thevenin and Norton equivalents, maximum power transfer theorem and superposition theorem in various electrical circuits.
Energy Storage Elements: Series-parallel combinations of inductances and capacitances, concepts of transient and steady state response with dc source.
Magnetic Circuit: Composite series magnetic circuit, parallel and series-parallel circuits, comparison between electrical and magnetic quantities, hysteresis and hysteresis loss, magnetic materials.

Resources:
Textbook(s):
[1] C. Alexander and M. Sadiku, *Fundamentals of Electric Circuits*, 7th ed. New York: McGraw-Hill, 2020.
Reference(s):
[1] R. L. Boylestad, *Introductory Circuit Analysis*, 12th ed. India: Pearson Education, 2010.

[2] J. W. Nilsson and S. A. Riedel, *Introductory Circuits for Electrical and Computer Engineering*, 1st ed. Prentice Hall, 2001.

0713-121: Electrical Circuits II

Course Code : 0713-121 **Course Title** : Electrical Circuits II
Credit : 3 **Contact Hours** : 3 Hours/ week **Pre-requisite** : 0713-111

Course Rationale:
One of the core requirements for students studying electrical engineering is to develop the skill for analyzing AC circuits using different techniques. The goal of the course is to improve students' ability to analyze AC circuits. Students will learn to apply laws and theorems to solve both single and three phase AC circuits. Analysis of magnetically coupled circuits will also be done in this course.

Course Objectives:
The objectives of this course are to –

- Make students capable of explaining voltage, current, and impedance in phasor domains.
- Develop the capacity to calculate the equivalent impedance of an electrical network having different configurations.
- Teach network theorems to solve AC circuits in the phasor domain.
- Explain the three-phase connection topology and analyze the three-phase circuits
- Calculate AC power of single and three-phase circuits.
- Solve magnetically coupled circuits and calculate the stored energy in magnetically coupled inductors.

Course Contents:
Introduction to sinusoidal steady-state analysis: Sinusoidal sources, phasor, impedance, admittance, reactance, susceptance, voltage, current, power of R, L, C. R-L, R-C, R-L-C circuits with sinusoidal source, Series - parallel and Delta-Wye simplifications of circuits with R, L, Cs, Sinusoidal steady-state power calculations, RMS values, Real and reactive power, Phasor diagrams.
Techniques of general AC circuit analysis (containing both independent and dependent sources): Node-voltage method, Mesh current method, Source transformations, Thevenin and Norton Equivalents, Maximum power transfer theorem.
Three-phase circuits: Three-phase supply, balanced and unbalanced circuits, power calculation and measurements, Power factor improvement.
Magnetically coupled circuits: Dot convention, Mutual inductance and coupling coefficient, Analysis of magnetically coupled circuits, Transformer action.
Miscellaneous: Circuits with non-sinusoidal excitations, power and power factor of ac circuits with multiple sources of different frequencies, Transients in AC circuits, Resonance in AC circuits.

Resources:
Textbook(s):
[1] C. Alexander and M. Sadiku, *Fundamentals of Electric Circuits*, 7th ed. New York: McGraw-Hill, 2020.
[2] G. F. Kerchner and R. M. Corcoran, *Alternating-Current Circuits*, 4th ed. Wiley, 1960.
Reference(s):
[1] R. L. Boylestad, *Introductory Circuit Analysis*, 12th ed. India: Pearson Education, 2010.

0713-122: Electrical Circuits Laboratory

Course Code : 0713-122 **Course Title** : Electrical Circuits Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-111

Course Rationale:
To verify the laws and theorems of circuit analysis fully, students need to perform some experiments practically in the laboratory that demonstrate and prove the authenticity of the theories. After completing this course, students will have a better understanding of KVL, KCL, circuit theorems and AC circuits by having a practical experience of working with small-scale electrical circuits.

Course Objectives:
The objectives of this course are to –

- Conduct hands-on experience about electrical circuit components, laboratory instruments and their usage.
- Teach how to design various complex circuit networks that contain resistances, voltage sources, capacitances and inductances.
- Make the students capable of analyzing circuits by observing the measured voltage and current values of the circuits.
- Develop the ability to work with three-phase lines and power calculations.

Course Contents:
Perform experiments and design projects based on 0713-111 and 0713-121.

Resources:
Textbook(s):
[1] C. Alexander and M. Sadiku, *Fundamentals of Electric Circuits*, 7th ed. New York: McGraw-Hill, 2020.
[2] R. L. Boylestad, *Introductory Circuit Analysis*, 12th ed. India: Pearson Education, 2010.
Reference(s):
[1] J. W. Nilsson and S. A. Riedel, *Introductory Circuits for Electrical and Computer Engineering*, 1st ed. Prentice Hall, 2001.

0713-124: Circuit Simulation Laboratory

Course Code : 0713-124 **Course Title** : Circuit Simulation Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-111

Course Rationale:
The aim of the course is to enable students to simulate any electrical and electronic circuits in software environments named PSpice and OrCAD. It will create the foundation of students to analyze electrical and electronic circuits as pre-study requirements in real life cases. Students will also learn to design specific problems of electrical and electronic circuits by simulation.

Course Objectives:
The objectives of this course are to –

- Familiarize students with electrical and electronic circuits.
- Enable students to use PSpice and OrCAD software to simulate electrical and electronic circuits.
- Verify the circuit theories through simulation.
- Practice complex design problems regarding electrical and electronic-based on realistic aspects.

Course Contents:
Perform experiments and design projects based on 0713-111 and 0713-121.

Resources:
Textbook(s):
[1] C. Alexander and M. Sadiku, *Fundamentals of Electric Circuits*, 7th ed. New York: McGraw-Hill, 2020.
[2] R. L. Boylestad, *Introductory Circuit Analysis*, 12th ed. India: Pearson Education, 2010.
Reference(s):
[1] J. W. Nilsson and S. A. Riedel, *Introductory Circuits for Electrical and Computer Engineering*, 1st ed. Prentice Hall, 2001.

0714-211: Electronics I

Course Code : 0714-211 **Course Title** : Electronics I
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-111

Course Rationale:
Electronics I is a core course of Electrical and Electronic Engineering. To understand in-depth the basic characteristics of electronic devices such as diode, BJT and MOSFET as well as their applications is an essential requirement for students aiming to further study electronics or any of its related fields. The purpose of this course is to teach students such fundamental concepts.

Course Objectives:

The objectives of this course are to –

- Make the students understand the operation and terminal characteristics of diodes, BJTs, and MOSFETs.
- Prepare the students to apply the basic knowledge to circuits involving diodes, BJTs, and MOSFETs with DC only or DC and AC sources, as well as BJT and MOSFET amplifier circuits to evaluate amplifiers' performance parameters.
- Introduce the students about the applications of BJT and MOSFET in different types of amplifier circuits and the evaluation of related performance parameters from these circuits.

Course Contents:

Semiconductor Diodes: Semiconductor material and properties, p-n junction, Diodes, current-voltage characteristics, diode circuits, DC analysis and models, AC equivalent circuits, Zener diodes, Application of diode circuits, half wave and full wave rectifiers, bridge rectifiers, rectifiers with filter capacitor, regulators, clipper and clamper circuits, other diode types, photo diodes and Light Emitting Diodes (LED).

Bipolar Junction Transistor (BJT): BJT device structure and operation, Current-Voltage Characteristics, Early effect, DC analysis of BJT circuits, basic transistor applications, Biasing in BJT amplifier circuits, multistage circuits, small signal operation, BJT linear amplifiers-basic configurations, CE amplifiers, AC load lines, CC and CB amplifier, multistage amplifiers, power consideration, Frequency Response, Amplifier frequency response, system transfer function, amplifiers with circuit capacitors.

MOS Transistors: Structure of MOSFET, Operation, Current-Voltage Characteristics, MOS Device Models, Channel length modulation, DC circuit analysis, basic MOSFET applications, Biasing in MOS amplifier circuits, multistage MOSFET circuits, small signal operations. MOSFET amplifier: basic transistor amplifier configurations-Common-Source, Common-Gate Stage, Source Follower (common drain), single stage integrated circuit MOSFET amplifiers, multistage MOSFET amplifiers. Junction Field effect transistor (JFET): Structure and physical operation of JFET, transistor characteristics, pinch-off voltage.

Resources:

Textbook(s):

[1] R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 13th ed. Pearson Education India, 2015.

Reference(s):

[1] A. S. Sedra and K. C. Smith, *Microelectronic Circuits*. Oxford University Press, 2010.

0713-213: Energy conversion I

Course Code : 0713-213 **Course Title** : Energy Conversion I
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Different electrical machines are taught in this course. The topics which are covered in this course have great implications in industrial and other real-life applications. The main purpose of this course is to give the students in-depth knowledge on the construction, working principle, characteristics, and application of different transformers, induction motors, and induction generators.

Course Objectives:
The objectives of this course are to-

- Introduce with the principles of energy conversion.
- Give the basic knowledge on the construction and working principle of transformer, induction motor and induction generator.
- Make it understand about the characteristics and performance of the transformer, induction motor and induction generator.
- Develop the ability to solve problems on electrical machines.

Course Contents:
Transformer: principle of operation, construction, no load and excitation current, behaviour during loading, leakage flux, ideal transformer, leakage reactance and equivalent circuit of a transformer, equivalent impedance, voltage regulation, losses and loss minimization techniques, efficiency, determination of parameters by tests, polarity of transformer windings, transformer parallel operation, Autotransformer, instrument transformers.
Three phase transformers: Construction, connection configuration, vector group, parallel operation, power application etc.
Three phase induction motor: construction, squirrel cage, wound rotor, Working principle, rotating magnetic field, synchronous speed, Slip and its effect on rotor frequency and voltage, Torque in induction motor, equivalent circuit of an induction motor, air gap power, mechanical power and developed torque, torque-speed characteristic, losses, efficiency and power factor, classification, shaping of torque speed characteristic, determination of induction motor parameters by tests, methods of braking, speed control and starting.
Single Phase Induction Motor: operation, double revolving field theory, starting methods, equivalent circuit, torque-speed characteristic and performance calculation.
Induction generator: Working principle and operation, characteristics, voltage build up, applications in wind turbines.

Resources:
Textbook(s):
[1] B. L. Theraja and A. K. Theraja, *A Textbook of Electrical Technology - Volume II (AC & DC Machines)*, 24th ed. S. Chand Publishing, 2008.
Reference(s):
[1] S. J. Chapman, *Electric Machinery Fundamentals*, 5th ed. McGraw-Hill, 2012.

0713-215: Electrical Properties of Materials

Course Code : 0713-215 **Course Title** : Electrical Properties of Materials
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0533-111

Course Rationale:
The purpose of this course is to teach students the fundamental concepts and step by step realization process of basic characteristics of electrical and electronic materials. This course will create the background needed to understand the physics of device operations and also prepare students for advanced courses in solid state and quantum electronics. It provides an excellent opportunity to prepare themselves for advanced study in a variety of different areas of solid-state engineering and material science: metals, semiconductors, superconductors, optical, magnetic and amorphous materials

Course Objectives:

The objectives of this course are to -

- Explain basic crystal structures and their parameters.
- Capable Students to realise the physics behind thermal and electrical conductions as well as quantum natures.
- Find the possible polarization and magnetic properties in different types of materials.
- Calculate fermi levels, concentrations, and lattice parameters.

Course Contents:

Elementary Materials Science Concepts: Bonding theory of solids, types of crystals, unit cell and lattice, different cubic crystals and their parameters, crystal direction and plane, allotropes, crystal defects.

Electrical and Thermal Conduction in Solids: Drude model, drift mobility and conductivity, temperature dependent resistivity, Mathiessen and Nordheim's rule, residual resistivity, hall effect, temperature conductivity of metals and insulators.

Elementary Quantum Physics: Definition of light, photoelectric effect, compton scattering, x ray diffraction, black body radiation, De broglie relationship, Schrodinger equation and infinite potential wall, Heigenberg's uncertainty principle.

Modern Theory of Solids: Molecular orbital theory of bonding, Bloch Function Wave, electron effective mass, Kronig-Penny model, density-of-states, carrier statistics: Boltzmann and Fermi-Dirac distributions, quantum Theory of metals – free electron / Sommerfield Model, conduction in Metals, Debye Heat Capacity, temperature, frequency, Dulong-Petit Law.

Modern Theory of Solids: Dielectric constant, different types of polarization, Claussius-Massotti equation, frequency dependent dielectric constant and capacitor model, Debye equation and Cole-Cole plot, Dielectric breakdown of solids, liquids, and gasses.

Magnetic Properties and Superconductivity: Magnetic dipole, magnetic permeability and susceptibility, hysteresis, hard and soft magnetic materials, different types of magnetic materials, superconductivity, BCS theory.

Resources:

Textbook(s):

[1] S. Kasap, *Principles of Electronic Materials and Devices*, 4th Edition. New York: McGraw Hill, 2017.

Reference(s):

[1] D. A. Neamen, *Semiconductor Physics and Devices: Basic Principles*, 4th Edition. New York: McGraw-Hill, 2011.

[2] W. D. Callister and D. G. Rethwisch, *Materials Science and Engineering*, 9th ed. Wiley, 2014.

0714-217: Continuous Signals & Linear Systems

Course Code : 0714-217 **Course Title** : Continuous Signals & Linear Systems
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:

This is an introductory course to Signals and Systems. The course will provide an insight into how signals can be represented in time domain and how they can be transformed into other domains. The resultant alternative viewpoint allows more intuitive/ simpler solutions to various engineering problems. The students will also learn about analytical techniques that allow modelling the behaviour of the systems and gain an insight into the characteristics of signals. The course will provide skills to model, analyse and design signals and systems in general.

Course Objectives:

The objectives of this course are to -

- Develop the knowledge to recognize, sketch and manipulate basic signals commonly used in engineering applications.
- Classify signals according to input-output characteristics of continuous time (CT) linear systems.
- Teach system properties of linearity, time (in) variance, causality, memory and stability.
- Develop the capability of spectra of signals and frequency responses of CT LTI systems use them to determine performance characteristics, such as stability and frequency response.

Course Contents:

Classification of signals and Systems: signals- classification, basic operation on signals, elementary signals, representation of signals using impulse function; systems- classification, Properties of Linear Time Invariant (LTI) systems: Linearity, causality, time-invariance, memory, stability.

Time domain analysis of LTI systems: Differential equations- system representation, order of the system, solution techniques, zero state and zero input response, system properties, impulse response- convolution integral, determination of system properties, state variable- basic concept, state equation and time domain solution.

Frequency domain analysis of LTI systems: Fourier series- properties, harmonic representation, system response, frequency response of LTI systems; Fourier transformation properties, system transfer function, system response and distortion less systems. Applications of time and frequency domain analyses.
Laplace transformation: properties, inverse transform, solution of system equations, system transfer function, system stability, frequency response and application.

Resources:
Textbook(s):
[1] B. P. Lathi and R. Green, *Signal Processing and Linear Systems*, 2nd ed. New York: Oxford University Press, 2021.
[2] S. S. Soliman and M. D. Srinath, *Continuous and Discrete Signals and Systems*. Prentice Hall, 1998.
Reference(s):
[1] B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4th ed. New York: Oxford University Press, 2009.

0714-221: Electronics II

Course Code : 0714-221 **Course Title** : Electronics II
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-211

Course Rationale:
Electronics II is a core course of Electrical and Electronic Engineering. To understand in-depth the basic characteristics of electronic devices such as Op-Amp, Filters, and Oscillator as well as their applications is an essential requirement for students aiming to further study electronics or any of its related fields. The purpose of this course is to teach students such fundamental concepts regarding amplifier and their frequency response.

Course Objectives:
The objectives of this course are to –
- Make students understand the operation and performance of Op-Amp.
- Develop the student's ability to design electronics filter and oscillator circuits.
- Introduce the student with various amplifiers and their frequency response.

Course Contents:
Operational Amplifiers (Op-Amp): Properties of ideal OP-Amps, inverting and non-inverting amplifiers, summer, subtractor, integrators, differentiator, exponential, logarithmic amplifier, voltage follower and other applications of Op-Amp circuits, Differential and common mode amplifier, CMRR, Comparator circuits: zero crossing detector, voltage level detector, Schmitt trigger, application of different comparator circuits, DC imperfections, input bias and offset current, offset voltage, null circuits, slew rate, drift, open loop & closed loop gain and frequency response of Op-Amps.
Active Filters: Different types of active butter-worth filters and specifications, realization of first, second and third order low, high pass filters using Op-amps, wideband and narrowband active band-pass filters, notch filters, application of active filters.

Stability and Oscillators: Oscillator operation, Barkhausen criteria, signal generators, sinusoidal oscillators, Phase shift oscillator, RC, LC oscillator, Wein-bridge oscillator, Resonant Circuit Oscillator, Crystal oscillators, Non-sinusoidal Oscillators, Relaxation oscillator, square wave generator, timer circuit design, Multivibrators: Astable, monostable, and bi-stable multivibrators.
Feedback Amplifiers: Basic feedback concept, feedback topologies, voltage (series-shunt) amplifiers, current (shunt-series) amplifiers, transconductance (series-series) amplifiers, transresistance (shunt-shunt) amplifiers, loop gain, stability of feedback circuit, frequency compensation.
Introduction to Power Amplifier: Class A, Class B, Class AB, Class C operation.
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.

Resources:
Textbook(s):
[1] R. F. Coughlin and F. F. Driscoll, *Operational Amplifiers & Linear Integrated Circuits*, 5th ed. Pearson Education, 1998.
Reference(s):
[1] J. Millman and C. C. Halkias, *Integrated Electronics: Analog and Digital Circuits and Systems*, 1st ed. McGraw-Hill, 1972.

0714-222: Electronics Laboratory

Course Code : 0714-222 **Course Title** : Electronics Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-211

Course Rationale:
This course aims to give a practical demonstration of the operation of electronic equipment. In the Electronics laboratory course, students will be able to practice theoretical knowledge of basic electronic circuits such as half wave and full wave rectifier, clipping and clamping circuit, op-amp application and different types of active and passive filters. They will learn to implement these applications both in hardware and software.

Course Objectives:
The objectives of this course are to –
- Introduce the student with practical operation mechanisms and characteristics of electronic equipment.
- Give students practical exposure to the usage of different equipment with different conditions.
- Develop the student's ability to design electronics circuits.

Course Contents:
Laboratory experiments will be conducted based on the theory taught in Electronics I and Electronics II.

Resources:
Textbook(s):
[1] R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory,* 13th ed. Pearson Education India, 2015.
Reference(s):
[1] J. Millman and C. C. Halkias, *Integrated Electronics: Analog and Digital Circuits and Systems,* 1st ed. McGraw-Hill, 1972.

0713-223: Energy Conversion II

Course Code : 0713-223 **Course Title** : Energy Conversion II
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-213

Course Rationale:
Different electromechanical energy conversion principles are taught in this course. This course addresses the topics which have significant importance in industrial and other real-world applications, particularly in the generation of electrical energy and motor operation. The primary goal of this course is to provide students with a thorough understanding of the construction, operation, characteristics, and applications of Synchronous and DC machines.

Course Objectives:
The objectives of this course are to –
- Familiarize with the basic knowledge of the construction and working principles of Synchronous and DC machines.
- Understand the characteristics and performance analysis of Synchronous and DC machines.
- Help in developing the ability to solve the problems related to electrical machines.

Course Contents:
Synchronous generator: construction, armature (stator) and rotating field (exciter), excitation system with brushes and brushless excitation system, cooling, generated voltage equation of distributed short pitched armature winding, armature winding connections and harmonic cancellation in distributed short pitched winding, equivalent circuit, synchronous impedance, generated voltage and terminal voltage, phasor diagram, voltage regulation with different power factor type loads, determination of synchronous impedance by tests, phasor diagram, equation of developed power and torque of synchronous machines.
Parallel operation of generators: requirement of parallel operation, conditions, synchronizing, effect of synchronizing current, hunting and oscillation, synchroscope, phase sequence indicator, load distribution of alternators in parallel, droop setting, frequency control, voltage control, house diagrams.
Synchronous Motors: construction, operation, starting, effect of variation of load at normal excitation, effect of variation of excitations, V curves, inverted V curves and compounding curves, power factor adjustment, synchronous capacitor and power factor correction, synchronous condenser.
DC Generator (DG): principle of operation, constructional features, characteristics of various generators, build-up process, armature reaction, losses in dc generator, voltage regulation.

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

Resources:
Textbook(s):
[1] S. J. Chapman, *Electric Machinery Fundamentals*, 5th ed. McGraw-Hill, 2012.
Reference(s):
[1] B. L. Theraja and A. K. Theraja, *A Textbook of Electrical Technology - Volume II (AC & DC Machines)*, 24th ed. S. Chand Publishing, 2008.

0713-224: Energy Conversion Laboratory

Course Code : 0713-224 **Course Title** : Energy Conversion Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-213

Course Rationale:
Transformer and other electrical machines play a vital role in power generation, transmission and industrial manufacturing and these machines need to drive properly. The topics which are covered in this course have great implications in industrial and other real-life applications. The main purpose of this course is to give the students hands-on experience on up-to-date electric machines, drives and instruments, as well as to improve their preparation theory learned from lectures.

Course Objectives:
The objectives of this course are to –

- Make students introduced with Different electrical machines such as Single-phase transformer, three phase transformer, Induction motor, Capacitor start motor, Synchronous Generator, DC Generator and motor.
- Give students in-depth knowledge of the construction and application of different electrical machines.
- Make students able to determine the Equivalent Circuits of different Electrical machines and evaluate the performance characteristics of different Electrical machines at different operating conditions.

Course Contents:
Laboratory experiments will be conducted based on the theory taught in 0713-213 and 0713-223.

Resources:
Textbook(s):
[1] S. J. Chapman, *Electric Machinery Fundamentals*, 5th ed. McGraw-Hill, 2012.
Reference(s):
[1] B. L. Theraja and A. K. Theraja, *A Textbook of Electrical Technology - Volume II (AC & DC Machines)*, 24th ed. S. Chand Publishing, 2008.

0714-225: Electromagnetic Fields and Waves

Course Code : 0714-225 **Course Title** : Electromagnetic Fields and Waves
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0533-111

Course Rationale:
In order to understand electrical systems, modern communication systems, and microwave engineering students must be familiar with various electromagnetic fields and waves theorems and their application. The course covers the fundamentals of electromagnetic and how it is used in modern communications, as well as basic electrostatics and magnetostatics rules and ideas.

Course Objectives:
The objectives of this course are to –

- Familiarize students with different mathematical tools for investigating different electromagnetic systems.
- Make the students capable of understanding diverse magnetostatic and electrostatic systems.
- Acquaint students with the different electromagnetic waves functionalities in accordance with various theories.

Course Contents:
Basic Laws of Vector Analysis: Orthogonal Coordinate Systems; Transformation between Coordinate Systems Curvilinear coordinates, rectangular, cylindrical, and spherical coordinates, Differential Length, Area and Volume; Line, Surface and Volume Integrals; Gradient, Divergence and Curl of Fields.
Electrostatics: Coulomb's law, force, electric field intensity, electrical flux density. Gauss's Law with an application, Divergence of an Electrostatic Field, Electrostatic potential, Electric Dipole, boundary conditions in Electrostatics, Laplace's and Poisson's equations, the energy of an electrostatic system.
Magnetostatics: Concepts of a magnetic field, Ampere's law, Stoke's Theorem, Vector magnetic potential, Magnetic Dipole, Energy of a Static Magnetic Field, Completeness of Specification of Electric and Magnetic Fields.
Maxwell's equations: Voltages induced by changing Magnetic Fields, Continuity of charge, the concept of displacement current, physical picture of displacement current, Maxwell's Equations in Differential Equation form, in Large Scale form, and for the periodic case. Poynting's Theorem for Energy relations in an Electromagnetic Field. Application of Maxwell's Equations in Wave Propagation, Application of Maxwell's Equations in Penetration of Electromagnetic Fields into a Good Conductor. Boundary Conditions for Time-Varying Systems, Wave Propagation. Potentials used with varying charges and currents, The Retarded Potential concepts.

Resources:
Textbook(s):
[1] D. Cheng, *Field and Wave Electromagnetics*, 2nd ed. Addison-Wesley, 1989.
[2] M. N. O. Sadiku, *Principles of Electromagnetics*, 6th ed. Oxford University Press, 2015.
Reference(s):
[1] K. D. Prasad, *Electromagnetic Fields And Waves*, 1st ed. Satya Prakashan, 2001.

0713-227: Transmission and Distribution of Electrical Power

Course Code : 0713-227 **Course Title** : Transmission and Distribution of Electrical Power
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-111

Course Rationale:
This Transmission and Distribution of Electric Power course comprises analysis of different transmission and distributed electrical parameters to dispatch any required action to reduce the electrical power loss and to improve power transmission quality, and safety. The goal of this course is to help the student to receive clear and unambiguous knowledge on transmission and distribution equipment or project-related inquiries for working in the practical field and enhance technical skills.

Course Objectives:
The objectives of this course are to –

- Prepare students with requisite basic knowledge about key parameters of transmission and distribution of modern power supply system.
- Familiarize students with different problems related to power transmission and distribution and discuss their solutions.
- Boost the student's depth on problem-solving, so that students can design and solve any problems that arise in transmission and distribution systems.

Course Contents:
Transmission Line Constants: Resistance, Inductance and Capacitance.
Electric power supply system: Single line diagram, ac/dc system, 1-phase and 3-phase system.
Electrical performance of transmission line: Resistance and skin effects. Current and voltage relation on a transmission line.
Representation of line: short, medium and long transmission line, tee and pi representation, exact solution. Equivalent circuit of a long line.
Mechanical design of transmission line: Sag and stress analysis; wind and ice loading; supports at different elevations; conditions at erection; effect of temperature changes.
Insulators for overhead lines: Types of insulators, their constructions, and performance. Potential distribution in a string of insulators, string efficiency. Methods of equalizing potential distribution; special types of insulators, testing of insulators.
Generalized line constant: general line equation in terms of A, B, C, D constants. Relations between constants, charts of line constants, constants of combined networks, measurement of line constants.
Circle diagrams: receiving and sending end power-circle diagrams. Power transmitted: maximum power, universal power-circle diagrams.
Voltage regulation of transmission line: 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.
Substation: Substation equipment, bus bar arrangements, substation earthing, neutral grounding, substation automation, GIS substation.

Distribution System: DC and AC distribution system, Types of distribution scheme, and performance analysis. Modern Technology with Power Transmission: HVDC, SCADA, SMART Grid.

Resources:
Textbook(s):
[1] V. K. Mehta and R. Mehta, *Principles of Power System*. S. Chand Publishing, 2005.
[2] W. D. Stevenson, *Elements of Power System Analysis*, 4th edition. McGraw-Hill, 1982.
Reference(s):
[1] D. P. Kothari and I. J. Nagrath, *Modern Power System Analysis*, 3rd ed. Tata McGraw-Hill Publishing Company, 2003.

0714-311: Communication Engineering

Course Code : 0714-311 **Course Title** : Communication Engineering
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
The aim of this course is to get students introduce to basics of communication and relevant theories that comprises the data processing techniques such as modulation, demodulation, transmission medium and its properties, effect of noise and attenuation. The goal is to prepare students so that in their next practical life students will be able to identitfy, analyze, and update any communication-based system, and do the basic troubleshooting.

Course Objectives:
The objectives of this course are to –
- Develop the knowledge in communication systems and its parameters.
- Teach analog and digital modulation techniques.
- Enable to understand the digital modulation Techniques.
- Teach different Multiplexing and multiple access techniques.

Course Contents:
Overview of communication systems: fundamental elements, system limitations, message source, bandwidth requirements, transmission media types, bandwidth and transmission capacity.
Noise: Source, characteristics of various types of noise and signal to noise ratio.
Information theory: Measure of information, source encoding, error free communication over a noisy channel, channel capacity of a continuous system and channel capacity of a discrete memory less system.
Communication systems: Analog and digital.
Continuous wave modulation: Transmission types - base-band transmission, carrier transmission, amplitude modulation- introduction, double side band, single side band, vestigial side band, quadrature, spectral analysis of each type, envelope and synchronous detection, angle modulation instantaneous frequency, frequency modulation (FM) and phase modulation (PM), spectral analysis, demodulation of FM and PM.
Pulse modulation: Sampling - sampling theorem, Nyquist criterion, aliasing, instantaneous and natural sampling, pulse amplitude modulation principle, bandwidth requirements, pulse

code modulation (PCM) - quantization principle, quantization noise, differential PCM, demodulation of PCM; delta modulation (DM) - principle, adaptive DM; line coding - formats and bandwidths.
Digital modulation: Amplitude Shift keying-principle, ON-OFF keying, bandwidth requirements, detection, noise performance, phase-shift keying (PSK) principle, bandwidth requirements, detection, differential PSK, quadrature PSK, noise performance, frequency-shift Keying (FSK) - principle, continuous and discontinuous phase FSK, minimum-shift keying, bandwidth requirements, detection of FSK.
Multiplexing: Time- division multiplexing (TDM) principle, receiver synchronization, frame synchronization, TDM of multiple bit rate systems, frequency-division multiplexing-principle, de-multiplexing, wavelength-division multiplexing, multiple-access network-time-division multiple-access, frequency-division multiple access, code-division multiple-access (CDMA) - spread spectrum multiplexing, coding techniques and constraints of CDMA.
Communication system design: design parameters, channel selection criteria and performance simulation.

Resources:
Textbook(s):
[1] B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4th edition. New York: Oxford University Press, 2009.
[2] D. Kennedy, *Electronic Communication Systems*, 4th edtion. McGraw-Hill, 1992.
Reference(s):
[1] M. L. Anand, *Principles of Communication Engineering*, 1st ed. Taylor & Francis 2021.

0714-312: Communication Engineering Laboratory

Course Code : 0714-312 **Course Title** : Communication Engineering Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
Students will learn about different types of Analog and digital modulation¸ different types of Analog and digital demodulation, modulator and demodulator kit, practical knowledge on hardware.

Course Objectives:
The objectives of this course are to –
- Develop the ability to learn about modulators and demodulator kits
- Understand the design specification of analog and digital modulation techniques

Course Contents:
Laboratory experiments will be conducted based on the theory taught.

Resources:
Textbook(s):
[1] B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4th ed. New York: Oxford University Press, 2009.

[2] D. Kennedy, *Electronic Communication Systems*, 4th ed. McGraw-Hill, 1992.
Reference(s):
[1] M. L. Anand, *Principles of Communication Engineering*, 1st ed. Taylor & Francis, 2021.

0714-313: Digital Signal Processing

Course Code : 0714-313 **Course Title** : Digital Signal Processing
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-217

Course Rationale:
Digital signal processing (DSP) is the use of digital processing, such as by computers or more specialized digital signal processors, to perform a wide variety of signal processing operations in audio and speech processing, sonar, radar and other sensor array processing, spectral density estimation, statistical signal processing, digital image processing, data compression, video coding, audio coding, image compression, signal processing for telecommunications, control systems etc. The purpose of the course is to give student the basic background in Digital Signal Processing, its techniques and application in digital signal and system processing.

Course Objectives:
The objectives of this course are to –

- Teach the fundamental concepts of DSP theory such as sampling theory, discrete frequency, and Z –transform
- Make students understand about DTFT, DFT, and FFT
- Provide the concept of filtering, time-frequency methods, and relations between them
- Deliver the concepts of FIR and IIR filters, their frequency response, and characteristics
- Make students capable of designing and implementing FIR and IIIR filters using different methods, and how to test, analyze and refine design

Course Contents:
Introduction to Digital Signal Processing: Review of Signal and Systems, Basic Elements of Digital Signal Processing (DSP), Signal Types, Application Areas of DSP, System Properties, Typical Signal Processing Operations, Discrete-time signals and systems, Analog to Digital Conversion, Linear Time-Invariant (LTI) System, Analysis of LTI systems, Impulse Resolution Method, Difference Method, Convolution, Correlation, Transient and Steady-state conditions, Stability of LTI system, Realization of LTI system.
Z-transform: The Z- transform and its application in signal processing, Elementary Signals, ROC, Poles, and Zeros, System Stability, Schur-Cohn Stability Test, Inverse Z-transform, Bilinear Z transform.
Discrete Transforms: Discrete-Time Fourier Series (DTFS), Discrete-Time Fourier Transform (DTFT) and its properties, Discrete Fourier Transform (DFT) and its properties, Inverse Discrete Fourier Transform (IDFT), Fast Fourier Transform (FFT), Inverse Fast Fourier Transform (IFFT),

Ideal Filter Characteristics Lowpass, Highpass, and Bandpass Filters, Digital Resonators, Notch Filters, Comb Filters. All-Pass Filters. Digital Sinusoidal Oscillators
Correlation and Convolution: Review of convolution, circular convolution, autocorrelation, cross-correlation.
Digital filters: Distortion less Filtering, Introduction to Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters, various techniques of FIR and IIR filter design, the realization of FIR and IIR filters, Linear phase response, FIR Coefficient Calculation: Window Method, Optimal Method, Frequency Sampling Method, finite-precision effects

Resources:
Textbook(s):
[1] J. G. Proakis, *Digital Signal Processing: Principles, Algorithms, and Applications*. Pearson Education India, 2007.
Reference(s):
[1] R. J. Schilling and S. L. Harris, *Fundamentals of Digital Signal Processing Using MATLAB*, 2nd ed. Stamford, CT: Cengage Learning, 2010.

0714-314: Digital Signal Processing Laboratory

Course Code : 0714-314 **Course Title** : Digital Signal Processing Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-217

Course Rationale:
Digital signal processing (DSP) is the use of digital processing, such as by computers or more specialized digital signal processors, to perform a wide variety of signal processing operations. The purpose of the course is to give student hands-on experience on its algorithmic, computational, and programming aspects, and to learn programming of DSP hardware for real-time signal processing applications.

Course Objectives:
The objectives of this course are to –
- Strengthen student's knowledge of DSP fundamentals
- Familiarize them with practical aspects of DSP algorithm development and implementation

Course Contents:
Introduction to MATLAB & Script files, Sampling (Uniform and Non-Uniform), Quantization and Reconstruction of Analog Signals, Implementation of Discrete-time Signal (Basic Signals, Addition, Multiplication, Shifting, Folding, Convolution, Correlation, System Response of Difference Equation), Z-transform and its application, Frequency-Domain Analysis (DTFS, DFT, DFS, Circular & Linear Convolution, Correlation, Modulation), FIR filter design (Truncation, Standard Window, Kaiser Window, etc.

Resources:
Textbook(s):
[1] J. G. Proakis, *Digital Signal Processing: Principles, Algorithms, and Applications*. Pearson Education India, 2007.

[2] R. J. Schilling and S. L. Harris, *Fundamentals of Digital Signal Processing Using MATLAB*, 2nd ed. Stamford, CT: Cengage Learning, 2010.
Reference(s):
[1] MATLAB Documentation.

0713-315: Power System Analysis

Course Code : 0713-315 **Course Title** : Power System Analysis
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
The course serves as a good introduction for power system analysis and stability. It covers, among others, load-flow analysis, economic load dispatch, frequency and voltage control and power system stability. By learning all the fundamentals about power system analysis, students will continue their study of power system analysis for a career in power engineering and electrical engineering.

Course Objectives:
The objectives of this course are to –

- Develop the concept of Inductance and Capacitance in transmission lines
- Understand the elements of a power system including generators, transmission lines, and transformers.
- Calculate of Ybus & Zbus from a power system network
- Evaluate power flow problems by application of the Gauss-Seidal method
- Teach network under both balanced and unbalanced fault conditions and interpret the results
- Develop the knowledge of power system operation and stability

Course Contents:
Inductance and capacitance in transmission lines (single-phase, 3-phase, equilateral and unsymmetrical spacing), power network representation, per unit systems, reactance of synchronous generator and equivalent circuit, voltage characteristics of loads, real power and reactive power flow in a system, bus impedance and bus admittance matrix, network calculation and node elimination, load flow studies with Gauss-Seidel method, Faults in transmission line and symmetrical fault analysis, symmetrical components (positive, negative and zero sequence networks of generators, transformers, lines) sequence network of systems, unsymmetrical fault analysis (single line to ground, line to line and double line to ground fault), power system stability analysis (steady state, transient and dynamic stability, two machine systems, swing equation, equal area criteria)

Resources:
Textbook(s):
[1] H. Saadat, *Power System Analysis*, 3rd edition. PSA Publishing LLC, 2011.
Reference(s):
[1] W. D. Stevenson, *Elements of Power System Analysis*, 4th edition. McGraw-Hill, 1982.
[2] D. P. Kothari and I. J. Nagrath, *Modern Power System Analysis*, 3rd ed. Tata McGraw-Hill, 2003

0713-316: Power System Analysis Laboratory

Course Code : 0713-316 **Course Title** : Power System Analysis Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
Power System Analysis Laboratory course is developed to allow the student to analyze the performance of power system networks by conducting various experiments. This course also teaches the students computer programs for analysis of power systems.

Course Objectives:
The objectives of this course are to –

- Understand the power systems modelling and experimental verification
- Introduce with Power simulator
- Make students enable to address the underlying concepts & approaches behind analysis of power system networks using software tools
- Make it capable to analyze the faults and stability in power system using software tools

Course Contents:
Laboratory Experiments will be conducted based on the theory taught in 0713-315.

Resources:
Textbook(s):
[1] H. Saadat, *Power System Analysis*, 3rd edition. PSA Publishing LLC, 2011.
[2] J. D. Glover, T. Overbye, and M. S. Sarma, *Power System Analysis and Design*. Cengage Learning, 2016.
Reference(s):
[1] W. D. Stevenson, *Elements of Power System Analysis*, 4th edition. McGraw-Hill, 1982.
[2] D. P. Kothari and I. J. Nagrath, *Modern Power System Analysis*, 3rd ed. Tata McGraw-Hill Publishing Company, 2003.

0713-320: Engineering Drawing & Services Design Laboratory

Course Code : 0713-320 **Course Title** : Engineering Drawing and Services Design Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
Green, safe and cost-effective services design in compliance with codes and standards are the master concern of modern building design. This course aims at designing electrical building services, i.e., electrical systems and installations that provide power, movement, communication, comfort and safety in modern buildings

Course Objectives:
The objectives of this course are to-

- Get students familiar with the sectional and isometric views of geometric figures and elevation of the multi-storied building
- Get students introduced to CAD tools for building services design
- Learn students about professional wiring rules and electrical protection systems for industry, residential building, substations etc
- Make students skilled at designing modern security systems, fire and electrical protection systems, building communication system, illumination etc. along with traditional wiring

Course Contents:
Introduction: lettering, numbering, and heading, instrument and their use sectional views and isometric views of solid geometrical figures. Plan, elevation and section of a multi-storied building, services drawings, detailed drawing of lattice towers, Familiarization with CAD tools for building services design.
Wattage rating of common electrical equipment, earthing requirements & various methods, Earthing and lightning protection system design, Safety regulations and health issues, design of security systems including CCTV, Concept of fire prevention and its importance, Fire detection (smoke, heat etc.) and alarm system (with voice evacuation), firefighting system (sprinkler system, hose), Installation of substation, BBT, air-conditioning, heating, lifts and elevators. Design for intercom, public address systems, telephone system and LAN.
Wiring system design, drafting, and estimation. Design for illumination and lighting, lux, lumen, choice of luminaries for various applications- domestic building, office building and industry.
Introduction to building regulations, codes and standards: BNBC, NFPA etc, Terminology and definitions, distribution boxes, cables and conduits, Familiarization with symbols and legends used for electrical services design. A design problem on a multi-storied building.

Resources:
Textbook(s):
[1] B. Rigby, *Design of Electrical Services for Buildings*, 6th ed. Routledge, 2013.
Reference(s):
[1] S. L. Uppal, *Electrical Wiring - Estimating & Costing*, 4th ed. Khanna, 1986.

0714-321: Control Systems

Course Code : 0714-321 **Course Title** : Control Systems
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-121

Course Rationale:
Nowadays, automation in every aspect of life is very common; from automatic toothbrushes to drone video making, from automatic humidifiers to driverless cars everything has become part of our daily lives. Moreover, implementation of control systems can be observed in robotics (defense, medical, industry etc.). The engineers must have a clear idea about the theoretical knowledge of automatic control systems and also about the implementation of

control techniques in practical applications. The main purpose of this course is to familiarize the students about the modeling, analysis and simulation of control systems.

Course Objectives:

The objectives of this course are to -

- Familiarize the students with the fundamental concepts of open loop and closed loop system
- Prepare students to represent and analyse control systems
- Make the students capable of implementing the various techniques of control systems to design a controller under specific conditions

Course Contents:

Introduction to feedback control: Open loop and closed loop system, terminologies with examples, elements of basic control systems.

System representation using Transfer function: Time domain and frequency domain representation basics, Transfer function basics and modelling electrical, mechanical, and electromechanical system using differential equation and transfer function, electrical systems, first order, second order and higher order, damping of R-L-C circuits, transient characteristics of system to unit, step, ramp, parabolic functions.

Analysis of system using time domain: Time domain specifications, Location of poles and stability by Routh's criterion, effect of additional poles/zeros, steady state error, parameter sensitivity, types of systems (type-1,2 etc.), examples, steady state error and static error coefficient, Controllability, Observability.

Equivalent System Representation: different types of representation and conversion using Block diagram and signal flow graph (SFG) both in frequency and time domain, simplification to canonical form by Mason's rule.

Analysis of system using frequency response: Bode plot, Nyquist's and Nichol's plots, Gain margin, phase margin, maximum magnitude, resonant frequency, and bandwidth correlation with tune response. Stability from Nyquist diagram (direct: polar plot). Gain adjustment using Nichol's chart, Construction rules, dominant poles, stability, PID compensation using root locus.

System representation using State space: formation of state equations, transfer function from state equation, stability and eigen- values of state transition matrix, controller design using state variable, state space to transfer function and vice versa.

Controller design: Proportional control, Lead-lag control, PID control, Introduction to pole placement compensation, introduction to digital control system, sampled data systems, stability analysis in Z-domain.

Resources:

Textbook(s):

[1] N. S. Nise, *Control Systems Engineering*. Wiley, 2004.

[2] K. Ogata, *Modern Control Engineering*, 5th edition. Boston: Pearson, 2009.

Reference(s):

[1] S. K. Bhattacharya, *Control Systems Engineering*. Pearson Education India, 2008.

[2] J. J. D'Azzo and C. H. Houpis, *Linear Control System Analysis and Design: Conventional and Modern*. McGraw-Hill, 1988.

0714-322: Control Systems Laboratory

Course Code : 0714-322 **Course Title** : Control Systems Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-121

Course Rationale:
The purpose of this course is to give students hands-on and open-ended practical experiences with advanced experimental tools (programmable logic controller and DC motor control module). This course will provide a brief understanding of mathematical modeling, feedback systems in the automation industry and implementation of a controller for certain conditions for stable, robust control systems.

Course Objectives:
The objectives of this course are to -

- Learn to analyze and modeling of different physical systems using the transfer function
- Enable students to design controllers meeting different requirements in DC motor control module
- Familiar students with industry-level PLC and automation

Course Contents:
Perform experiments and design projects based on 0714-321.

Resources:
Textbook(s):
[1] N. S. Nise, *Control Systems Engineering*. Wiley, 2004.
[2] K. Ogata, *Modern Control Engineering*, 5th edition. Boston: Pearson, 2009.
Reference(s):
[1] S. K. Bhattacharya, *Control Systems Engineering*. Pearson Education India, 2008.
[2] J. J. D'Azzo and C. H. Houpis, *Linear Control System Analysis and Design: Conventional and Modern*. McGraw-Hill, 1988.

0714-323: Digital Electronics

Course Code : 0714-323 **Course Title** : Digital Electronics
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-211

Course Rationale:
Combinational and sequential logic techniques are the basic of digital systems. To understand recent digital systems and techniques students have to know number systems and their applications, manipulation and operation of Boolean algebra, various types of gates and their usage to design and analysis of combinational and sequential circuits. The purpose of this course is to make students understand the fundamental concepts and application of logic gates so that they can analyze and design modern digital systems.

Course Objectives:
The objectives of this course are to -

- Make students understand the fundamental concepts of number system and Boolean algebra
- Prepare students to analyse and synthesize combinational and sequential logic circuits
- Make the students familiar with various digital integrated circuits logic families

Course Contents:
Number systems, binary codes, Boolean algebra, standard and canonical forms, Boolean function simplification, logic gates.
Design procedures of Adder, subtractor, code converters, parity bit checker and magnitude comparator, combinational circuit design and analysis, encoder and decoder, multiplexer and demultiplexer, ROM, PLA.
Introduction to sequential circuits, Basic building block of sequential circuit-Flip-flops: SR, JK, Master slave, T and D type flip-flops and their characteristic tables & equations; triggering of flip-flops; flip-flop excitation table. 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, Finite state machine.
Digital IC logic families: Brief description of TTL, DTL, RTL, ECL, STTL, I2L, MOS and CMOS logic including transmission gate.

Resources:
Textbook(s):
[1] M. M. Mano, *Digital Logic and Computer Design*, 4th ed. Pearson India, 2007.
Reference(s):
[1] R. J. Tocci, N. Widmer, and G. Moss, *Digital Systems: Principles and Applications*, 11th ed. Upper Saddle River, N.J: Pearson, 2010.
[2] S. Brown and Z. Vranesic, *Fundamentals of Digital Logic with VHDL Design*, 3rd ed. Boston: McGraw Hill, 2008.

0714-324: Digital Electronics Laboratory

Course Code : 0714-324 **Course Title** : Digital Electronics Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-211

Course Rationale:
Practically verification of the theories and concepts taught in digital electronics course is important to understand the usage of various logic gates to design and analysis of combinational and sequential circuits. The purpose of this course is to develop students' skills for applying the knowledge of basic digital electronic circuits by performing hands-on and open-ended practical experiences.

Course Objectives:
The objectives of this course are to -
- Explain digital electronic components and their usage

- Develop student's capability to design combinational and sequential circuits
- Make the students capable for open-ended electronic system design

Course Contents:
Laboratory Experiments will be conducted based on the theory taught in EEE 317.

Resources:
Textbook(s):
[1] M. M. Mano, *Digital Logic And Computer Design*, 4th ed. Pearson India, 2007.
Reference(s):
[1] R. J. Tocci, N. Widmer, and G. Moss, *Digital Systems: Principles and Applications*, 11th ed. Upper Saddle River, N.J: Pearson, 2010.
[2] S. Brown and Z. Vranesic, *Fundamentals of Digital Logic with VHDL Design*, 3rd ed. Boston: McGraw Hill, 2008.

0713-325: Measurement and Instrumentation

Course Code : 0713-325 **Course Title** : Measurement and Instrumentation
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
In order to understand the technology and tools behind the recent automation and control industry, it is essential to know about the various measuring techniques and instrument categories. The main purpose of this course is to provide learners conceptual knowledge about various electronic measuring instruments and make students capable of choosing a specific measuring instrument based on their requirement.

Course Objectives:
The objectives of this course are to –
- Introduce the students with the necessity of different measuring instruments and their design principle
- Familiarize the students with the working principle of different measuring instruments and technical solutions to handle different errors
- Acquaint the students with the architecture and working principle of advanced measuring instrument and their applications

Course Contents:
The basics of measurement: define measurement and instrumentation system, functional elements of measurement system, different static and dynamic characteristics of measurement and instrumentation system, electrical standards, identify different types of instruments and their classification, application of measurement and instrumentation system. Errors: Measurement errors and their statistical characterization, Factors influencing measurement errors, elimination of noise, Gaussian Curve.
Electrical measuring instruments: PMMC, moving iron and electrodynamometer for measuring current, voltage, power, and energy. DC ammeter, DC voltmeter, Multirange ammeter, voltmeter, Multimeter, Ohmmeter, Power factor and Q meters, magnetic

measurement, ballistic galvanometers, flux meter, learn about instrument transformers and their application.
Measuring electrical quantities: Different techniques for measuring resistance, capacitance and inductance, balancing condition of AC bridge, cable faults and localization of cable faults.
Transducer: Different types of transducers and their use in measurement and instrumentation: mechanical, optical, and electrical, Sensor and transducer identification, measurement of non-electrical quantities: temperature, pressure, strain, force, torque liquid flow and level.
Electronic measuring instruments and Data Transmission: A/D and D/A converters, sample and hold circuits, data acquisition and signal conditioning, ranging and amplification, Computer-based Instrument Systems, Automation, and remote control. Basic operation of oscilloscope, Lissajous Pattern, Oscilloscope probes, Digital oscilloscope basics, application of oscilloscope, measuring frequency, voltage amplitude, time interval using oscilloscope, Storage oscilloscopes and their use.

Resources:
Textbook(s):
[1] A. K. Sawhney, *A Course in Electrical and Electronic Measurements and Instrumentation*. Dhanpat Rai & Co., 1987
Reference(s):
[1] A. S. Morris, *Measurement and Instrumentation Principles*, 3rd ed. Oxford: Boston: Butterworth-Heinemann, 2001.
[2] P. Purkait, B. Biswas, and C. Koley, *Electrical and Electronics Measurements and Instrumentation*. McGraw Hill Education, 2017.

0714-327: Power Electronics

Course Code : 0714-327 **Course Title** : Power Electronics
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
Power Electronics is an advanced electronic course which will provide detailed introduction of various high efficiency electronics equipment, impart an understanding of their switching mechanism, provide knowledge about methodology of converter design and focus on their implementation in industrial purpose.

Course Objectives:
The objectives of this course are to –
- Introduce students with power electronics equipment
- Teach students the switching mechanism of power electronics equipment
- Make them understand the operation of various phase controller, converter & inverter circuits
- Teach the utilization of power converters in various controlled and drive applications

Course Contents:
Introduction to power electronics: Definition, Types of power electronics circuits, applications.

Power semiconductor devices: Reverse Recovery Characteristics, Power Diodes, Power MOSFET, SCR, DIAC, TRIAC, LASCR, RCT, UJT, GTO, MCT, MTO and IGBT.
Controlled Rectifier: Single Phase and three-phase, Semi-Converter, Full Converter, Dual Converter, Rectifier with Inductive & Motor Load.
DC Choppers: Definition, Classifications, Step-down, Step- up chopper, Buck, Boost and Buck-Boost regulators, Cuk Converter, SEPIC converter.
DC/AC Inverters: Principle, Single phase and Three phase inverters with resistive and inductive load, voltage control of single and three phase inverters, PWM Inverter.
Cycloconverters: Single phase and three phase cycloconverter, Frequency Control, Comparison with DC link Inverter.
Power Supplies: DC Power Supply-Switch Mode Power Supply (SMPS), Flyback, Forward, Push Pull converter. AC Power Supply- Uninterruptible Power Supply (UPS).
Motor Drive: Motor adjustable speed control mechanism, Controller based AC/DC drives.
Application: Electronic Timer, Induction Heating Control, Battery charge controller, Frequency Controller, Power electronics for transmission, distribution, and control in the future power system, including Stand-alone residential Solar system, Grid-Tied Solar System, Smart Grid, HVDC system.

Resources:
Textbook(s):
[1] M. H. Rashid, *Power Electronics: Circuits, Devices & Applications*, 4th ed. Upper Saddle River, NJ: Pearson, 2013.
[2] M. S. J. Asghar, *Power Electronics*. PHI Learning Pvt. Ltd., 2004.
Reference(s):
[1] N. Mohan, T. M. Undeland, and W. P. Robbins, *Power Electronics: Converters, Applications, and Design*, 3rd ed. Hoboken, NJ: Wiley, 2002.

0714-328: Power Electronics Laboratory

Course Code : 0714-328 **Course Title** : Power Electronics Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
Power Electronics Laboratory course is developed to allow the student to work through various stages of designing power converters. This course consists of an introduction to switching converter concepts, a gate drive circuit design, choice of values for the major components in the converter, control circuit design, and completing the final circuit.

Course Objectives:
The objectives of this course are to –
- Introduce students with the basic topologies of switching circuits
- Teach them the power converter circuit modeling, simulation and experimental verification
- Introduce them with MATLAB-Simulink
- Make them capable to investigate the integration of power electronic converters for controlling devices

Course Contents:
Laboratory Experiments will be conducted based on the theory taught in 0714-327.

Resources:
Textbook(s):
[1] M. H. Rashid, Ed., *Power Electronics Handbook*, 4th ed. Oxford: Butterworth-Heinemann, 2017.
[2] M. H. Rashid, *Introduction to Pspice Using Orcad for Circuits and Electronics*. Upper Saddle River, NJ: Prentice Hall, 2003.
Reference(s):
[1] D. Hart, *Power Electronics*, 1st ed. New York: McGraw Hill, 2010

0714-411: Microprocessor and Interfacing

Course Code : 0714-411 **Course Title** : Microprocessor and Interfacing
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-323

Course Rationale:
The knowledge of microprocessors and interfacing is very important as most of the systems are computerized. The basic knowledge of computer's architecture helps the students to troubleshoot, develop and innovate the technology. After completing this course students will be able to understand the computer architecture, interfacing, and high level languages.

Course Objectives:
The objectives of this course are to –

- Make students understand the basic architecture and working principles of Intel 8086 microprocessor
- Familiarize the students with assembly language programming
- Enable students to design real world applications using microprocessors and microcontrollers

Course Contents:
Basic components of a computer system: Simple-As-Possible (SAP) computer, SAP-1, selected concepts from SAP-2 and SAP- (jump, call, return, stack, push and pop). Evolution of microprocessors, Introduction to Intel 8086 microprocessor, features, architecture, Minimum mode operation of 8086 microprocessor, system timing diagrams of read and write cycles, memory banks, design of decoders for RAM, ROM and PORT.
Introduction to Intel 8086 Assembly Language Programming: Basic instructions, logic, shift and rotate instructions, addressing modes, stack management and procedures, advanced arithmetic instructions for multiplication and division, instructions for BCD and double precision numbers, introduction to 8086 programming with C language.
Hardware Interfacing with Intel 8086 microprocessor: programmable peripheral interface, programmable interrupt controller, programmable timer, serial communication interface, keyboard and display interface (LED, 7 segment, dot matrix and LCD).

Resources:
Textbook(s):
[1] Y. Yu and C. Marut, *Assesmbly Language Programming and Organization IBM PC*, 1st ed. New York: McGraw-Hill/Irwin, 1992.
Reference(s):
[1] A. P. Malvino and J. A. Brown, *Digital Computer Electronics*, 3rd ed. Lake Forest, Ill: Career Education, 1992.
[2] D. V. Hall, *Microprocessors and Interfacing*. Mcgraw Hill Higher Education, 2005.

0714-412: Microprocessor and Interfacing Laboratory

Course Code : 0714-412 **Course Title** : Microprocessor and Interfacing Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-323

Course Rationale:
This laboratory course is used to provide intensive practical exposure to the students in the field of microprocessor architecture and industrial control through different circuits using assembly language. The lab also provides the facility to interface the microprocessor.

Course Objectives:
The objectives of this course are to –
- Introduce the basics of assembly language
- Make students able to perform arithmetic and logical operations using assembly language programming.
- Develop the ability to design aspects of I/O and Memory Interfacing circuits

Course Contents:
Laboratory experiments will be conducted based on the theory taught in 0714-411.

Resources:
Textbook(s):
[1] Y. Yu and C. Marut, *Assesmbly Language Programming and Organization IBM PC*, 1st ed. New York: McGraw-Hill/Irwin, 1992.
Reference(s):
[1] A. P. Malvino and J. A. Brown, *Digital Computer Electronics*, 3rd ed. Lake Forest, Ill: Career Education, 1992.
[2] D. V. Hall, *Microprocessors and Interfacing*. Mcgraw Hill Higher Education, 2005.

0713-421: Power Stations and Substations

Course Code : 0713-421 **Course Title** : Power Stations and Substations
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-315

Course Rationale:
Power generation is the main key point for modern life. All the existing technologies will go shut down without power. A power station is a facility for the generation of electric power

and an electrical substation is a station within an electricity generation, transmission, and distribution system that uses transformers to change voltage from high to low or vice versa. The majority of power plants throughout the world generate electricity by burning fossil fuels including coal, oil, and natural gas. Nuclear power and renewable energy sources such as solar, wind, wave, geothermal, and hydropower are examples of clean energy sources. The purpose of this course is to teach students about modern power plants and substations.

Course Objectives:

The objectives of this course are to –

- Introduce primary energy sources for power generation.
- Provide overview on substations and its equipment.
- Teach general concepts of conventional and non-conventional power generation plants.
- Familiarize students with important terms and factors associated with power plant economics.
- Make students understand about different power plants and their power generation principles.

Course Contents:

Energy sources: Fossil fuels (coal, oil, natural gas), nuclear and renewable energy (solar, wind, hydro, biomass, geothermal). Importance of electrical or modern energy. Learning on energy security and climate change: availability of energy sources, import dependency, projected energy demand, expected energy supply--mix for power generation and energy transformation, Greenhouse Gas (GHG) emissions from power plants and public health, GHG emissions mitigation opportunities. Overview of the global and Bangladesh power sector and plans on future energy-mix for power generation.

Power stations and performance: Load curve, connected load, demand factor, diversity factor, load factor, plant factor, utilization factor. Load curve development for a household/community/industry, unit consumed, electricity bill assessment.

Power station performance and operating characteristics: efficiency, heat rate, incremental rate method, Station performance characteristics, Station incremental rate, capacity scheduling. Base load and peak load, load division.

Economics of power generation: cost of electrical energy, levelized cost of energy, methods of determining depreciation, Interconnected System: Capacity savings, power sharing amongst units for economic allocation, Independent Power producer, captive power, site selection of power stations.

Working principles and main components of different power stations such as hydro power, nuclear power, thermal power station (steam turbine and gas turbine and combined cycle).

Energy Tariff: description, types, and tariff in Bangladesh.

Modern technologies and resources for power generation. Global installation trend of renewable-based power stations, investment costs and efficiency improvement. Prospects of renewables (solar PV and wind) for power generation in Bangladesh. Government commitments on Nationally Determined Contributions (NDCs) and opportunity to meet the NDC targets.

Substations: Classification, layout, necessity, construction, and function of its components.

Resources:
Textbook(s):
[1] V. K. Mehta and R. Mehta, *Principles of Power System*. S. Chand Publishing, 2005.
[2] G. R. Nagpal and S. C. Sharma, *Power Plant Engineering*, Khanna Publishers, 1995.
Reference(s):
[1] B. G. A. Skrotzki and W. A. Vopat, *Power Station Engineering and Economy*. New York: McGraw-Hill, 1960
[2] M. V. Deshpande, *Elements of Electrical Power Station Design*, PHI Learning, 2009.

0719-410: Industrial Training

Course Code : 0719-410 **Course Title** : Industrial Training
Credit : 1 **Pre-requisite** : Completion of minimum 100 credits

Course Rationale:
The students need to have industry and workshop exposure, where they can experience real life equipment, materials/models, instruments and various types of manufacturing process related to Electrical and Electronic Engineering. This course has been designed to provide real-life experiences to DIU EEE students through industrial training or internship in the fields of electrical and electronic engineering to help them prepare for their career.

Course Objectives:
The objectives of this course are to –

- Make students capable to gain the practical skills in parallel with the theoretical knowledge in an industrial environment
- Develop students' interpersonal skills, teamwork skills, leadership skills, time management skills and communication skills
- Enable students to build up network with industry for career development
- Expose the students to the responsibility of an engineer or electrical & electronic engineering profession

Course Synopsis:
Students are required to attend the industrial training at any company related to electrical and electronic engineering discipline for a period of 4 to 6 weeks. An Industrial Training report should be prepared at the end of the training. The report is expected to demonstrate development of practical and professional skills in engineering through technical experience and application of theoretical knowledge.

0719-400: Capstone Project

Course Code : 0719-400 **Course Title** : Capstone Project
Credit : 5 **Pre-requisite** : Completion of minimum 100 credits

Introduction:
The capstone project or final year design project is a project that allows students to actively integrate and apply all they have learned to design, develop, implement and analyze their

own research project/study that has an educational, societal and scientific focus. The students under the guidance of a faculty or industry advisor will select a problem to work on for their project, analyze the problem, and formulate a detailed plan to reach a solution, perform necessary evaluations and/or experimentation, identify and/or propose meaningful results and solutions, test the proposal to the extent possible, prepare a detailed report, and present their completed work to a boarder group. Each capstone project will be executed by a group of students (generally not more than 3 members) under the supervision of an academic staff and/or with an industrial partner.

Course Rationale:
In Capstone Project the students gain practical experience tackling real-world problems with the knowledge and skills they have achieved during their undergrad student life. The successful completion of such projects facilitates students in their entrance to industry from academics. Besides student will learn soft skills to demonstrate their works in form of technical report and project presentation in an effective manner.

Course Objectives:
The objectives of this course are to –

- Enable students to implement the knowledge gathered through various theoretical and laboratory courses.
- Expose the students to the contemporary problems and issues related to implementation of electrical and electronic engineering projects.
- Design engineering solutions to complex problems utilising a systems approach.
- Expose the students in stages of an engineering project cycle including the design, development, operation, simulation, data collection and analysis.
- Enhance students' skills pertaining to scientific and technical report writing and presentation.
- Improve students' capability more independently with effective supervision in identifying, discovering and enhancing knowledge in research fields

Indicative Content:
Engineering design, planning and conducting, experiments and test, data acquisition and analysis, organize technical and scientific findings, technical report writing, public speaking, project presentation skills.

TECHNICAL ELECTIVES

Power and Energy

Elective I (CO mapping default value)

0713-431: Power System Protection

Course Code : 0713-431 **Course Title** : Power System Protection
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-315

Course Rationale:
Power system protection course provides an overview of the principles and schemes for protecting power lines, transformers, buses and generators. This course presents the fundamentals of power system protection and its application. The purpose of this course is to teach students the basic elements of switchgear for the protection of costly electrical equipment.

Course Objectives:
The objectives of this course are to –

- Make the student understand the importance and scope of power system protection.
- Introduce the students with power system protection and switchgear equipment and schemes.
- Develop the ability to design and illustrate the power system protection schemes.

Course Contents:
Fundamentals of Protection in Power Systems: Switchgear, switches, circuit breakers, fuses, relays, bus-bar arrangements, switchgear accommodation, short-circuit, overcurrent, differential current, difference of phase angles, over and under voltages, power direction, faults in a power system.
Switchgear equipment: circuit breakers: Principle of arc extinction, selection criteria and ratings of circuit breakers, types - air, oil, SF6 and vacuum. MCB, MCCB, ACB for protection of low-tension circuits and their selection criteria. Fuses: types- low voltage fuses, high voltage fuses, fuse element materials. Instrument transformers: CT and PT. Relays: Electromagnetic attraction relays, induction relays, basic modules, over current, differential, distance and directional relays.
Unit protection schemes: Generator, transformer, motor, bus bar, transmission and distribution lines. Overvoltage Protection, Neutral grounding.

Resources:
Textbook(s):
[1] V. K. Mehta and R. Mehta, *Principles of Power System*. S. Chand Publishing, 2005
Reference(s):
[1] S. S. Rao, *Switchgear Protection and Power Systems*, 13th ed. Khanna Publishers, 2008.
[2] P. J. Freeman, *Electric Power Transmission and Distribution*. Harrap, 1968.

0713-432: Power System Protection Laboratory

Course Code : 0713-432 **Course Title** : Power System Protection Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-315

Course Rationale:
This course aims to provide a practical illustration of power system protection equipment and their operations. It will also provide experimental and project-oriented verification of schemes of power system protection. The course will complement the knowledge gained in the parallel course 0713-431 which deals with the theory of power system protection.

Course Objectives:
The objectives of this course are to –

- Introduce the student with characteristics and practical operation mechanisms of switchgear equipment.
- Give students practical exposure to the usage of different switchgear equipment with different conditions.
- Develop the student's ability to design protection circuits for specific needs.

Course Contents:
Laboratory experiments will be conducted based on the theory taught in 0713-431.

Resources:
Textbook(s):
[1] V. K. Mehta and R. Mehta, *Principles of Power System*. S. Chand Publishing, 2005
Reference(s):
[1] S. S. Rao, *Switchgear Protection and Power Systems*, 13th ed. Khanna Publishers, 2008.
[2] P. J. Freeman, *Electric Power Transmission and Distribution*. Harrap, 1968.

0713-433: High Voltage Engineering

Course Code : 0713-433 **Course Title** : High Voltage Engineering
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
This course provides depth knowledge on the principles of Electric field strength (electric stress), Gaseous Dielectrics, Properties of Liquid and Solid Dielectrics, Breakdown in Liquid and Solid Dielectrics, Generation of High-Test Voltages, Measurement of High Voltage, Non-destructive High Voltage Testing and Quality Control, Insulation Coordination and Over Voltages in Power Systems. The topics covered in this course will be helpful for the electrical engineers in their practical field.

Course Objectives:
The objectives of this course are to –

- Make the students understand the fundamental concepts of different types of dielectrics.
- Prepare the students to analyze the properties of solid and liquid dielectrics.

- Make the students familiar with the concept of generation and measurement of high voltages.

Course Contents:
Electric field strength (electric stress), Gaseous Dielectrics, Properties of Liquid and Solid Dielectrics, Breakdown in Liquid and Solid Dielectrics, Generation of High Test Voltages, Measurement of High Voltage, Non-destructive High Voltage Testing and Quality Control, Insulation Coordination and Over Voltages in Power Systems.

Resources:
Textbook(s):
[1] J. Kuffel and E. Kuffel, *High Voltage Engineering Fundamentals*, 2nd ed. Newnes, 2000.
Reference(s):
[1] M. S. Naidu and V. Kamaraju, *High Voltage Engineering*, 5th ed. Tata-McGraw Hill Education, 2013

0713-434: High Voltage Engineering Laboratory

Course Code : 0713-434 **Course Title** : High Voltage Engineering Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
This course provides experimental and project-oriented verification of principles of Electric field strength (electric stress), Gaseous Dielectrics, Properties of Liquid and Solid Dielectrics, Breakdown in Liquid and Solid Dielectrics, Generation of High Test Voltages, Measurement of High Voltage, Non-destructive High Voltage Testing and Quality Control, Insulation Coordination and Over Voltages in Power Systems.

Course Objectives:
The objectives of this course are to –
- Make the students understand the fundamental concepts of different types of dielectrics.
- Prepare the students to analyze the properties of solid and liquid dielectrics.
- Make the students familiar with the concept of breakdown of gaseous, liquid and solid dielectrics.

Course Contents:
Laboratory experiments will be conducted based on the theory taught in 0713-433.

Resources:
Textbook(s):
[1] J. Kuffel and E. Kuffel, *High Voltage Engineering Fundamentals*, 2nd ed. Newnes, 2000.
Reference(s):
[1] M. S. Naidu and V. Kamaraju, *High Voltage Engineering*, 5th ed. Tata-McGraw Hill Education, 2013

0713-435: Renewable Energy

Course Code : 0713-435 **Course Title** : Renewable Energy
Credit : 3 **Contact Hours** : 3 Hours/week **Credit** : None

Course Rationale:
This aim of the course is to provide insights of importance and challenges of different renewable energy sources including solar, wind, biomass, geothermal, and other renewables which is essential to make green energy system in Bangladesh. It will be conducted through experimental and project-oriented verification of different kinds of renewable based power systems.

Course Objectives:
The objectives of this course are to –

- Explain the importance of renewable energy resources, their types and electricity generation.
- Enable students to understand renewable-based power system operation.
- Develop in-depth knowledge on the prospects and challenges of the renewable system in Bangladesh.
- Enable students to understand the integration and operation of solar PV, solar thermal, wind, geothermal, biomass power plants for the development of Smart-grid or microgrid in future.

Course Contents:
Sources of renewable energy, importance and drawback of renewable energy sources.
Solar Energy: Solar PV: Statistics regarding solar radiation and wind speed. Insolation: geographical distribution, atmospheric factors, measurements. Solar cell: Construction, solar cell materials, principle of operation, spectral response, factors affecting conversion efficiency, I-V characteristics, Maximum power point (MPP), PV modules and arrays: stationary and tracking. PV systems: stand alone, battery storage, inverter interfaces with grid.
Solar Thermal: The selective surfaces, the working principle of flat plate solar collectors, its important components and its usage, Construction and working principle of concentrated solar power (CSP) station.
Wind Energy: Wind turbine generators: Construction, operational characteristics, cut-in and cut-out speed control, grid interfacings, AC-DC-AC link, Motion of wind, Energy and Power Calculation, Distribution of Wind Speed, Types of Wind Turbine, sizing and system design.
Biomass Energy: Types of biomass and application, Energy content in biomass, Biomass from quickly growing plants, Energy conversion process of biomass, Biomass based fuel, Application of Biomass energy: Biogas and Biofuel, Biomass gasifier, biogas digester, biomass energy calculations.
Geothermal Energy: Layout, construction, classification and working principle of geothermal power plant.
Other renewables: Mini and Micro-hydro, Tidal energy, Wave and marine current energy, Energy storage systems, pumped storage hydro, Fuel cell.
Renewable energy policies and recent trend in the development of renewable energy technologies.

Development status, policy and future development plans, Challenges and prospect of renewable energy development in Bangladesh, Potential of solar PV (utility scale, rooftop, floating solar PV) for power generation, wind potential (onshore and offshore) in Bangladesh, Global trend, Cost of renewable energy and development trend.

Resources:

Textbook(s):

[1] N. Jenkins and J. Ekanayake, *Renewable Energy Engineering*, 1st ed. Cambridge University Press, 2017.

[2] A. F. Zobaa and R. C. Bansal, Eds., *Handbook of Renewable Energy Technology*. World Scientific, 2011.

[3] V. K. Mehta and R. Mehta, *Principles of Power System*. S. Chand Publishing, 2005.

Reference(s):

[1] M. Kamran and M. R. Fazal, *Renewable Energy Conversion Systems*. Elsevier Bv., 2021.

[2] M. R. I. Sheikh, Ed., *Energy Storage*. Intechopen, 2010.

0713-436: Renewable Energy Laboratory

Course Code : 0713-436 **Course Title** : Renewable Energy Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:

This course provides experimental and project-oriented verification of different kinds of renewable based power systems. Sources of renewable energy, importance and drawback of renewable energy sources. Solar, wind, biomass, geothermal, and other renewables. Renewable energy prospects in Bangladesh will be detailed here.

Course Objectives:

The objectives of this course are to –

- Teach the importance of renewable energy resources and their types.
- Understand the ways to generate electricity from renewable resources.
- Make the students competent with renewable-based power system operation.
- Give the students in-depth knowledge on the prospects and challenges of renewable system in Bangladesh
- Make the student understand solar PV, solar thermal, wind, geothermal, biomass power plants and their integration and operation for the development of Smart-grid or microgrid in future.

Course Contents:

Laboratory experiments will be conducted based on the theory taught in 0713-435.

Resources:

Textbook(s):

[1] N. Jenkins and J. Ekanayake, *Renewable Energy Engineering*, 1st ed. Cambridge University Press, 2017.

[2] A. F. Zobaa and R. C. Bansal, Eds., *Handbook of Renewable Energy Technology*. World Scientific, 2011
[3] V. K. Mehta and R. Mehta, *Principles of Power System*. S. Chand Publishing, 2005.
Reference(s):
[1] M. Kamran and M. R. Fazal, *Renewable Energy Conversion Systems*. Elsevier Bv., 2021
[2] M. R. I. Sheikh, Ed., *Energy Storage*. Intechopen, 2010.

0713-437: Power System Operation and Control

Course Code : 0713-437 **Course Title** : Power System Operation and Control
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
With multiple interconnections between nearby power systems, modern power systems have risen in size. Advanced computer-based techniques are required for proper planning, operation, and control of such large power systems. The topics which are covered in this course have a great implication in Electricity generation, transmission and distribution systems. The main purpose of this course is to give the students in-depth knowledge on SCADA system, State estimation, unit commitment and electricity market.

Course Objectives:
The objectives of this course are to –
- Introduce the power system operation and its control mechanism.
- Provide the students with the requisite basic knowledge of the data acquisition technique.
- Make the students understand the process of controlled generation and meet the forecasted load.
- Introduce the electric market and its characteristics and operation.
- Give the idea about the power system security and state estimation.

Course Contents:
Vertically integrated vs. deregulated power system. Real-time operation: SCADA; EMS (energy management system); various data acquisition devices - RTU, IED, PMU, DFDR, WAMPAC (wide area monitoring, protection and control). Application functions: state estimation; short term load forecasting; unit commitment (UC); economic dispatch (ED); optimal power flow (OPF). Frequency control: generation and turbine governors, droop, frequency sensitivity of loads, ACE (area control error), AGC (Automatic Generation Control) and coordination with UC and ED; frequency collapse and emergency load shed.
Power system security: static and dynamic; security-constrained OPF. Electricity market operation: GenCos, ISO, DisCos, bidding, spot market, social welfare, market clearing price (MCP), locational marginal price (LMP), bilateral contracts and forward market hedging. Demand-side control: DMS (distribution management system), DSM112 (demand-side management), smart grid concept.

Resources:
Textbook(s):
[1] J. Grainger and W. Stevenson, *Power System Analysis*, 1st ed. McGraw Hill, 1994

[2] D. P. Kothari and J. S. Dhillon, *Power System Optimization*. PHI Learning, 2010.

Reference(s):
[1] P. Kundur, *Power System Stability and Control*, 1st ed. McGraw Hill, 1994.

0713-438: Power System Operation and Control Laboratory

Course Code : 0713-438 **Course Title** : Power System Operation and Control Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
This course will give a firm foundation in classical methodologies and modern approaches in power systems for diverse normal and fault scenarios, including operation, security, balanced and unbalanced fault, and transient stability assessments. The topics which are covered in this course have a great implication in electricity generation, transmission and distribution systems. The main purpose of this course is to give the students hands-on experience on SCADA system, State estimation, unit commitment and electricity market.

Course Objectives:
The objectives of this course are to –

- Introduce different data acquisition techniques and devices for the SCADA system.
- Study load forecasting techniques.
- Make the students skilled in determining the economic loading of generating units.
- Give the students in-depth knowledge on Automatic Generation Control.
- Make the students understand the Electric market and its behavior and control.

Course Contents:
Laboratory Experiments will be conducted based on the theory taught in 0713-437.

Resources:
Textbook(s):
[1] J. Grainger and W. Stevenson, *Power System Analysis*, 1st ed. McGraw Hill, 1994
[2] D. P. Kothari and J. S. Dhillon, *Power System Optimization*. PHI Learning, 2010.
Reference(s):
[1] P. Kundur, *Power System Stability and Control*, 1st ed. McGraw Hill, 1994.

TECHNICAL ELECTIVES

Power and Energy

Elective II (CO mapping default value)

0713-439: Special Machines

Course Code : 0713-439 **Course Title** : Special Machines
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
Bulk energy conversion is often done with conventional electrical machinery. Electrical machines, on the other hand, are utilized for specialized purposes. Position control systems, robotics and mechatronics, electric vehicles, and high-speed transit are all utilizing these equipment in increasing numbers. To understand the course, students have to know different types of special purpose machines and their characteristics which have higher efficiency, smaller size, useful for specific applications.

Course Objectives:
The objectives of this course are to –

- Make the students understand the theory, construction and design of several non-traditional machines.
- Enable students to apply in-depth analysis of several special purpose machines.
- Make the students familiar with many applications of several non-traditional machines.

Course Contents:
Series universal motor, permanent magnet DC motor, Unipolar and bipolar brush less DC motors, Stepper motor and control circuits.Reluctance and hysteresis motors with drive circuits, switched reluctance motor. Electrostatic motor, repulsion motor, synchronous and control transformers. Permanent magnet synchronous motors.Acyclic machines: Generators, conduction pump and induction pump. Magneto hydrodynamic generators, Fuel Cells, thermoelectric generators, flywheels, Vector control, linear motors and traction.Wind turbine generators: induction generator, AC-DC-AC conversion. Latest development in different types of electrical machines.

Resources:
Textbook(s):
[1] K. Venkataratnam, *Special Electrical Machines*. Universities Press, 2021.
Reference(s):
[1] A. E. Fitzgerald, C. Kingsley, and S. D. Umans, *Electric Machinery*, 6th ed. McGraw Hill, 2005

0713-441: Energy Economics

Course Code : 0713-441 **Course Title** : Energy Economics
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Energy economics is an elective course that offers those who will adapt power as a major. Energy economics is a large field of science that deals with the supply and consumption of energy in society. The efficiency with which energy may be generated is given economic relevance by considering the cost of energy services and their related value. The aim of this course is to make students enable to make and analyze energy policies that will solve the upcoming energy crisis.

Course Objectives:
The objectives of this course are to –

- Develop greater awareness of the micro issues associated with energy.
- Appreciate the critical contribution of energy to our domestic and global economy.
- Make students understand the demand for and supply of non-renewable energy, i.e. fossil fuels (viz. crude oil, natural gas, coal).
- Enable to compute electricity tariff calculation.

Course Contents:
Background and Introduction: Energy economics, Energy & Alternative Classifications of Energy, Global trend of Energy, The Historical Situation of Energy, and Relation between Energy Consumption, GDP and World Population, Energy system, Energy Balance Information, Energy intensity and Energy Elasticity.
Global Energy Supply and demand: Demand and supply Basics, Price formation in perfect market, Historical Trends in Global Energy Supply and Demand, Market, Market Regulation, Types of Regulation, The Regulatory Process, Market Competition, Price formation in a perfect market, Regulation and Deregulation.
Fossil Fuels Process of petroleum formation, Classification of petroleum, Process of Oil refining, Market of crude oil, OPEC Seizes Control: Oil Embargoes of 1973 and 1979, Are we running out of oil? Production of Natural gas, Delivery of Natural Gas, Transmission pipelines, Market for Natural Gas, natural gas market is smaller than oil market.
Energy Cost: Time Value of Money, Economics of Electricity Supply, Driving Factors for Power Plant Cost, General Concepts & Definitions in reference to Tariff calculation, Identification of Project Costs , Method of Cost calculation for a solar home system plant, Method of calculation of 150 MW capacity natural gas power plants, Comparison of cost for different technology.
Demand side management: The Global Need for Energy, Overview of World Energy Demand and Supply, Energy Demand Management, Evaluation of DSM, Justification for DSM, Approaches for energy Demand analysis, Demand elasticity, Energy Consumption by End-use Sector
Power Generation and Renewable energy: Variable Renewable energy resource and its challenges, Ancillary demand, Economics of RE.

Energy, Security and climate change: energy independence, Energy–Environment Interactions, Economics of the Environment Protection.

Resources:
Textbook(s):
[1] J. M. Griffin and H. B. Steele, *Energy Economics and Policy*, 2nd ed. Academic Press, 1986.
Reference(s):
[1] J. Evans and L. C. Hunt, *International Handbook on the Economics of Energy*. Cheltenham: Edward Elgar Pub, 2011

0713-443: Power System Reliability

Course Code : 0713-443 **Course Title** : Power System Reliability
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0713-223

Course Rationale:
Power System Reliability is one of the elective courses of Electrical and Electronic engineering. The topics which are covered in this course have a great implication in Electricity generation, transmission and distribution system. The main purpose of this course is to give the students in-depth knowledge on application of probability in power system operation, evaluation of reliability indices, tie line and interconnected systems.

Course Objectives:
The objectives of this course are to –

- Introduce with reliability of power system.
- Give the students requisite basic knowledge on probability, Probability distribution and its application in the electrical power system.
- Make the students understand about the reliability indices of power system.
- Introduce with the reliability evaluation techniques.

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

Resources:
Textbook(s):
[1] R. Billinton and R. N. Allan, *Reliability Evaluation of Engineering Systems: Concepts and Techniques*, 2nd ed. Springer, 1992
Reference(s):
[1] R. Billinton and R. N. Allan, *Reliability Evaluation of Power Systems*. Springer, 1996.

TECHNICAL ELECTIVES

Electronics

Elective I (CO mapping default value)

0714-445: VLSI Circuits

Course Code : 0714-445 **Course Title** : VLSI Circuits
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
This course covers basic theories and techniques of digital VLSI circuit design in CMOS technology. In this course, students will study the fundamental concepts and structures of designing digital VLSI systems ranging from CMOS devices and circuits, standard CMOS fabrication processes, CMOS design rules and layout, various circuit families and memory cells, subsystems design to testing VLSI circuits.

Course Objectives:
The objectives of this course are to –

- Make students understand basic integrated circuit technology and basic fabrication steps of a CMOS process.
- Teach them to design logic gates and create layouts of them.
- Make them competent in calculating the delay and power consumption of CMOS Circuits.
- Prepare students to design various types of memory cells and subsystems.
- Make students able to understand how to check VLSI circuits employing different fault models.

Course Contents:
VLSI technology: Top-down design approach, technology trends and design styles. Review of MOS transistor theory: Threshold voltage, body effect, I-V equations and characteristics, Noise Margins, NMOS inverter, CMOS inverter, CMOS gate design, pass-transistor and transmission gates, Buffer, Multiplexer, CMOS latches and Flip-Flops.
IC fabrication and Stick Diagram: Photolithography, CMOS process flow. Stick Diagram: Lambda-based layout design rules, CMOS circuit design process using stick diagram and area estimation.
CMOS circuit characteristics and performance estimation: Resistance, capacitance, rise and fall times, delay, gate transistor sizing and power consumption. Reliability issues: Latch-up, Electromigration.
Circuit Families: pseudo-NMOS, dynamic CMOS, clocked CMOS and CMOS domino logic.
CMOS circuit and logic design: Physical design of simple logic gates.
Memory elements design: 6 transistors static CMOS memory cell, 4 transistors dynamic memory cell, 3 transistor and 1 transistor dynamic memory cell.

CMOS subsystem design: Adders, multiplier and memory system, Arithmetic Logic Unit. Programmable Logic Arrays. I/O systems.
Testing VLSI circuits. Finite State Machine design: Design of Moore Type and Mealy type FSM using Verilog.

Resources:
Textbook(s):
[1] N. H. E. Weste and D. M. Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th ed. Pearson India, 2010.
Reference(s):
[1] N. H. E. Weste and K. Eshraghian, *Principles of CMOS VLSI Design*, 2nd ed. Addison Wesley, 1994.
[2] L. E. M. Brackenbury, *Design of Vlsi Systems: A Practical Introduction*, 1st ed. Scholium Intl, 1987.

0714-446: VLSI Circuits Laboratory

Course Code : 0714-446 **Course Title** : VLSI Circuits Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
This laboratory course aims to familiarize the students with the basics of VLSI circuit design as well as the analysis and simulation of VLSI circuits.

Course Objectives:

The objectives of this course are to-
- Familiarize students with Electric software for circuit design.
- Teach students to design and simulate logic gates.
- Make students capable of creating cells and layout of logic gates.
- Prepare students to design circuits with layouts using VLSI techniques.
- Get students introduced to VLSI circuit testing & debugging.

Course Contents:
Laboratory experiments will be conducted based on the theory taught in VLSI Circuits which includes design, layout and simulation of digital CMOS circuits using VLSI techniques.

Resources:
Textbook(s):
[1] D. Perry, *VHDL: Programming By Example*, 4th ed. McGraw-Hill Education, 2002.
[2] N. H. E. Weste and D. M. Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th ed. Pearson India, 2010.
[3] N. H. E. Weste and K. Eshraghian, *Principles of CMOS VLSI Design*, 2nd ed. Addison Wesley, 1994.
[4] N. K. Jha and S. Kundu, *Testing and Reliable Design of CMOS Circuits*. Springer, 1989.
Reference(s):
[1] L. E. M. Brackenbury, *Design of Vlsi Systems: A Practical Introduction*, 1st ed. Scholium Intl, 1987.

0714-447: Optoelectronic Devices

Course Code : 0714-447 **Course Title** : Optoelectronic devices
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
This course is designed to give an overview of optoelectronic device technology so that the students will be able to understand how optoelectronic devices work and how effectively one can couple this optical device in IC. The syllabus covers the basics of optoelectronics ranging from basic optics to semiconductor materials to optoelectronic device structures.

Course Objectives:
The objectives of this course are to -

- Make students understand the optical properties of the semiconductor.
- Prepare students to demonstrate different properties of light like particle and wave nature, polarization, interference, diffraction and black body radiation.
- Make students understand the working principle of various optoelectronic devices like LED, Lasers and Photo Detectors.

Course Contents:
Optical properties in semiconductors: Direct and indirect band-gap materials, radiative and non-radiative recombination, optical absorption, photo-generated excess carriers, minority carrier lifetime, luminescence and quantum efficiency in radiation.
Properties of light: Particle and wave nature of light, photoelectric effect, polarization, interference, diffraction and blackbody radiation.
Light-emitting diode (LED): Principles, materials for visible and infrared LED, internal and external efficiency, loss mechanism, structure and coupling to optical fiber, surface and edge-emitting LEDs.
Stimulated emission and light amplification: Spontaneous and stimulated emission, Einstein relations, population inversion, absorption of radiation, threshold conditions.
Semiconductor Lasers: Population inversion, laser cavity, operating wavelength, threshold current density, power output, hetero-junction lasers, optical and electrical confinement. Introduction to quantum well lasers.
Photodetectors: Photoconductors, junction photodetectors, PIN detectors, avalanche photodiodes and phototransistors.
Solar cells: Solar energy and spectrum, silicon and Schottky solar cells.
Modulation of light: Phase and amplitude modulation, acousto-optic effect and magneto-optic devices.
Introduction to integrated optics.

Resources:
Textbook(s):
[1] J. Wilson and J. Hawkes, *Optoelectronics: An Introduction*, 3rd ed. Prentice Hall, 1998.
[2] A. Yariv, *Optical Electronics in Modern Communications*, 5th ed. Oxford University Press, 1997.
Reference(s):
[1] J. M. Senior, *Optical Fiber Communications: Principles and Practice*, 3rd ed. Pearson, 2008.
[2] K. A. Jones, *Introduction to Optical Electronics*. Harper & Row, 1987.

[3] C. L. Wyatt, *Electro-Optical System Design: For Information Processing*, 2nd ed. McGraw-Hill, 1991.

0714-448: Optoelectronics Devices Laboratory

Course Code : 0714-448 **Course Title** : Optoelectronics Devices Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
The course will be suitable for undergraduate seniors who need greater theoretical and practical knowledge of semiconductor-based optoelectronic devices and electronic analog circuits used to interface them, and solar cells

Course Objectives:
The objectives of this course are to-

- Make students able to calculate absorption characteristics and spontaneous emission characteristics of materials.
- Teach students how to analyze reflection, transmission, radiative and non-radiative recombination of light in semiconductors.
- Capable students to describe the light-current-voltage relationships of LEDs, laser diodes, and photodiodes and demonstrate how to measure associated parameters.
- Make students able to calculate gain and threshold characteristics of lasers and to identify lasing modes.
- Make students able to analyze output performances of ideal and practical solar cells based on solar irradiation condition, operating temperature, diode ideality factor, series and shunt resistances

Course Contents:
Light Absorption and Emission Properties of Materials: Numerical calculation of absorption characteristics of materials and analysis of spontaneous emission characteristics of materials.
Reflection, Transmission, Radiative and Non-Radiative Recombination of Light in Semiconductors: numerical calculation of reflection and transmission of light incident onto a semiconductor, analysis of radiative and non-radiative recombination rates in a semiconductor, and determine the internal quantum efficiency of material from the recombination rates.
Characterization of Light Emitting Diodes (LEDs): Calculation of (i) output spectrum, (ii) output optical power (L) -current (I) characteristics, and (iii) I-V characteristics of LED.
Study of the gain and threshold characteristics of lasers: calculation of the gain line shape of lasers and locating competing lasing modes, calculation of the threshold gain and understanding its dependence on cavity parameters, identification of lasing modes, and study the effects of population inversion on the number of lasing modes.
Study of Ideal and Practical Solar Cells: analysis of output performances of ideal and practical solar cells based on solar irradiation condition, operating temperature, diode, ideality factor, series and shunt resistances.

Resources:
Textbook(s):
[1] P. Bhattacharya, *Semiconductor Optoelectronic Devices*, 2nd ed. Prentice Hall, 1996.
[2] S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 3rd ed. Wiley-Interscience, 2006.
Reference(s):
[1] S. Kasap, *Optoelectronics and Photonics: Principles and Practices*, 2nd ed. Pearson, 2012.

0714-449: Biomedical Electronics

Course Code : 0714-449 **Course Title** : Biomedical Electronics
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
Biomedical electronics is a course related to the application of engineering principles and design concepts to medicine and biology for healthcare purposes. This course will provide a basic knowledge to measure and analyze bio signals. The main focus of this course is to develop the ability to interpret and diagnose bio signals to solve problems in the field of biomedical science

Course Objectives:
The objectives of this course are to-

- Introduce human anatomy and its parameters.
- Make the students understand the basic signals in the field of biomedical.
- Familiarize the students about the origins and characteristics of some of the most commonly used biomedical signals.
- Teach the fundamentals of transducers, amplifiers and filters as applicable to physiology.
- Prepare students to apply various electronic systems for diagnosis and monitoring of bio-signal.

Course Contents:
Human body: Cells and physiological systems. Bioelectricity: genesis and characteristics, bio-electric potential.
Measurement of bio-signals: Ethical issues, transducers, amplifiers and filters, noise in bio-signal, Measurement and detection of blood pressure.
Electronic System: Electrocardiogram, electronic manometer, Plethysmography and electromagnetic flow meter. Electroencephalogram, cerebral angiography and chronicle X-ray. Brain scans. Electromyogram (EMG). Tomograph, Magnetic resonance imaging, Ultrasonogram. Patient monitoring system and medical telemetry. Therapeutic devices: cardiac pacemakers and defibrillators. Electrical safety in bio instrumentations and sensing.

Resources:
Textbook(s):
[1] L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, *Biomedical Instrumentation and Measurements*, 2nd ed. Pearson, 1979.
Reference(s):
[1] J. G. Webster, Ed., *The Measurement, Instrumentation and Sensors Handbook*, 1st ed. CRC Press, 1998.

0714-450: Biomedical Electronics Laboratory

Course Code : 0714-450 **Course Title** : Biomedical Electronics Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
This course will be suitable for undergraduate seniors who will acquire knowledge on medical instrumentation to carry out design projects and for conducting research in biomedical instrumentation.

Course Objectives:
The objectives of this course are to-

- Introduce the students with analog and digital circuit analysis - the use of resistor networks, capacitors and inductors, steady-state and dynamic circuit behaviour, active circuits, amplifiers, logic gates, combinatorial and sequential circuits, A/D conversion for biomedical applications.
- Teach them the acquisition of basic biomedical signals using data acquisition systems and processing of the acquired data with appropriate software such as MATLAB.
- Develop the students to design appropriate data acquisition circuits for acquiring appropriate biomedical signals.
- Make the students understand electrical safety in biomedical circuits and applications.
- Prepare students to design a Patient Monitoring System

Course Contents:
Perform experiments based on 0714-449.

Resources:
Textbook(s):
[1] L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, *Biomedical Instrumentation and Measurements*, 2nd ed. Pearson, 1979.
Reference(s):
[1] J. G. Webster, Ed., *The Measurement, Instrumentation and Sensors Handbook*, 1st ed. CRC Press, 1998.

TECHNICAL ELECTIVES

Electronics

Elective II (CO mapping default value)

0714-451: Solid State Devices

Course Code : 0714-451 **Course Title** : Solid State Devices
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
This course provides the graduate-level introduction to understand, analyze, characterize and design the operation of semiconductor devices such as transistors, diodes, solar cells, light-emitting devices, and more. The course will primarily appeal to electrical engineering students whose interests are in applications of semiconductor devices in circuits and systems. The treatment is physics-based, provides derivations of the mathematical descriptions, and enables students to quantitatively analyze device internal processes, analyze device performance, and begin the design of devices given specific performance criteria.

Course Objectives:
The objectives of this course are to -

- Make the student understand the characteristics and operations of semiconductor devices.
- Familiarize them with the physical concept behind the operation of semiconductor devices.
- Make the students capable of understanding the operation of different transistors made of semiconductor materials.

Course Contents:
Semiconductors in Equilibrium: Energy bands, intrinsic and extrinsic semiconductors, Fermi levels, electron and hole concentrations, temperature dependence of carrier concentrations, and invariance of Fermi level.
Carrier Transport Processes and Excess Carriers: Drift and diffusion, generation and recombination of excess carriers, built-in-field, recombination-generation SRH formula, surface recombination, Einstein relations, continuity and diffusion equations for holes and electrons and quasi-Fermi level.
PN Junction: Basic structure, equilibrium conditions, contact potential, equilibrium Fermi level, space charge, non-equilibrium condition, forward and reverse bias, carrier injection, minority, and majority carrier. Currents, transient and AC conditions, time variation of stored charge, reverse recovery transient, and capacitance.
Bipolar Junction Transistor: Basic principle of PNP and NPN transistors, emitter efficiency, base transport factor and current gain, diffusion equation in the base, terminal currents, coupled-diode model and charge control analysis, Ebers-Moll model, and circuit synthesis. BJT non-ideal effects; Hetero-junction transistors.

Metal-Semiconductor Junction: Energy band diagram of metal-semiconductor junctions, rectifying and ohmic contacts.
MOS Structure: MOS capacitor, energy band diagrams and flat band voltage, threshold voltage and control of threshold voltage, static CV characteristics, qualitative theory of MOSFET operation, body effect, and current-voltage relationship of a MOSFET. Non-ideal characteristics of MOSFET: channel-length modulation and short channel effects in MOSFETs. MOS scaling.
Introduction to Multigate FET Architecture: Double gate MOSFET, FinFET, Surrounding gate FET, high- K dielectric FETs.

Resources:
Textbook(s):
[1] S. Kasap, *Principles of Electronic Materials and Devices*, 4th ed. McGraw Hill, 2017.
[2] D. A. Neamen, *Semiconductor Physics and Devices: Basic Principles*, 4th ed. McGraw Hill, 2011.
Reference(s):
[1] B. Streetman and S. Banerjee, *Solid State Electronic Devices*, 7th ed. Pearson, 2014

0714-453: Compound Semiconductor Devices

Course Code : 0714-453 **Course Title** : Compound Semiconductor Devices
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
Compound semiconductor-based heterostructures are very promising in the field of semiconductor devices. To learn about heterostructure devices, several theories and definitions need to be learned. The purpose of this course is to make students learn the theories, applications and make them able to analyse the characteristics of those devices.

Course Objectives:
The objectives of this course are to -

- Introduce students to the basics of compound semiconductors and their application-specific characteristics.
- Teach students the concept of heterostructure devices.
- Make students introduced to different applications of heterojunctions in practical devices.
- Prepare them to analyze different heterostructure devices.
- Make students able to identify challenges and solutions regarding the heterojunction devices.

Course Contents:
Introduction to Semiconductor Physics and Hetero-Junctions:
Energy band and energy gap, carrier concentration, thermal equilibrium, carrier transport phenomenon, Zinc-blend crystal structures, growth techniques, alloys, bandgap, basic optoelectronic properties, the density of carriers in intrinsic and doped compound semiconductors.

Materials, band alignment, band offset and Anderson's rule in heterojunctions, Single and double-sided hetero-junctions, quantum wells and quantization effects, lattice mismatch, and strain.
Hetero-Junction Diode: Band banding, carrier transport and I-V characteristics.
Hetero-Junction Field-Effect Transistor: Structure and principle, band structure, carrier transport, I-V characteristics, non-ideal effects, quasi-static analysis, extended Gummel-Poon model, Ebers-Moll model and frequency response of heterojunction bipolar transistor (HBT).
Structure and principle, band structure, carrier transport, I-V characteristics of high electron mobility transistor (HEMT).
Optical devices: Application of the physics of heterostructure in the analysis of MQW LED and LASER.
Resonant Tunnelling Devices: Physics and operation of resonant tunneling diodes, device physics, operation and characteristics of resonant tunneling transistor.

Resources:
Textbook(s):
[1] D. A. Neamen, *Semiconductor Physics and Devices: Basic Principles*, 4th ed. McGraw Hill, 2011.
Reference(s):
[1] M. Shur, *Physics of Semiconductor Devices*, 1st ed. Pearson, 1990.
[2] S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 3rd ed. Wiley-Interscience, 2006.

0714-455: Nano-electronics and Nanotechnology

Course Code : 0714-455 **Course Title** : Nano-electronics and Nanotechnology
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
Nano-electronics and Nanotechnology is an advanced course in the field of electronics. Nanotechnology is the near-atomic manipulation of matter to create new structures, materials, and technologies. Many fields, including medical, consumer goods, energy, materials, and manufacturing, will benefit from the technology. This course will provide knowledge regarding the approaches of electronic devices in molecular scale, describe the electron at the nanoscale and introduce quantum mechanics including quantization, the wave-particle duality, wave functions. The main focus of this course is to develop the ability to interpret and apply technology to solve problems in the field of electronics.

Course Objectives:
The objectives of this course are to-
- Teach the basics of electronics, transistors, band structure models, Nano capacitors.
- Familiarize the students with the basics of Nanomaterials, Nanoscience and technology.
- Make the students develop a deep understanding of micro and Nano systems, their design and various applications as well as micro and Nano fabrication techniques.

Course Contents:

Basic concepts: 3D, 2D, 1D carriers, DOS, carrier densities, directed moments, quantized conductance, semi classical carrier transport, ballistic transport (classical and quantum).

The MOSFET: MOS electronics: the MOS capacitor, MOSFET energy bands vs. bias, 2D electrostatics (the geometrical scaling factor). MOSFET current-voltage characteristics: General expression, linear region current, saturation region current (long channel), saturation region current (velocity saturated), full-range (above threshold and sub-threshold).

The bipolar transistor: Device structure, I-V characteristics, MOSFET as a bipolar transistor.

CMOS technology: the CMOS inverter and digital gates, device, circuit and system, figures of merit, MOSFET scaling, system considerations.

The ballistic MOSFET: the mean-free paths and L, ballistic I-V ($T > 0$ non-degenerate, $T = 0$ degenerate and $T > 0$), numerical simulation of the ballistic MOSFET. Scattering theory of the MOSFET: I-V in terms of the transmission coefficient, the transmission coefficient (low and high), the mean-free path for backscattering.

Beyond the silicon MOSFET (the Carbon Nanotube FET): carbon nanotubes, band-structure basics, MIS electrostatics of carbon nanotube capacitors, theory of the ballistic CNTFET, CNTFETs vs. MOSFETs, discussion.

Resources:

Textbook(s):

[1] S. Lindsay, *Introduction to Nanoscience*. Oxford: Oxford University Press, 2009.

[2] V. V. Mitin, V. A. Kochelap, and M. A. Stroscio, *Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications*. Cambridge: Cambridge University Press, 2008.

Reference(s):

[1] M. Lundstrom, Ed., *Lessons from Nanoscience: A Lecture Notes*. World Scientific, 2012.

TECHNICAL ELECTIVES

Communication and Signal Processing

Elective I (CO mapping default value)

0714-457: Telecommunication Engineering

Course Code : 0714-457 **Course Title** : Telecommunication Engineering
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
To understand telecommunication engineering students, have to know the basic structure and classification of telecommunication system, switching system, traffic analysis, architecture of different types of networks and network layer and spread-spectrum analysis. The purpose of this course is to teach students the fundamental concepts and modern hierarchy of telecommunication systems.

Course Objectives:
The objectives of this course are to -

- Equip students with the necessary background and technical knowledge for Telecommunications systems.
- Teach students to establish interconnection between all nodes on a network.
- Prepare students to analyse traffic systems.
- Equip students with the necessary background and technical knowledge for Telecommunications systems.
- Teach students to establish interconnection between all nodes on a network.
- Prepare students to analyse traffic systems.
- Introduce students to technology of modern telephone services and network.

Course Contents:
Basic of telecommunication networks including National and International regulatory bodies, Telephone apparatus, Telephone Exchanges, subscriber loop, supervisory tones, PSTN, Wireless Adhoc Networks, Wireless Sensor Networks.
Analog and digital switching systems including Strowger and Crossbar switching systems, Stored program control (SPC) systems, Space division switching, time division switching, blocking probability and multistage switching, and digital memory switch, Circuit switching and hybrid switching, Virtual circuit and datagrams, routing.
Traffic Analysis: Traffic characterization, grades of service, network blocking probabilities, delay system and queuing.
Modem telephone services and network: Internet telephony, facsimile, integrated services digital network, asynchronous transfer mode and intelligent networks, spread-spectrum techniques, network layer.

Resources:
Textbook(s):
[1] F. Mazda, Ed., *Telecommunications Engineer's Reference Book*, Focal Press, 1998
Reference(s):
[1] Ericsson, *GSM System Survey*. Pearson, 2002.

0714-458: Telecommunication Engineering Laboratory

Course Code : 0714-458 **Course Title** : Telecommunication Engineering Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
To understand telecommunication engineering students have to know the basic structure and classification of telecommunication systems, switching system, traffic analysis, architecture of different types of networks and network layer and spread-spectrum analysis. The purpose of this course is to teach students the fundamental concepts and modern hierarchy of telecommunication systems.

Course Objectives:
The objectives of this course are to -

- Make understand the generation of AM signals using different modulation processes (DSB-LC, DSB-SC), the reception of FM signals and the structures of various FM demodulators.
- Develop an understanding of the fundamentals of sampling and pulse modulation with pulse amplitude modulation (PAM), pulse-width modulation (PWM), and pulse-position modulation (PPM) techniques.
- Make students capable of analysing switching systems and characterize them.
- Learn the concept of PSTN.

Course Contents:
Basics of modulation technique in telecommunication networks including AM, FM, PAM, PWM, PPM.
Local signaling and line scan. Analog and digital switching systems including switching principles, operation, configuration, transition of switching centre and switching call.
Testing and traffic measurements.
Basic principle of PSTN, VoIP, voice handling in PSTN, switching in PSTN and IP networks.

Resources:
Textbook(s):
[1] F. Mazda, Ed., *Telecommunications Engineer's Reference Book*, Focal Press, 1998
Reference(s):
[1] Ericsson, *GSM System Survey*. Pearson, 2002.

0714-459: Optical Fiber Communication

Course Code : 0714-459 **Course Title** : Optical Fiber Communication
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
This is an elective course under the Communication major group of the department which will provide needful theoretical and practical knowledge on basic elements of optical fiber transmission, photodetectors and optical amplifiers.

Course Objectives:
The objectives of this course are to –

- Teach the basic elements of optical fiber transmission link, fiber modes configurations and structures.
- Make students capable of understanding different kind of losses, signal distortion, SM fibers.
- Teach about the various optical sources, materials and fiber splicing.
- Make them understand about fiber optical receivers and noise performance in photo detector.
- Explain the different types of optical amplifier.

Course Contents:
Introduction to optical fiber communication, Overview of optical fiber communications, Light propagation through optical fiber: Ray optics theory and mode theory.
Optical fiber: Types and characteristics, transmission characteristics, Geometrical-optics description, wave propagation, dispersion in single-mode fibers, dispersion induced limitations, fiber losses, nonlinear optical effects, fiber manufacturing, fiber joints and fiber couplers.
Optical transmitters and light sources: basic concepts, light-emitting diodes, semiconductor lasers, laser diodes, control of longitudinal modes, laser characteristics, transmitter design.
Detectors: PIN photodetector and avalanche photodetectors. Receiver analysis: receiver design, receiver noise, receiver sensitivity, sensitivity degradation, receiver performance, direct detection and coherent detection, noise and limitations.
Transmission limitations: Chromatic dispersion, nonlinear refraction, four-wave mixing and laser phase noises.
Optical amplifier: Laser and fiber amplifiers, SOA, Raman amplifiers, EDFA, applications and limitations. Multi-channel optical system: Frequency division multiplexing, wavelength division multiplexing and co-channel interference, Radio on fiber technology, Fiber optic access network.

Resources:
Textbook(s):
[1] J. M. Senior, *Optical Fiber Communications: Principles and Practice*, Pearson, 2008.
Reference(s):
[1] G. P. Agrawal, *Fiber-Optic Communication Systems*. Wiley, 1997.

0714-460: Optical Fiber Communication Laboratory

Course Code : 0714-460 **Course Title** : Optical Fiber Communication Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
This is an elective course under the Communication major group of the department and the course will be suitable for undergraduate seniors who need greater theoretical and practical knowledge on basic elements of optical fiber transmission, photodetectors and optical amplifiers.

Course Objectives:
The objectives of this course are to –

- Teach students practically the basic elements of optical fiber transmissions.
- Make them understand practically and calculate the different kind of losses, signal distortion.
- Impart the knowledge of the fiber optical receivers and noise performance in photo detector.
- Make them understand practically the transmission of information through optical fiber.

Course Contents:
Optical fiber, Optical transmitters and light sources, Detectors, Transmission limitations, Optical amplifier: Laser and fiber amplifiers, SOA, Raman amplifiers, EDFA, applications and limitations. Multi-channel optical system: Frequency division multiplexing, wavelength division multiplexing and co-channel interference, Radio on fiber technology, Fiber optic access network.

Resources:
Textbook(s):
[1] J. M. Senior, *Optical Fiber Communications: Principles and Practice*, Pearson, 2008.
[2] J. Hayes, *The FOA Reference Guide to Fiber Optic Network Design*. CreateSpace Independent Publishing Platform, 2016.
Reference(s):
[1] G. P. Agrawal, *Fiber-Optic Communication Systems*. Wiley, 1997.

0714-461: Microwave Engineering

Course Code : 0714-461 **Course Title** : Microwave Engineering
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
Analysis of radiation is crucial while dealing with today's wireless communication systems. Therefore, herein, concepts of microwave and field theories will be taught to develop a fundamental theoretical knowledge-base of the students regarding waveguide structure formation, waveguide characteristics, antennas to be used in a specific scenario, and relevant

radiation pattern. After completing this course, students will be able to analyse practically used antennas and associated parameters.

Course Objectives:
The objectives of this course are to –

- Comprehend the voltage-current analogy of different microwave transmission lines.
- Show the use of Smith chart in impedance matching and the calculation different parameters.
- Introduce the boundary conditions and Maxwell's equations to obtain the modal solutions of an arbitrary waveguide structure.
- Formulate the wave propagation characteristics of different rectangular and circular waveguides.

Course Contents:
Transmission lines: Voltage and current in ideal transmission lines, reflection, transmission, standing wave ratio, impedance transformation, Smith chart, impedance matching and lossy transmission lines.
Waveguides: general formulation, modes of propagation and losses in parallel plate, rectangular and circular waveguides.
Microstrips: Structures and characteristics, rectangular resonant cavities, energy storage, losses and radiation, small current element, radiation resistance, radiation pattern and properties, Hertzian and halfwave dipoles.
Antennas: Mono pole, horn, rhombic and parabolic reflector, array, and Yagi-Uda antenna.

Resources:
Textbook(s):
[1] D. M. Pozar, *Microwave Engineering*, 4th ed. Hoboken, NJ: Wiley, 2011.
[2] C. A. Balanis, *Antenna Theory: Analysis and Design*, 4th ed. Wiley, 2016.
Reference(s):
[1] S. Y. Liao, *Microwave Devices and Circuits*. Englewood Cliffs, N.J: Prentice Hall, 1996.

0714-462: Microwave Engineering Laboratory

Course Code : 0714-462 **Course Title** : Microwave Engineering Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
In this course, students will be introduced to different microwave components and their general working principles, the characteristic impedance of transmission line, Standing wave ratio (SWR), Smith chart and its application for unknown impedance measurement etc. The purpose of this course is to teach students the fundamental concepts of microwave engineering and give them hands-on practical experiences.

Course Objectives:
The objectives of this course are to –

- Introduce different microwave components and their working principle.
- Measure the characteristic impedance of the transmission line.

- Make students capable of measuring the characteristics parameter of the different waveguides.
- Make the students capable of analyzing the unknown load impedance of a terminated transmission line by measuring VSWR and using smith chart.

Course Contents:
Perform experiments and design projects based on 0714-461.

Resources:
Textbook(s):
[1] D. M. Pozar, *Microwave Engineering*, 4th ed. Hoboken, NJ: Wiley, 2011.
[2] C. A. Balanis, *Antenna Theory: Analysis and Design*, 4th ed. Wiley, 2016.
Reference(s):
[1] S. Y. Liao, *Microwave Devices and Circuits*. Prentice Hall, 1996.

TECHNICAL ELECTIVES

Communication and Signal Processing

Elective II (CO mapping default value)

0714-463: Wireless and Cellular Communication

Course Code : 0714-463 **Course Title** : Wireless and Cellular Communication
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
The aim of this course is to get students introduced to cellular communication and its different aspects which helps them to cope with the rapidly growing communication sector.

Course Objectives:
The objectives of this course are to –

- Make students introduced to Analog and digital cellular systems.
- Make students capable in frequency management and channel assignment.
- Make students introduced with handoffs and dropped calls.
- Get students introduced to diversity techniques.
- Get students introduced to evolutions of digital cellular systems: GSM, TDMA and CDMA.

Course Contents:
Introduction: Concept, evolution and fundamentals. Analog and digital cellular systems.
Cellular Radio System: Frequency reuse, co-channel interference, cell splitting and components. Mobile radio propagation: Propagation characteristics, models for radio propagation, antenna at the cell site and mobile antenna.
Frequency Management and Channel Assignment: Fundamentals, spectrum utilization, fundamentals of channel assignment, fixed channel assignment, non-fixed channel assignment, traffic and channel assignment.
Handoffs and Dropped Calls: Reasons and types, forced handoffs, mobile-assisted handoffs and dropped call rate.
Diversity Techniques: Concept of diversity branch and signal paths, carrier to noise and carrier to interference ratio performance.
Digital cellular systems: Global system for mobile, time division multiple access and code division multiple access.

Resources:
Textbook(s):
[1] G. L. Stüber, *Principles of Mobile Communication*, 3rd ed. New York: Springer, 2011.
Reference(s):
[1] T. S. Rappaport, *Wireless Communications: Principles and Practice*. Upper Saddle River, N.J: Prentice Hall, 2002.

0714-465: Random Signal Processing

Course Code : 0714-465 **Course Title** : Random Signal Processing
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0542-221

Course Rationale:
Random Signals and Processes is a basic requirement course of Electrical and Electronic Engineering. Understanding the fundamentals of probability theory and random processes and signals is a requirement for students aiming to further study communications, signal processing, information and coding, and other fields.

Course Objectives:
The objectives of this course are to –

- Make students understand the fundamental concepts of probability theory and its applications.
- Prepare students to analyze and synthesize real-life scenarios in which probability and its associated concepts can be measured.
- Make students understand the fundamental concepts of probability theory and its applications
- Introduce the students to stochastic processes and their importance.

Course Contents:
Probability and its applications, Bayes's theorem, conditional probability and various applications of conditional probability including those in real life.
Random variables and related parameters: expectation, variance, moments, distribution functions, specialized inequalities such as Chebyshev's and Markov's inequalities
Specified probability distributions: Bernoulli, binomial, Poisson, geometric, exponential, Erlang, uniform, normal.
Bivariate random variables and related parameters
Introduction to the power spectrum, covariance, and correlation.

Resources:
Textbook(s):
[1] O. C. Ibe, *Fundamentals of Applied Probability and Random Processes*, 1st ed. Academic Press, 2005.
[2] S. Miller and D. Childers, *Probability and Random Processes: With Applications to Signal Processing and Communications*. Academic Press, 2012.
Reference(s):
[1] A. Papoulis and U. Pillai, *Probability, Random Variables and Stochastic Processes with Errata Sheet*, 4th ed. Boston, Mass.: McGraw-Hill Europe, 2002.
[2] P. Peebles, *Probability, Random Variables, and Random Signal Principles*, 4th ed. New York: McGraw-Hill Science, 2000.

0714-467: Digital Filter Design

Course Code : 0714-467 **Course Title** : Digital Filter Design
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-221

Course Rationale:
Digital Filter Design is an advanced course on Digital Signal Processing. Digital filters and other signal processing algorithms have become a way of life, since many communication tasks have gone digital. The purpose of this course is to enable the students to perform frequency domain analysis effectively and design optimum digital filters depending on the requirements of a system. In this course, students will be able to apply their knowledge for designing optimum systems with help of DSP.

Course Objectives:
The objectives of this course are to –

- Familiarize the students with the fundamental concepts of open-loop and closed-loop systems.
- Prepare students to represent and analyze control systems.
- Make the students capable of implementing the various techniques of control systems to design a controller under specific conditions.
- Familiar students with different filter structures and their implementation limitations.
- Prepare students to perform spectral estimation methods for frequency-domain analysis.
- Improve students understanding of adaptive filtering methods and their various applications in system designing.

Course Contents:
Discrete-Time Signal Processing: Sampling, interpolation, and decimation; Fast Fourier Transform (FFT), fast convolution by FFT using the overlap-save or overlap-add methods.
Filter Designing: IIR and FIR filter design and implementation issues: filter structures, coefficient quantization and sensitivity, finite wordlength arithmetic or signal quantization, limit cycles, noise shaping.
Spectral Estimation Methods: Introduction, Non-Parametric Methods, Minimum Variance Spectrum Estimation, Parametric Methods
Adaptive Filtering: Introduction, FIR Adaptive Filtering, Adaptive Recursive Filters, Recursive Least Squares.

Resources:
Textbook(s):
[1] S. K. Mitra, *Digital Signal Processing: A Computer-Based Approach*, 2nd ed. McGraw-Hill Higher Education, 2001.
[2] S. O. Haykin, *Adaptive Filter Theory*, 5th ed. Pearson, 2013.
[3] M. H. Hayes, *Statistical Digital Signal Processing and Modeling*, 1st ed. Wiley, 1996.
Reference(s):
[1] A. Oppenheim and R. Schafer, *Discrete-Time Signal Processing*, 3rd ed. Pearson, 2009.

0714-481: Satellite and Radar Communication

Course Code : 0714-481 **Course Title** : Satellite and Radar Communication
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
To understand Satellite and Radar Communication students, have to know the basic structure and classification of Satellite and Radar system, satellite orbits, satellite frequency bands, architecture of different types of multiple access techniques, propagation channel, basic satellite networking and basics of radar signal propagation and detection. The purpose of this course is to teach students the fundamental concepts and modern hierarchy of Satellite and Radar Communication systems.

Course Objectives:
The objectives of this course are to -

- Equip students with the necessary background and technical knowledge for Satellite and Radar communication systems.
- Teach students to establish interconnection between all satellite orbits.
- Prepare students to analyse different Satellite frequency bands.
- Prepare students to analyse radar signals, noise and clutter.
- Introduce students to technology of modern radar transmitter and receivers services and networks.

Course Contents:
Introduction to Satellite Communication, Satellite frequency bands, satellite orbits, satellite types, regulation of the spectrum and interference, propagation channel, air interfaces, link budget analysis, Digital Modulation, Error Correction Codes, Multiple Access, receiver synchronization, baseband processing, fixed and mobile applications, basics of satellite networking.
Radar equation, radar cross section, information contents in radar signals, noise and clutter, radar detectors, Doppler and MTI radar, pulse compression, CW and FM-CW radar, radar transmitter and receivers, introduction to polarimetric radar and synthetic aperture radar.

Resources:
Textbook(s):
[1] D. Roddy, *Satellite Communications*, 4th ed. New York: McGraw Hill, 2006.
[2] W. A. Imbriale, S. (Shichang) Gao, and L. Boccia, "System Architectures of Satellite Communication, Radar, Navigation and Remote Sensing," in *Space Antenna Handbook*, Wiley, 2012, pp. 76–105
Reference(s):
[1] A. K. Maini and V. Agrawal, *Satellite Communications*. Wiley, 2010.
[2] M. Skolnik, *Introduction to Radar Systems*, 3rd ed. McGraw-Hill Education, 2002.

TECHNICAL ELECTIVES

Computer and Information Technology

Elective I (CO mapping default value)

0714-469: Microprocessor System Design

Course Code : 0714-469 **Course Title** : Microprocessor System Design
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-411

Course Rationale:
This course introduces the principles and applications of microprocessors. Topics emphasized are embedded microprocessor architecture and organization in detail incorporation with High-Level Language (HLL), as well as fundamentals of designing and interfacing in microprocessor-based embedded systems. This course provides a brief understanding of the fundamentals of microprocessor operation, writing coherent and error-free HLL programs, and designing basic interfacing circuits for microprocessor-based embedded systems which are targeted for biomedical or health care applications using HLL completely with confidence.

Course Objectives:
The objectives of this course are to –

- Introduce students to the Embedded System Design
- familiarize with Microcontroller Units
- learn the students how to design the embedded system with C Programming
- Prepare students to analyze the Peripheral Programming, Sensor Interfacing and Application Specific MCU.

Course Contents:
Limitations of 16-bit processors. 32-bit microprocessors (Intel 80386/80486, Motorola 68000) internal architecture, addressing modes, instructions, memory and I/O interfaces system design, programming, applications to industrial process control.
Embedded processors architecture, advanced port, programming, and controller design for adjustable speed motor devices.

Resources:
Textbook(s):
[1] Y. Yu and C. Marut, *Assesmbly Language Programming and Organization IBM PC*, 1st ed. New York: McGraw-Hil, 1992.
Reference(s):
[1] A. P. Malvino and J. A. Brown, *Digital Computer Electronics*, 3rd ed, McGraw Hill, 1992.
[2] D. V. Hall, *Microprocessors and Interfacing*. McGraw Hill Higher Education, 2005.

0714-470: Microprocessor System Design Laboratory

Course Code : 0714-470 **Course Title** : Microprocessor System Design Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-411

Course Rationale:
The Microprocessor design laboratory course consists of two parts that are used to provide intensive practical exposure to the students in the field of microprocessor architecture and industrial control through them. In the first part, students will perform experiments to verify practically the theories and concepts learned in Microprocessor System Design. In the second part, students will design simple systems using the principles learned in Microprocessor System Design.

Course Objectives:
The objectives of this course are to –

- Make students understand microprocessor architecture and Microprocessor-based System.
- Prepare students to implement different theories and concepts for microprocessor and Microprocessor-based System.
- Enable to design different microprocessor-based embedded system.

Course Contents:
Laboratory experiments will be conducted based on the theory taught in 0714-469.

Resources:
Textbook(s):
[1] Y. Yu and C. Marut, *Assesmbly Language Programming and Organization IBM PC*, 1st ed. New York: McGraw-Hill/Irwin, 1992.
Reference(s):
[1] A. P. Malvino and J. A. Brown, *Digital Computer Electronics*, 3rd ed, McGraw Hill, 1992.
[2] D. V. Hall, *Microprocessors and Interfacing*. McGraw Hill Higher Education, 2005.

0714-471: Web Design and Software Development Fundamentals

Course Code : 0714-471 **Course Title** : Web Design and Software Development Fundamentals
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0613-222

Course Rationale:
In the modern world, knowledge of information and technology is very essential, especially for an EEE graduate who will be working with networking, automation, IOT. This introductory course of web and software will help to understand the application of software engineering principles and techniques to the development, deployment, and maintenance of high-quality Web-based systems and applications. The course addresses the concepts, methods, technologies, and techniques of developing Web sites that collect, organize and expose information resources.

Course Objectives:

The objectives of this course are to –

- Familiarize the students with the basic of web engineering and the basic of software development
- Make students able to test the stability of a software.
- Familiarize students with the requirements of a client for a web or software with critical reasoning.
- Make students able to build software and develop a web.

Course Contents:

Web File Management: Files and Folders, Downloading Web Pages, Editing Code, Zipping Folders, Designers Lounge: The Web Development Process, Zipping folders and Submitting Work, HTML Tags, Choosing a Website Topic, Overview of HTML Tags, The HTML Template, The Head, Formatting Content, Compound Tags, Character Entities, Commenting and Formatting Code, Other HTML Tags, HTML Attributes and Images: Acquiring Images, Graphics File Formats, Editing Images, The img Tag, Absolute Links, Embedding Media, Relative Links, Validating Code. CSS – Styling Tags: CSS Basics, Colors and Inline Styles, Internal Style Sheets and Basic Formatting, Tidbit: CSS3, External Stylesheets, Common Properties, Designers Lounge: Creating Effective Color Palettes, CSS – Page Layout: Classes IDs Divs Spans, The Box, Boxes in Boxes, Styling Page Divisions. Nav Bars: Designers Lounge: Google Chrome Developer Tools, adding a Navigation Bar, Customizing a Navigation Bar. Publishing Websites: FTP and Web Servers. Designing with Sections: Sections and Background Colors, Background Images, Adding Navigation Bar, Tidbit: Typography. Javascript: Adding a jQuery Animated Scrolling Effect, Designers Lounge: Coding, Responsive Design: Designers Lounge: Page Layout, Mental Models & Chunking, Media Queries, Multiple Media Queries, Targeting Devices, Images and Video, Columns and Tweaks, The Viewport, On Your Own Tidbit: Mobile First Design, Front End Frameworks: Explore Bootstrap Elements, Downloading Bootstrap, Downloading a Bootstrap Example, Tidbit: Bootstrap Themes and the Parallax Effect, Reviewing the Example Code, Replacing Page Content, Customizing the Design, Framework or CMS.
Objective Domain Matrix, Understanding Application Lifecycle Management, Understanding Requirements Analysis, Understanding the Design Process, Understanding Software Development, Understanding Software Testing, Understanding Release Management, Understanding Testing, Understanding Testing Methods, Understanding Testing Levels, Understanding Data Structures, Understanding Arrays, Understanding Queues, Understanding Stacks, Linked Lists, Understanding Sorting Algorithms, Understanding BubbleSort, Understanding QuickSort, Skill, competency and proficiency assessment of the software.

Resources:

Textbook(s):

[1] S. M. Schafer, *Web Standards Programmer's Reference: HTML, CSS, JavaScript, Perl, Python, and PHP*, 1st ed. Indianapolis: Wrox, 2005.

[2] I. Sommerville, *Software Engineering*, 10th ed. Boston: Pearson, 2015.

Reference(s):

[1] J. Kurose and K. Ross, *Computer Networking: A Top-Down Approach*, 7th ed. Boston: Pearson, 2016

[2] N. C. Zakas, *Professional JavaScript for Web Developers*, 3rd ed. Wrox, 2012.

[3] C. Bates, *Web Programming: Building Internet Applications*, 3rd ed. Chichester, England ; Hoboken, NJ: Wiley, 2006

0714-472: Web Design and Software Development Fundamentals Laboratory

Course Code : 0714-472 **Course Title** : Web Design and Software Development Fundamentals Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0613-222

Course Rationale:
In this growing world the knowledge of information & technology is very essential. Especially for an electrical engineer who works with networking, automation, IOT, feels the necessity of a webpage or software to integrate/connect with the hardware to visualize or interpret data. So this laboratory course along with theory makes students to develop software or webpage efficiently & maintain it properly.

Course Objectives:
The objectives of this course are to –

- Learn the basics of different languages for web/software development.
- Familiar with different data structure and algorithm development process.
- Enable to develop software and webpage.
- Know about the troubleshooting procedure of software and webpage.

Course Contents:
Based on the theory course of 0714-471.

Resources:
Textbook(s):
[1] S. M. Schafer, *Web Standards Programmer's Reference: HTML, CSS, JavaScript, Perl, Python, and PHP*, 1st ed. Indianapolis: Wrox, 2005.
[2] I. Sommerville, *Software Engineering*, 10th ed. Boston: Pearson, 2015.
Reference(s):
[1] J. Kurose and K. Ross, *Computer Networking: A Top-Down Approach*, 7th ed. Boston: Pearson, 2016
[2] N. C. Zakas, *Professional JavaScript for Web Developers*, 3rd ed. Wrox, 2012.
[3] C. Bates, *Web Programming: Building Internet Applications*, 3rd ed. Wiley, 2006

0714-473: Embedded System Design

Course Code : 0714-473 **Course Title** : Embedded System Design
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-323

Course Rationale:
This course will provide basic skills in embedded systems design that are usable in designing digital control units for consumer electronics, industrial automation, telecommunication systems, etc. At the end of this course, students will be able to program MCU and embed IDE with practical equipment for automation and advanced controlling. The main focus of this course is to acquaint the student with basic principles and procedures to design custom embedded controllers.

Course Objectives:
The objectives of this course are to –

- Make students understand the fundamental concepts of MCU units, IDE, and embedded design.
- Prepare students to program with peripheral devices.
- Familiar students with various analog and digital sensors interfacing and design specifications.

Course Contents:
MCU introduction: architecture, memory and registers management, built-in peripheral, Introduction to embedded-C and development environment- IDE, variable types, I/O operation, Array and string, Functions, Pointers, IDE, Peripheral programming- I/O port, timer/counter and interrupt programming
Device interfacing: various display devices (LCD, Matrix etc), input devices, analog sensors interfacing, analog device drive designing and interfacing, High-level system introduction- 16/32 bit application-specific MCU, the advanced feature of embedded-C.
32-bit MCU intro: ARM architecture, feature, Advanced Programming- real-time system control, multitasking, real-time algorithm, Advanced embedded communications- USB, Ethernet, wireless, CAN, Mod-bus, Embedded OS- Various Tiny-OS, Embedded Linux, Windows CE, and OS for hand-held devices (Android, Symbian, etc.).

Resources:
Textbook(s):
[1] G. Perry and D. Miller, *C Programming: Absolute Beginner's Guide*, 3rd ed. Indianapolis, Indiana: Que Publishing, 2013.
[2] S. Monk, *Programming Arduino: Getting Started with Sketches*, 2nd ed. New York: McGraw Hill, 2016.
Reference(s):
[1] M. Arora, *Embedded System Design: Introduction to SoC System Architecture*, 1st ed. Austin: Learning Bytes Publishing, 2016.

0714-474: Embedded System Design Laboratory

Course Code : 0714-474 **Course Title** : Embedded System Design Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : 0714-323

Course Rationale:
The primary aim of the Embedded System Design Laboratory course is to develop the ability to design microcomputer-based embedded systems. This class will allow students to learn microcomputer interfacing from both a hardware and software perspective.

Course Objectives:
The objectives of this course are to –

- Introduce embedded hardware & software design tools.
- Make understand the concept of the real-time operating system.

- Enable students to grasp the main idea of embedded system design both in hardware and software.

Course Contents:
Perform experiments and design projects based on course 0714-473.

Resources:
Textbook(s):
[1] G. Perry and D. Miller, *C Programming: Absolute Beginner's Guide*, 3rd ed. Indianapolis, Indiana: Que Publishing, 2013.
[2] S. Monk, *Programming Arduino: Getting Started with Sketches*, 2nd ed. New York: McGraw Hill, 2016.
[3] M. Jiménez, R. Palomera, and I. Couvertier, *Introduction to Embedded Systems: Using Microcontrollers and the MSP430*. New York: Springer, 2013
Reference(s):
[1] M. Arora, *Embedded System Design: Introduction to SoC System Architecture*, 1st ed. Austin: Learning Bytes Publishing, 2016.

TECHNICAL ELECTIVES

Computer and Information Technology

Elective II (CO mapping default value)

0714-475: Machine Learning and Artificial Neural Network

Course Code : 0714-475 **Course Title** : Machine Learning and Artificial Neural Network
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-217

Course Rationale:
Machine Learning and Artificial Neural Network course is based on an idea to design a system to predict and analyze data without minimum human intervention. The course covers supervised classification based on e.g., artificial neural networks (deep learning), as well as unsupervised learning (clustering), regression, optimization (evolutionary algorithms and other search methods), and reinforcement learning, in addition to adaptive filtering.

Course Objectives:
The objectives of this course are to –

- Make students understand the basic and powerful machine learning techniques using Python libraries and implement them using real-life examples.
- Prepare students to identify a problem category and evaluate the model performance upon solving it.
- Make the students able to build a solution fulfilling specific requirements and justify the work.

Course Contents:
Introduction to Machine Learning: Definition, Supervised, Unsupervised and Semi-supervised problem scenarios, Data collection and preprocessing.
Machine Learning Algorithms: Linear Regression with one variable, Linear Regression with multiple variables, Logistic Regression.
Neural Network Representation: Non-linear hypothesis, Multiclass classification, Backpropagation algorithm, Introduction to Convolutional Neural Network and Sequential Model, Hyperparameter tuning.
Model Representation & Evaluation Criteria: Model Representation, Cost Function, Optimization Algorithms, Regularization, Gradient checking, Random initialization, Model Selection, Train/Test/Validation Split, Learning Curve, Error analysis.
Unsupervised Learning: K-means clustering, Decision Tree, Random Forest, Dimensionality Reduction and Anomaly Detection
Implementation with Python: Use of Python libraries (pandas, NumPy, Scikit-learn, Keras, PyTorch), Implementation of different ML algorithms, Mini Project.
Adaptive Filtering: Introduction, FIR Adaptive Filtering, Adaptive Recursive Filters, Recursive Least Squares.

Resources:
Textbook(s):
[1] A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 3rd ed. O'Reilly Media, 2022.
[2] F. Chollet, *Deep Learning with Python*, 1st ed. Manning, 2017.
[3] S. Shalev-Shwartz and S. Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, 1st ed. Cambridge University Press, 2014.
Reference(s):
[1] W. Richert and L. P. Coelho, *Building Machine Learning Systems with Python*. Birmingham Mumbai: Packt Publishing, 2013.
[2] C. C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, 1st ed. Cham, Switzerland: Springer, 2018.

0714-477: Information and Coding Theory

Course Code : 0714-477 **Course Title** : Information and Coding Theory
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0613-222

Course Rationale:
The Information and coding theory course is designed to provide knowledge on advanced information and coding theories. This course will discuss how to mathematically model information sources and communication channels, how to optimally compress and transmit information, and how to design error-correcting codes that allow us to reliably communicate over noisy communication channels. After completion of this course, students will be able to design a communication system with minimal bandwidth, minimal error, and the highest security.

Course Objectives:
The objectives of this course are to –
- Make students understand the fundamental concepts of Information, Entropy, and channel capacity.
- Prepare students to implement & analyze various source coding, channel coding & network coding.
- Make students capable of designing communication systems with optimal bandwidth and error.
- Make the students familiar with cryptography and network security.

Course Contents:
Entropy and Mutual Information: Entropy, joint entropy and conditional entropy, Relative entropy and mutual information, chain rules for entropy, Jensen's inequality and log-sum inequality
Differential Entropy: Differential entropy and discrete entropy, joint and conditional differential entropy, properties of differential entropy, Entropy Rates of Stochastic Process: Markov Chain, Entropy rate and hidden Markov models.

Source Coding: Classification of codes, Kraft inequality, Source coding theorem, Optimal codes, Huffman code and its optimality, Shannon-Fano-Elias coding, arithmetic coding.
Channel Capacity: Channel Models, Discrete memory less channels – BSC, BEC; Channel capacity and properties of channel capacity, channel coding theorems, joint source and channel coding theorem, Gaussian Channel, Band limited channel, Parallel Gaussian Channel, Gaussian Channel with feedback.
Error Control Coding: Block Codes: Definitions and Principles: Hamming weight, Hamming distance, Hamming bound, Minimum distances decoding. Linear block codes, Single parity codes, Hamming codes, Hadamard codes, Repetition codes, Cyclic codes – BCH code, RS code, Syndrome calculation, Encoder and decoder, CRC.
Convolution Codes: Convolution codes – code tree, trellis, state diagram, Encoding, Decoding: Sequential search and Viterbi algorithm. Principle of Turbo coding.
Network Coding: Fundamentals of Network Coding: Butterfly networks, graphs and networks, the max-flow min-cut theorem, the multi-source multicast problem, deterministic code design for network coding, randomized network coding, application of network coding.
Cryptography and network security: Basic introduction, types and importance.

Resources:
Textbook(s):
[1] R. Bose, *Information Theory, Coding and Cryptography*, 3rd ed. McGraw Hill Education India Private Limited, 2017.
Reference(s):
[1] A. Saha, N. Manna, and S. Mandal, *Information Theory, Coding & Cryptography*, 1st ed. Pearson India, 2013.
[2] B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4th ed. Oxford University Press, 2009.

0714-479: Data Communication & Computer Networks

Course Code : 0714-479 **Course Title** : Data Communication & Computer Networks
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : 0714-311

Course Rationale:
This course presents an overview of data communications and computer networks, including data transmission techniques, encoding methods, network models, data communication services and network standardization. The main focus of this course is to provide brief knowledge on layered network architecture, Link Layer protocols, high-speed packet switching, queueing theory, Local Area Networks, and Wide Area Networking issues, including routing and flow control.IoT and its data collection techniques also discussed in details.

Course Objectives:
The objectives of this course are to –
- Make students understand the general terminologies and trends in Data Communication and Computer networks.

- Familiarize with the field of computer networking and communication, emphasizing network topologies, different layers of the network model and interference issues.
- Enable to analyze in-depth techniques of data transmission, interfacing, line coding, network Protocols, and IP addressing.
- Learn about IOT and its data collection techniques.

Course Contents:

Data Communication Techniques: Serial and parallel transmission, Asynchronous and synchronous transmission, Line coding, block coding. Error detection and correction. CRC and other methods. RS232 (or EIA 232D) V.24 interface standard.

Categories of networks, network topologies, an overview of TCP/IP protocol suite and OSI model. Data Link Control: Flow control, Error Detection, High-level Data Link Control (HDLC).

Wireless LAN, IEEE 802.11 and Bluetooth. Cellular telephony and satellite networks. Internetworks, IP address, ARP and ICMP. Routing techniques, distance vector routing and link state routing, multicast routing. Transport layer- UDP and TCP protocols, DNS and address resolution. Internet applications, e- mail and file transfer SMTP and FTP, HTTP and World Wide Web. Virtual circuit switching and, Frame Relay and ATM, congestion control and quality of service in frame relay and ATM.

Internet of Things (IoT): Components of an IoT Solution, Competing Standards for IoT, IoT specialization in different sector, Data acquisition, Analysis and Visualization of Data, Big Data and IoT, IoT Data Collection in the Cloud, Privacy and Security of Data, Cloud-based Data Collection, Cloud-based Data Collection.

Resources:

Textbook(s):

[1] B. A. Forouzan, *Data Communications and Networking*, 5th ed. McGraw Hill, 2012.
[2] B. Sklar and F. J. Harris, *Digital Communications: Fundamentals and Applications*, 2nd ed. Prentice Hall, 2020.

Reference(s):

[1] W. Stallings, *Data and Computer Communications*, 10th ed. Boston: Pearson, 2013.
[2] F. Halsall, *Data Communications, Computer Networks, and Open Systems*, 4th ed. Wokingham, England: Pearson, 1996.
[3] J. Kurose and K. Ross, *Computer Networking: A Top-Down Approach*, 7th ed. Boston: Pearson, 2016.

LANGUAGE

0232-111: Functional Bengali Language

Course Code : 0232-111 **Course Title** : Functional Bengali Language
Credit : 2 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
বাংলা ভাষার উৎস, সাধু ও চলিত বাংলা, মিশ্র বাংলার প্রকৃতি, গঠন ও ব্যবহার, আধুনিক বাংলার প্রচার ও প্রসার, প্রায়োগিক বাংলার ব্যকরণ ও আচরণ, প্রায়োগিক বাংলায় ঘটনা-সমুহের পর্যালোচনা। বাংলার বনাম ইংরেজি, ইংরেজির বাংলা প্রতিশব্দ, ইংরেজি ও বাংলার দ্বন্দ ও সমন্বয়। বাংলার ভবিষ্যত ও ভবিষ্যতের বাংলা, ভাষা যখন অস্তিত্ব, বাংলার জন্য বাংলা।

Course Objectives:
এই কোর্সের প্রধান উদ্দেশ্যগুলো হলো -

- বাংলা ভাষার বিবর্তন সম্পর্কে জানা
- বাংলা ব্যাকরণের আলোকে শুদ্ধ ভাষা ব্যবহার
- প্রকৌশল পেশায় বাংলার প্রয়োগ জানা
- বাংলা ভাষার গভীরতা এবং পরিধি আলোচনা

Course Contents:
বাংলা ভাষার বিবর্তন – বাংলা ভাষার উৎস, সাধু ও চলিত বাংলা, সাধু ভাষার বিবর্তন।
আধুনিক বাংলা – আধুনিক বাংলার উৎস ও প্রয়োজনীয়তা, মিশ্র বাংলার প্রকৃতি, গঠন ও ব্যবহার, আধুনিক বাংলার প্রচার ও প্রসার।
প্রায়োগিক বাংলা – বাংলা ভাষার ক্ষেত্রসমুহ, প্রায়োগিক বাংলার ব্যকরণ ও আচরণ, প্রায়োগিক বাংলায় ঘটনা-সমুহের পর্যালোচনা।
বাংলা বনাম ইংরেজি – বাংলার বনাম ইংরেজি, ইংরেজির বাংলা প্রতিশব্দ, ইংরেজি ও বাংলার দ্বন্দ ও সমন্বয়।
প্রকৌশল পেশায় বাংলা – চিঠি আদান-প্রদান, প্রস্তাবনা ও গবেষণাপত্র প্রনয়ণ, নিয়োগ বিধি ও দাপ্তরিক নীতিমালা গঠণ, পরিবেশ ও আইনগত বিষয়ে ভাষা জ্ঞান, প্রযুক্তি শেয়ারিংএ কথ্য ও সাধু ভাষার পার্থক্য ও সমন্বয়। বুঝা, লেখা ও বলা বিষয়ে জ্ঞান ও চর্চা।
বাংলার মাহাত্ম ও ক্ষমতা – বাংলার গভীরতা ও পরিধি, আন্তর্জাতিক ও আন্তর্জাতিক বাংলা।
ভবিষ্যতের বাংলা – বাংলার ভবিষ্যত ও ভবিষ্যতের বাংলা, ভাষা যখন অস্তিত্ব, বাংলার জন্য বাংলা।

Resources:
Textbook(s):
[1] বাংলা একাডেমী প্রমিত বাংলা ভাষার ব্যাকরণ ১ম খণ্ড (হার্ডকভার)- by স্বরোচিষ সরকার (সম্পাদক), মাহবুবুল হক (সম্পাদক) , জীনাত ইমতিয়াজ আলী (সম্পাদক) , ড. হাকিম আরিফ (সম্পাদক), রাজীব চক্রবর্তী (সম্পাদক) , রফিকুল ইসলাম (অধ্যাপক) (সম্পাদক)

0231-112: Professional English I

Course Code : 0231-112 **Course Title** : Professional English I
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
In this course, students will be introduced to conduct general discussion in English in various approaches and speak fluently in an effective oral presentation. This course is designed to enable students to tackle grammatical problems, including sentences construction, conditionals, vocabulary, and diction. A detailed analysis of scan and skin reading will improve reading skills and generate ideas through purposive reading.

Course Objectives:
The objectives of this course are to –

- Prepare students to conduct general discussion in English in various approaches.
- Teach to tackle grammatical problems in a technical report.
- Develop scan and skin reading.
- Make students capable of speaking fluently in an oral presentation

Course Contents:
General discussion: Introduction, various approaches to learning English.
Grammatical Problems: Construction of sentences, grammatical errors, sentence variety and style, conditionals, vocabulary and diction.
Reading Skill: Discussion readability, scan and skin reading, generating ideas through purposive reading, reading of selected stories.
Speaking Skill: Practicing dialogue, Storytelling, Effective oral presentation.

Resources:
Textbook(s):
[1] S. I. Choudhury and A. Haque, *Prose of Our Time*. Nowroze Kitabistan, 2010
[2] S. M. Amanullah, *A Guide to Correct Speech*. Dhaka: Albatross Publications, 2018.
[3] R. C. Sharma and K. Mohan, *Business Correspondence and Report Writing*, 5th ed. McGraw Hill Education, 2016.
Reference(s):
[1] M. Maniruzzaman, *Introduction to Linguistics*. Dhaka: Friends' Book Corner, 2013.
[2] M. L. Imhoof and H. Hudson, *From Paragraph to Essay: Developing Composition Writing*. Burnt Mill: Longman, 1975.
[3] A. S. Hornby, *Oxford Advanced Learner's Dictionary*, 8th ed. Oxford: Oxford University Press, 2010.
[4] R. Murphy, *English Grammar in Use*, 5th ed. Cambridge University Press, 2019.
[5] *Headway Advanced: Student Digital Pack*, 5th ed. UK: Oxford University Press.
[6] *Official IELTS Practice Materials*, 1st ed. Stuttgart: Cambridge University Press, 2012
[7] J. Gear and R. Gear, *Cambridge Preparation for the TOEFL Test Book*, 4th ed. Cambridge: Cambridge University Press, 2014.

0231-122: Professional English II

Course Code : 0231-122 **Course Title** : Professional English II
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** None

Course Rationale:
In this course, students will be introduced to conduct general discussion in English in various approaches and speak fluently in an effective oral presentation. This course is designed to enable students to tackle grammatical problems, including sentences construction, conditionals, vocabulary, and diction. A detailed analysis of scan and skin reading will improve reading skills and generate ideas through purposive reading.

Course Objectives:
The objectives of this course are to –

- Prepare students to conduct general discussion in English in various approaches.
- Teach to tackle grammatical problems in a technical report.
- Develop scan and skin reading.
- Make students capable of speaking fluently in an oral presentation.

Course Contents:
General discussion: Introduction, various approaches to learning English.
Grammatical Problems: Construction of sentences, grammatical errors, sentence variety and style, conditionals, vocabulary and diction.
Reading Skill: Discussion readability, scan and skin reading, generating ideas through purposive reading, reading of selected stories.
Speaking Skill: Practicing dialogue, Storytelling, Effective oral presentation.

Resources:
Textbook(s):
[1] S. I. Choudhury and A. Haque, *Prose of Our Time*. Nowroze Kitabistan, 2010
[2] S. M. Amanullah, *A Guide to Correct Speech*. Dhaka: Albatross Publications, 2018.
[3] R. C. Sharma and K. Mohan, *Business Correspondence and Report Writing*, 5th ed. McGraw Hill Education, 2016.
Reference(s):
[1] M. Maniruzzaman, *Introduction to Linguistics*. Dhaka: Friends' Book Corner, 2013.
[2] M. L. Imhoof and H. Hudson, *From Paragraph to Essay: Developing Composition Writing*. Burnt Mill: Longman, 1975.
[3] A. S. Hornby, *Oxford Advanced Learner's Dictionary*, 8th ed. Oxford: Oxford University Press, 2010.
[4] R. Murphy, *English Grammar in Use*, 5th ed. Cambridge University Press, 2019.
[5] *Headway Advanced: Student Digital Pack*, 5th ed. UK: Oxford University Press.
[6] *Official IELTS Practice Materials*, 1st ed. Stuttgart: Cambridge University Press, 2012
[7] J. Gear and R. Gear, *Cambridge Preparation for the TOEFL Test Book*, 4th ed. Cambridge: Cambridge University Press, 2014.

0231-212: Professional English III

Course Code : 0231-212 **Course Title** : Professional English III
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
In this course, students will be introduced to conduct general discussion in English in various approaches and speak fluently in an effective oral presentation. This course is designed to enable students to tackle grammatical problems, including sentence construction, conditionals, vocabulary, and diction. A detailed analysis of scan and skin reading will help students understand reading skills basics and generate ideas through purposive reading.

Course Objectives:
The objectives of this course are to –

- Prepare students to conduct general discussion in English in various approaches.
- Make the students tackle grammatical problems in a technical report.
- To enlighten the students about scan and skin reading.
- Teach to speak fluently in an effective oral presentation.

Course Contents:
Listening Skill: The phonemic systems and correct English pronunciation.
Writing Skill: Technical terminology and vocabulary, Writing emails, letters, Research proposal writing,
Professional document writing, Tender writing.
Approaches to Communication: Communication today, business communication, different types of business communication.
Speaking Skill: Practicing dialogue, Storytelling, Effective oral presentation.

Resources:
Textbook(s):
[1] S. I. Choudhury and A. Haque, *Prose of Our Time*. Nowroze Kitabistan, 2010
[2] S. M. Amanullah, *A Guide to Correct Speech*. Dhaka: Albatross Publications, 2018.
[3] R. C. Sharma and K. Mohan, *Business Correspondence and Report Writing*, 5th ed. McGraw Hill Education, 2016.
Reference(s):
[1] M. Maniruzzaman, *Introduction to Linguistics*. Dhaka: Friends' Book Corner, 2013.
[2] M. L. Imhoof and H. Hudson, *From Paragraph to Essay: Developing Composition Writing*. Burnt Mill: Longman, 1975.
[3] A. S. Hornby, *Oxford Advanced Learner's Dictionary*, 8th ed. Oxford: Oxford University Press, 2010.
[4] R. Murphy, *English Grammar in Use*, 5th ed. Cambridge University Press, 2019.
[5] *Headway Advanced: Student Digital Pack*, 5th ed. UK: Oxford University Press.
[6] *Official IELTS Practice Materials*, 1st ed. Stuttgart: Cambridge University Press, 2012
[7] J. Gear and R. Gear, *Cambridge Preparation for the TOEFL Test Book*, 4th ed. Cambridge: Cambridge University Press, 2014.

HUMANITIES

0222-111: Emergence of Bangladesh

Course Code : 0222-111 **Course Title** : Emergence of Bangladesh
Credit : 2 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
Emergence of Bangladesh is a multidisciplinary course designed to equip students with the knowledge on focal themes relating to Bangladesh. The first theme is the inevitability of the emergence of Bangladesh as a state entity in the context of a long historical background and the second theme draws attention to the experience of Bangladesh in governance and democratization. The students attending this course are expected to be made aware of the past and present of Bangladesh for the enlargement of their knowledge to face the challenges of the 21st century.

Course Objectives:
The objectives of this course are to –

- Make the students understand the SWOT (strengths, weaknesses, opportunities and threats) analysis on the geography, demography, society, culture, government and politics of Bangladesh.
- Teach through qualitative and quantitative analysis and design solutions for sustainable development.

Course Contents:
Part A: Roots of Bangladesh: Ancient Bengal, The Medieval Bengal, British Rule, Emergence of Bangladesh, Mind and Culture of Bangladesh, Education in Bangladesh, Literature, Ethnic Insurgency, Foreign policy.
Part B: Politics and Economy of Bangladesh (1971-2003), Government and Administration, Executive, Legislature, Judiciary.

Resources:
Textbook(s):
[1] S. M. Rahman, *Ausamapta Atmajiboni (The Unfinished Memoirs)*. Dhaka: The University Press Ltd., 2023.
[2] M. M. Khan and S. Ā. Hosena, *Bangladesh Studies: Politics, Administration, Rural Development, and Foreign Policy*. Center for Administrative Studies, University of Dhaka, 1985.
[3] S. Islam, Ed., *Banglapedia: National Encyclopedia of Bangladesh*, 2nd ed., 14 vols. Asiatic Society of Bangladesh, 2012.
Reference(s):
[1] M. A. Halim, *Constitution, Constitutional Law and Politics: Bangladesh Perspective*, 4th ed. Dhaka: CCB Foundation, 2008.
[2] A. M. Chowdhury and F. Alam, Eds., *Bangladesh on the Threshold of the Twenty-first Century*. Dhaka: Asiatic Society of Bangladesh, 2002.
[3] T. A. Chowdhury, *Socio-Economic Condition in Bangladesh*. Dhaka: New Age Publications, 2008.

0314-113: Sociology

Course Code : 0314-113 **Course Title** : Sociology
Credit : 2 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
This course is designed to provide knowledge regarding the origin and historical development of human civilizations in the world. This course introduces students to the basic concepts of Sociology which includes various social institutions, analyzes socialization, gender, inequality and power among other substantive societal issues. Attempts are made to relate these issues citing examples from various societies of the world including Bangladesh.

Course Objectives:
The objectives of this course are to –

- Introduce students to the origin and development of Sociology.
- Provide insight regarding the relationship among social, political, economic, religious and other institutions in societies.
- Familiarize the causes and consequences of social change in the light of globalization.
- Propagate a comparative outlook in theoretical issues of Sociology.

Course Contents:
Introduction: Society, Science and Technology-an overview, Scientific Study of Society, Social Elements, Society, Community, Association and Institution, Mode of Production and Society Industrial Revolution, Development of Capitalism.
Culture and Socialization: Culture, Elements of Culture, Technology and Culture, Cultural Lag, Socialization and Personality, Family, Crime and Deviance, Social Control. Technology, Society and Development, Industrialization and Development, Development and Dependency Theory, Sustainable Development, Development and Foreign Borrowing, Technology Transfer and Globalization, Modernity and Environment, Problem and Prospects.
Pre-industrial, Industrial and Post-industrial Society: Common Features of Industrial Society, Development and Types of Social Inequality in Industrial Society, Poverty, Technology and Society, Social Stratification and Social Mobility, Rural and Urban Life, and their Evaluation.
Population and Society: Society and Population, Fertility. Mortality and Migration, Technology and Human Migration, Theories of Population Growth-Demographic Transition Theory, Malthusian Population Theory, Optimum Population Theory, Population Policy.

Resources:
Textbook(s):
[1] A. Giddens, M. Duneier, R. P. Appelbaum, and D. Carr, *Introduction to Sociology*, 12th ed. W. W. Norton & Company, 2021.
Reference(s):
[1] H. Griffiths, E. Strayer, and S. Cody-Rydzewski, *Introduction to Sociology*, 2nd ed. Rice University: XanEdu Publishing Inc, 2015.

0223-121: Art of Living & Engineering Ethics

Course Code : 0223-121 **Course Title** : Art of Living & Engineering Ethics
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Success comes not just from knowledge and skills but also from behavior which can achieve only by learning and unlearning ways of thinking that finally craft body language and ensure effective living in this beautiful world. Specially, professional engineers have responsibility to serve the society and work to improve the welfare, health and safety, with the minimal use of natural resources and paying attention with regard to the environment and the sustainability of resources. In their professional fields, they have to face ethical, social and environmental issues and their decisions affect the world or society. It's engineers' obligation to be sensitive to ethical issues for the continuing professional development in their careers. It is, therefore, important that engineers have a clear understanding of how engineers should interact with the society, and the impacts of engineering decisions on the society and environment. The purpose of this course is to sensitize students to ethical, social and environmental issues in engineering; and equip students with the necessary skills required for ethical decision making. Societal and environmental safety, responsibilities, values, and rights of an engineer will be detailed here.

Course Objectives:
The objectives of this course are to –

- Teach humanitarian qualities as the basic tools for enjoying the journey from "I" to "We" to promote effective living in this precious world.
- Develop the ability to identify the core human values and responsibilities of engineers.
- Make the students able to understand and apply the engineering code of ethics and moral development theories.
- Enable the students to critically assess the effects of engineering decisions on society and environment.
- Develop skills to ensure environmental protection and sustainability to balance engineering for sustainable growth of the environment.
- Develop an appreciation of ethical responsibilities and rights of engineers towards public safety and welfare to prevent any engineering hazards.

Course Contents:
Behavior: Etiquette, Personal behavior, Professionalism, Self-esteem, Mind mapping, impression management, transforming failure into success, Emotional growth and personality,
Human Values: Morals, Values and Ethics, Integrity, Work Ethic, Honesty, Courage, Empathy, Self-Confidence, Character.
Engineering as Social Experimentation: Engineering as experimentation, Engineers as responsible experimenters, Codes of ethics, A balanced outlook on law, The challenger case study.

Safety, Responsibilities and Rights: Safety and risk, Assessment of safety and risk, Risk-benefit analysis and reducing risk, Bhopal and Chernobyl case studies.
Environmental Protection and Sustainability: Ethics of environmental protection, Environment issues from engineering aspects. Technology for a sustainable environment. Responsibility for environmental protection and sustainability.
Engineering Ethics: Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral autonomy, Kohlberg's theory, Gilligan's theory, Consensus and controversy, Models of Professional Roles, Theories about right action, Self-interest, Customs and religion, Uses of ethical theories. Valuing Time, co-operation and commitment.
Engineering ethics: Perspective Bangladesh
Learning to learn: Essential skills for 21st century survival

Resources:
Textbook(s):
[1] S. Khan and S. M. Rahman, *Art of Living*. Daffodil International University, 2012.
[2] C. E. Harris Jr., M. S. Pritchard, M. J. Rabins, R. James, and E. Englehardt, *Engineering Ethics: Concepts and Cases*, 5th Ed. Boston, MA: Cengage Learning, 2013.
[3] P. A. Vesilind and A. S. Gunn, *Engineering, Ethics, and the Environment*. New York: Cambridge University Press, 1998.
Reference(s):
[1] R. J. Nash, *Answering the "Virtuecrats": A Moral Conversation on Character Education*. New York: Teachers College Pr, 1997.
[2] T. Lickona, *Educating for Character: How Our Schools Can Teach Respect and Responsibility*. Random House Publishing Group, 1992.
[3] C. Fleddermann, *Engineering Ethics*, 4th ed. Pearson, 2011.

0709-311: Engineering Economics and Accounting

Course Code : 0709-311 **Course Title** : Engineering Economics and Accounting
Credit : 2 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
In this course, students will be introduced with different scope and methods of economics, demand, supply, consumer behaviour, marginal utility, consumer surplus, different types of cost and cost analysis, basics of accounting, account cycle, depreciation, costing etc. The purpose of this course is to teach students the fundamental concepts and modern hierarchy of economics and accounting.

Course Objectives:
The objectives of this course are to –
- Make the student understand the scopes and methods of economics.
- Familiarize the student with demand, supply, consumer behavior, marginal utility etc.
- Give the knowledge of laws of returns and internal and external economics.
- Give the students a clear concept about different types of cost and cost analysis.

- Familiarized the students with accounting and its various objectives, accounting cycle and depreciation.

Course Contents:
Economics: Definition, scope and methods. Demand, supply and their elasticity's; equilibrium analysis-partial and general; consumer behaviour, marginal utility; indifference curve, consumer's surplus; producer behaviour; iso-quant, iso- cost line. Factors of production function; production possibility curve; fixed cost and variable cost; short run and long run costs, total average and marginal cost; laws of returns; internal and external economics and diseconomies; market and market forms; perfect and imperfect competition; price output determinations. Introductory ideas on GNP, GDP, perceptual income, interest, rent, saving, investment, inflation; project approval, NPV, IRR and their application, cost benefit analysis.
Accounting: Definition, advantages, objects; nature of transaction; double entry system of book-keeping; classification of account.
Accounting cycle: Journal, ledger, trial balance, final account including adjustment.
Final accounts: Trading & manufacturing accounts, profit and loss accounts and balance sheet.
Depreciation: methods of depreciation.
Costing: Concept of cost, classification of cost, cost-sheet, distribution of overhead to the various cost center/ departments, calculation of departmental overhead rate and machine hour rate.
Job costing: preparation of job cost-sheet and quotation. Marginal costing & profit volume/ratio.

Resources:
Textbook(s):
[1] S. A. Hasib and S. E. Kabir, *Basic Accounting*. Dhaka: Ideal Books, 2006.
Reference(s):
[1] P. A. Samuelson and W. D. Nordhaus, *Economics*, 19th ed. Boston: McGraw Hill, 2009.

0031-421: Employability

Course Code : 0031-421 **Course Title** : Employability
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
This course is based on open topics relevant to the career, employment, entrepreneurship, and life challenges that the students may face after the completion of their undergraduate studies. Topics are emphasized on Goal settings, core motivation behind goals, creating long-term motivation, skills, habits and behaviors behind goals, motivating others' thoughts and visionary leadership, team building, career and innovation, critical thinking, CV writings and communications skills.

Course Objectives:
The objectives of this course are to –

- Make students capable of identifying one's strengths and areas for improvement.
- Teach them about career aspirations and desires with specific professional goals.
- Introduce them to the related professional context and constraints and opportunities.
- Make them use effective job searching strategies.

Course Contents:
Introduction to Employability, The Employability Challenges, Employability skills are essential
Self-Assessment, Career Planning, Building soft skills for Employability, Know Yourself, SWOT Analysis, improving technical skills, Soft Skills, Organizational Skills & Behavior, Professionalism, Responsibility, Work ethic, Presentation skills, Portfolio making Career Search
Technique, Teamwork and Leadership Skills Development, Ethics.
Resume preparation, Job search, Networking search strategies, Job application and Facing Interview, Employment communications, Career management.

Resources:
Textbook(s):
[1] D. A. M. Nawale and M. M. Nivargi, *An Introduction to Employability Skills*. Macmillan, 2018.

0421-311: Industrial Laws and Management

Course Code : 0421-311 **Course Title** : Industrial Laws and Management
Credit : 2 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
In this course, students will be introduced to different industrial laws and conservation act, factory act, different management functions and features like personal management, operational management, cost and financial management, management accounting, marketing management, technological management, etc. The purpose of this course is to teach students on the fundamental concepts and modern hierarchy of industrial law, operational management, project financing and project management.

Course Objectives:
The objectives of this course are to –

- Make the students understand industrial law and environmental conservation rule.
- Teach organizational structure and operational management policy.
- Familiarize the students with factory art, inspectional details, health, hygiene and factory safety.
- Illuminate the students about the basics of management accounting.
- Introduce the students with the concepts of different management functions and features.

Course Contents:
Industrial Law: Industrial Relation Ordinance 1969, Industrial Relation Ordinance 1975 (Section one to thirty-four), Environmental conservation act 1995, Environmental conservation Rule 1997.
Factory Act: Introduction, Inspection and Certifying surgeons, Health and Hygiene, Safety, Working hours of audits, Employment of young persons, leave and holydays with wages.
Management Functions and Organization: Evolution, management function: organization, theory and structure, span of control, authority delegation, manpower planning.
Personal Management: Importance, need hierarchy, motivation, leadership, wage incentives, performance appraisal, and participative management.
Operation Management: Production planning and control (PPC) functions, quantitative methods applied in production, quality management, location and layout planning safety and loss management.
Cost and Financial Management: Elements of cost products, cost analysis, investment analysis, and benefit cost analysis, risk analysis.
Management Accounting: Cost planning and control, budget and budgetary control.
Marketing Management: Concepts, strategy, sales promotion, patent laws.
Technology Management: Management of innovation and changes, technology life cycle. Case studies.

Resources:
Textbook(s):
[1] Panneerselvam, *Production and Operations Management*, 3rd ed. Prentice Hall India, 2012.
[2] P. L. Malik, *Industrial Law*. Eastern Book Company, 2017.

0709-321: Project Management and Finance

Course Code : 0709-321 **Course Title** : Project Management and Finance
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Practicing engineers needs to know and implement the concepts of project management, planning, budgeting, evaluation, monitoring and assessment. This course aims to enable students to manage a project in an efficient manner. A detailed analysis of project evaluation and review technique will help students to review the management strategy for the project. The return on investment (ROI) tool will be useful for the students to manage the finance aspect of project management.

Course Objectives:
The objectives of this course are to –

- Teach the students about various stages in project management, planning and management techniques.
- Make students capable for costing and budget preparation.
- Enable the students to understand and apply the tools to manage the financial aspect of project management.
- Develop students' capability to control and monitor the projects.

- Make the students able to understand the risks, management changes in a project.
- Make the students able to understand the impact of environment and society of a project.
- Develop the capability of students to communicate in written and oral forms.

Course Contents:

Introduction to Project Management: Defining project management, exploring opportunities in the project management field, developing project management skills, categorizing different types of projects, Understanding the difference between projects and programs.

Planning Project: Planning a project, identifying and delivering on your client's priorities, managing stakeholders, developing a project management plan, RACI Matrix, preventing 'scope creep', assessing the feasibility of a project, identifying and managing risks. executing project, entering into a contract, managing a project, setting up a project database, creating an effective work schedule, monitoring a project, conducting effective meetings, managing change, addressing problems.

Project Management Techniques: Identifying organizational structures, estimating costs and budgeting, using critical path project management tools (WBS, Gantt chart, Project Network Diagram), establishing the critical path, tracking project milestones, using the program evaluation and review technique (PERT tool), using process improvement tools (Fishbone, SIPOC), managing time, controlling quality, environmental impact assessment. Business and financial issues, understanding the importance of a business case, developing a business case, identifying project costs, calculating return on investment (ROI), calculating a payback period, determining net present value (NPV).

The Project from Start to Finish: Identifying the life cycle of a project, handing over a project, closing a project, reviewing a project, report writing, and presentation, compliance and ethics. People in the Project: Assembling your project team, planning resources for your project team, managing your project team, managing conflict within your team, communicating effectively, providing leadership, and fostering teamwork.

Resources:

Textbook(s):

[1] F. Cowell, *Textbook of Project Management (Finance and Capital market Series)*. 2016.

Reference(s):

[1] N. J. Smith, *Engineering Project Management*, 3rd ed. Oxford: Wiley-Blackwell, 2007.

[2] E. W. Merrow, *Industrial Megaprojects: Concepts, Strategies, and Practices for Success*, 2nd ed. Hoboken, New Jersey: Wiley, 2024.

BASIC SCIENCE

0533-111: Physics

Course Code : 0533-111 **Course Title** : Physics
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
This course introduces principles and the core concepts of physics at a foundation level. To understand basic physics, students have to know Heat and thermodynamics, thermometry, damped and forced harmonic oscillator, Equation of state, wave motion, and optical Instrument. The purpose of this course is to teach students the fundamental concepts and modern hierarchy of Physics.

Course Objectives:
The objectives of this course are to –

- Make students understand the fundamental concepts of Physics.
- Enable to apply an understanding of fundamental principles of physics and quantitative skills to problem solving.
- Familiarize students with the reactions and properties of different optical instruments.

Course Contents:
Heat and thermodynamics: Thermometry: Concepts of heat and temperature, measurement of high and low temperature, resistance thermometer, constant volume thermometer, thermo electric thermometer and pyrometer. Kinetic theory of gases: Fundamental assumption of kinetic theory, pressure excreted by a perfect gas, gas laws, Brownian movement, degrees of freedom, principle of equi-partition of energy, mean free path of gas molecules, Maxwell's Law of distributions of velocities.
Equation of state: Physical explanation of the behavior of real gases. Andrew's experiments, Vander walls equation, critical constants, defects of Vander wall's equation, state of matter near the critical point. Thermodynamics: Zeroth law of thermodynamics and its significance. First law of thermodynamics, work done during adiabatic and isothermal processes. Second law of thermodynamics, Carnot's cycle, Carnot's engine, thermionic emission, entropy changes in reversible and an irreversible process, entropy of a perfect gas, zero-point energy and negative temperature, Maxwell's thermo dynamical relations. Wave and oscillations: Wave and composition of simple harmonic motion, simple harmonic motion, average value of kinetic and potential energies of a harmonic oscillation, superposition of simple harmonic motions, uses of Lissajous figures.
Damped and forced harmonic oscillator: Damped oscillatory system, damped harmonic oscillation, LCR circuit, forced vibration, quality factor of forced oscillator, sharpness of resonance, phase of driven oscillator, power absorption. Wave Motion: Types of waves, progressive and stationary wave, energy distribution due to progressive and stationary wave, interference of sound wave, phase velocity and group velocity.

Sound Wave: Audible, ultrasonic, infrasonic and supersonic waves, Doppler's effects and its application, applications of ultrasonic sound. Acoustics: Intensity of sound, Bel, sound pressure level, phonon, acoustic intensity, architectural acoustics, diffraction of sound, musical sound and noises, speech, characteristics of musical Sound. Building Acoustic: Reverberation, Sabine's reverberation formula, growth intensity, decay intensity, reverberation time and absorption coefficient, requisites for good acoustic.
Optics: Interference: Nature of light, interference of light, coherent sources, young double slit experiment, energy distribution, condition for interference, production of interference fingers, Fresnel Bi-prism, Newton's ring. Optical Instrument: Photographic camera, simple microscope, compound microscope, telescope astronomical telescope, spectrometer.

Resources:
Textbook(s):
[1] G. U. Ahmed, *Physics for Engineers*, 1st ed., vol. 1, Dhaka: Hafiz Book Centre, 2005.
Reference(s):
[1] R. Murugeshan and K. Sivaprasath, *Modern Physics*, 14th ed. New Delhi: S. Chand, 2009.

0533-112: Physics Laboratory

Course Code : 0533-112 **Course Title** : Physics Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
This course introduces students to modern laboratory instruments and experimental techniques in Physics. This course will provide practical understanding of the principles and the core concepts of physics at a foundation level. The purpose of this course is to teach students the fundamental concepts and modern hierarchy of Physics through practical experiments.

Course Objectives:
The objectives of this course are to –

- Introduce the student with different instruments through the practical illustration of fundamental concepts of Physics.
- Enable to apply an understanding of fundamental principles of physics and quantitative skills to problem solving.

Course Contents:
Perform experiments based on 0533-111

Resources:
Textbook(s):
[1] G. U. Ahmed, *Physics for Engineers*, 1st ed., vol. 1, Dhaka: Hafiz Book Centre, 2005.
Reference(s):
[1] R. Murugeshan and K. Sivaprasath, *Modern Physics*, 14th ed. New Delhi: S. Chand, 2009.

0531-111: Chemistry

Course Code : 0531-111 **Course Title** : Chemistry
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Engineering necessitates the application of science, and chemistry is at the heart of all sciences. The more chemistry knowledge an engineer has, the better off he or she will be. In the future, global difficulties and problems will necessitate a thorough understanding of chemistry in order to find a worldwide solution. This course introduces principles and the core concepts in chemistry at a foundation level. The purpose of this course is to teach students the fundamental concepts and modern hierarchy of Chemistry.

Course Objectives:
The objectives of this course are to –

- Make students understand the fundamental concepts of Chemistry.
- Enable to apply an understanding of fundamental chemical principles and quantitative skills to problem solving.
- Familiarize the students about the chemical reactions and properties of different compounds.

Course Contents:
Atomic structure, quantum numbers, electronic configuration, periodic table, properties and uses of noble gas.
Different types of chemical bonds and their properties, molecular structure of compounds, different types of solutions and their compositions.
Phase rule, phase diagram of mono- component system, properties of dilute solutions.
Thermo-chemistry, chemical kinetics, chemical equilibrium, ionization of water and pH concept, electrical properties of solution.
Reactions and properties of various organic and inorganic compounds and their uses in different industries.

Resources:
Textbook(s):
[1] J. E. Huheey, E. A. Keiter, and R. L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*. New York: Pearson, 1997.
Reference(s):
[1] J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, and B. Sivasankar, *Vogel's Quantitative Chemical Analysis*, 6th ed. Harlow: Prentice Hall, 2000.

0531-112: Chemistry Laboratory

Course Code : 0531-112 **Course Title** : Chemistry Laboratory
Credit : 1 **Contact Hours** : 1 Hours/week **Pre-requisite** : None

Course Rationale:
Power system protection course provides an overview of the principles and schemes for protecting power lines, transformers, buses and generators. This course presents the fundamentals of power system protection and its application. The purpose of this course is to teach students the basic elements of switchgear for the protection of costly electrical equipment.

Course Objectives:
The objectives of this course are to –

- Introduce students with chemical analysis instruments.
- Teach students perform different reactions (specially titration) to obtain desired information.
- Make the students capable of analyzing the obtained information.

Course Contents:
Perform experiments based on 0531-111.

Resources:
Textbook(s):
[1] J. E. Huheey, E. A. Keiter, and R. L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*. New York: Pearson, 1997.
Reference(s):
[1] J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, and B. Sivasankar, *Vogel's Quantitative Chemical Analysis*, 6th ed. Harlow: Prentice Hall, 2000.

MATHEMATICS

0541-111: Differential and Integral Calculus

Course Code : 0713-124 **Course Title** : Circuit Simulation Laboratory
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
Calculus is the foundation for understanding so much of science and engineering makes sense. Differentiation and integration, two methods of calculus, are very valuable in the field of engineering, and are commonly employed for optimization and summation, respectively. In this course, students will be introduced with the basic rules and theorems of differential and integral calculus. This course is designed to help students learn to apply laws and theorems to solve different mathematical as well as engineering problems.

Course Objectives:
The objectives of this course are to –

- Teach about the theorems and rules of differential and integral calculus.
- Make the students capable of applying laws and theorems to solve mathematical problems.
- Teach the students different solution methods of calculus and make them capable to choose from them.

Course Contents:
Differential Calculus: Limits, continuity, and differentiability. Successive differentiation of various types of functions. Leibnitz's theorem, Rolle's theorem, Mean value theorem, Taylor's and Maclaurin's theorems in finite and infinite forms, Lagrange's form of remainders, Cauchy's form of remainders, expansion of functions, evaluation of indeterminate forms of L' Hospital's rule. Partial differentiation. Euler's theorem. Tangent and normal sub tangent and subnormal in Cartesian and polar co-ordinates, determination of maximum and minimum values of functions. Curvature asymptotes. Curve tracing.
Integral Calculus: Integration by the method of substitution. Standard integrals, integration by successive reduction, definite integrals, its properties and use in summing series. Walli's formulae, improper integrals. Beta function and Gamma function. Area under a plane curve and area of a region enclosed by two curves in Cartesian and polar coordinates, volumes and surface areas of solids of revolution.

Resources:
Textbook(s):

[1] K. Mohammad, P. K. Bhattacharjee, and Md. A. Latif, *A Text book on Differential Calculus*, 10th ed. Chittagong: S. Tripaty, 2001.
[2] K. Mohammad, P. K. Bhattacharjee, and M. A. Latif, *A Text Book on Integral Calculus (with Differential Equations)*. Dhaka: Gonith Prokashon, 1965.
[3] B. C. Das and B. N. Mukherjee, *Integral Calculus Including Differential Equations*, 52nd ed. Calcutta: UN Dhur & Sons, 2010.
[4] S. Narayan and P. K. Mittal, *Differential Calculus*, 30th ed. New Delhi: S. Chand, 1966.

Reference(s):
[1] M. L. Khanna and S. K. Pundir, *Differential Calculus*, 25th ed. Meerut: Jai Prakash Nath & Co., 2014.
[2] S. Narayan and P. K. Mittal, *Integral Calculus*, 11th ed. New Delhi: S. Chand, 2011.
[3] B. C. Das and B. N. Mukherjee, *Differential Calculus*, 43rd ed. Calcutta: UN Dhur & Sons, 1997.

0541-121: Linear Algebra and Complex Variable

Course Code : 0541-121 **Course Title** : Linear Algebra and Complex Variable
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Linear algebra is essential to nearly every sub-discipline of electrical engineering. In so many Electrical Engineering specialties, complex analysis is likely the most important ability to have learned. Circuit theory, electromagnetism, electrostatics, electromagnetics, and other fields of electrical engineering utilize complex analysis. This course is designed to help students learn to apply laws and theorems to solve different mathematical as well as engineering problems.

Course Objectives:
The objectives of this course are to –

- Familiarize the students with some advanced concepts and methods in mathematics.
- Make the students capable of using numerous approaches of complex number systems and matrix for solving different problems.
- Help students to gather knowledge of such a mathematical toolbox that has application in all branches of engineering.

Course Contents:
Linear Algebra: Introduction to systems of linear equations. Gaussian elimination. Definition of matrices. Algebra of matrices. Transpose of a matrix and inverse of matrix. Factorization. Determinants. Quadratic forms. Matrix polynomials. Euclidean n-space. Linear transformation from IRn to IRm. Properties of linear transformation from IRn to IRm. Real vector spaces and subspaces. Basis and dimension. Rank and nullity. Inner product spaces. Gram-Schmidt process and QR decomposition. Eigenvalues and Eigenvectors. Diagonalization. Linear transformations. Kernel and Range. Application of linear algebra to electric networks.
Complex Variable: Complex number system, general functions of a complex variable, limits and continuity of a function of complex variable and related theorems, complex function differentiation and the Cauchy- Riemann equations, infinite series. Convergence and uniform convergence. Line integral of a complex function. Cauchy integral formula Liouville's theorem. Taylor's and Laurent's theorem, singular points. Residue. Cauchy's residue theorem.

Resources:
Textbook(s):
[1] M. Spiegel, S. Lipschutz, J. Schiller, and D. Spellman, *Complex Variables*, 2nd ed. in Schaum's Outline Series. New York: McGraw Hill, 2009.
[2] H. Anton and C. Rorres, *Elementary Linear Algebra: Applications Version*, 10th ed. Hoboken, NJ: Wiley, 2010.
Reference(s):
[1] D. Abdul Quddus, *Functions of a Complex Variables*. Dhaka: Titas Prokashon, 2000.
[2] J. K. Goyal and K. P. Gupta, *Functions of a Complex Variable*. Pragati Prakashan, 2011.

0541-123: Ordinary and Partial Differential Equation

Course Code : 0541-123 **Course Title** : Ordinary and Partial Differential Equation
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
In engineering, we often end up with differential equations while designing a system or evaluating the performance of that system. For the proper understanding of the system, we need to solve these equations. The aim of this course is to introduce students to different types of Ordinary and Partial Differential Equations, various rules, and analysis methods. Students will learn to apply the rules and theorems to solve different problems. Analysis of some real-life-based problems will also be done in this course.

Course Objectives:
The objectives of this course are to –
- Introduce students to different types of differential equations and their properties.
- Make students able to understand the reason for using different approaches to solving ODE and PDE.
- Make students able to apply the knowledge of such a mathematical toolbox that has application in all branches of engineering.

Course Contents:
Ordinary Differential Equation: Formation of Differential Equation; First order and first-degree differential equation, Separation of Variables, Homogenous equation, Equation reducible to homogenous, Exact equation, Linear Equation, Reducible to Linear Equation; First Order but Higher Degree Differential Equation: Solvable for P; Solvable for y; Solvable for x; Clairaut's Equation; Lagrange's Equation; Linear Differential Equation with Constant Coefficients; Linear Differential Equation with right-hand side non zero; Variation of the parameter; Method of Successive approximation (Picard's method); Reduction of Order; Method of undetermined Coefficient; Matrix method; Series Solution; Various types of Application of Differential Equations
Partial Differential Equations: Introduction, Linear and non-linear first-order equation. Standard forms, linear equations of higher order, equations of the second order with variable coefficients. Wave equations, particular solution with boundary and initial conditions.

Resources:
Textbook(s):
[1] M. D. Raisinghania, *Ordinary and Partial Differential Equations*. S. Chand, 2020.
Reference(s):
[1] R. Bronson, *Differential Equations*, 4th ed. in Schaum's Outline Series. New York: McGraw-Hill Education, 2014.
[2] D. G. Zill, *A First Course in Differential Equations with Modeling Applications*, 10th ed. Boston, MA: Cengage Learning, 2012.

0541-211: Coordinate Geometry and Vector

Course Code : 0541-211 **Course Title** : Coordinate Geometry and Vector Analysis
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Engineering students often find parameters that need the consideration of suitable coordinate systems and vector analysis. From an electrical and electronic engineering point of view to properly understand the concepts of AC circuits, Electromagnetic fields and Waves, Solid state physics, Microwave engineering, and many more the fundamental knowledge of coordinate geometry and vector analysis is a must. So the main focus of this course is to introduce students to co-ordinate geometry and vector analysis. This course is designed to help students learn to apply laws to solve different mathematical as well as engineering problems.

Course Objectives:
The objectives of this course are to -
- Teach about the rules of coordinate geometry and vector analysis.
- Make the students capable of applying the knowledge of this course to solve mathematical problems as well as real-life projects.

Course Contents:
Coordinate Geometry: Introduction to coordinate system, straight line, circle, conics, and their properties, Change of axes; Pair of Straight line & 2^{nd} Degree General Equation; Direction Cosines and projections, Shortest Distance; Coordinates of a point in space in different systems; Plane; Quadratics.
Vector analysis: Multiple products of vectors. Linear dependence and independence of vectors. Differentiation and integration of vectors together with elementary applications. Line, surface, and volume integrals. Gradient of a scalar function, divergence and curl of a vector function, various formulae. Integral forms of gradient, divergence, and curl. Divergence theorem. Stoke's theorem, Green's theorem and Gauss's theorem.

Resources:
Textbook(s):
[1] S. A. Sattar, *A Text Book on Vector Analysis*, 4th ed. Dhaka: Ali Publications, 1982.
[2] A. F. M. A. Rahman and P. K. Bhattacharjee, *A Text Book on Co-Ordinate Geometry with Vector Analysis*, 9th ed. Chittagong: S Bhattacharjee, 1995.

Reference(s):
[1] M. Spiegel, S. Lipschutz, and D. Spellman, *Vector Analysis*, 2nd ed. in Schaum's Outline Series. New York: McGraw-Hill Education, 2009.

0541-213: Numerical Methods

Course Code : 0541-213 **Course Title** : Numerical Methods
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
In the solution of an engineering problem, we often use mathematical modelling of the problem to find its behavior. As the mathematical modelling of real-time functions is complex, we cannot always solve the procedure analytically because the analytical method is intractable. To explore this type of complex system in electrical engineering, one requires computational methods. Such methods include techniques for the solution of a complex function, function optimization, integration of function, interpolation from known value to an unknown value, and computer algorithm to solve systems of equations or differential equations. This course aims to develop the necessary skills required by the students for the numerical solution of complex engineering problems both manually & by computer programming.

Course Objectives:
The objectives of this course are to

- Introduce students to the basic theorems and techniques of numerical analysis.
- Make the students capable of modelling and solving complex problems by numerical methods
- Make students able to analyse the error rate and pitfalls of numerical methods.
- Skilled students to implement the algorithms of numerical methods to solve problems by computer programming.

Course Contents:
Introduction to numerical methods: Introduction, Basic concepts: round-off errors, floating-point arithmetic, Convergence, Importance, application of numerical methods
Solution of algebraic and transcendental equations: Method of iteration, False position method, Newton-Raphson method, Bisection Method, Secant method, Error analysis for Iterative Methods
Solution of the simultaneous linear equation: Cramer's rule, Iteration method, Gauss Jordan Elimination method, Gauss's-Seidel method
Interpolation: Diagonal and horizontal differences, Differences of a polynomial, Newton's formula for forward and backward interpolation, Lagrange's interpolation formula, Spline interpolation
Numerical differentiation: Use of Newton's interpolation formulas
Integration: General quadrature formula, Trapezoidal rule, Simpson's rule, Weddle's rule
Solution of ordinary differential equations: Euler's method, Picard's method, Taylor's series method, Runge-Kutta method

Least-squares approximation of functions: linear and polynomial regression, Fitting exponential and trigonometric functions. Theories will be explained with the help of software tools.

Resources:
Textbook(s):
[1] R. W. Hornbeck, *Numerical Methods,* 1st ed. Quantum Publications, 1975.
Reference(s):
[1] P. I. Kattan, *MATLAB for Beginners: A Gentle Approach,* Petra Books, 2009.
[2] S. Chapra and R. Canale, *Numerical Methods for Engineers*, 8th ed. New York: McGraw-Hill Education, 2020.

0542-221: Probability and Statistics

Course Code : 0542-221 **Course Title** Probability and Statistics
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Engineers often needed to work with a lot of data, it's statistical analysis and probability. For electrical engineers, it is also important to properly understand topics like DSP, DIP and solid-state physics. The knowledge of probability and statistics is a must. So the aim of this course is to give the students in-depth knowledge on probability and statistics with their different dimensions of evaluation and application of the subject knowledge in solving real-life engineering problems.

Course Objectives:
The objectives of this course are to-
- Give the students basic knowledge on probability, Probability distribution.
- Make the students understand statistics and data analysis.
- Introduce the students with the hypothesis.

Course Contents:
Introduction: Meaning and Definition of Statistics, Types of statistics, Characteristics, Necessity of learning Statistics, Scopes and applications of statistics in Engineering, Limitations and misuses of statistics, Population and sample, Parameter and statistic, Collection of Data, Meaning of data, types of data, Sources of statistical data, Data collection tools, Variable and types of variable, Level of measurement, Constructing frequency distribution and relative frequency distribution, Qualitative and quantitative data, Cumulative frequency distribution, Graphic presentation of a frequency distribution with merits and demerits.
Measures of Central Tendency, Ungrouped data, Arithmetic Mean, Geometric Mean, Harmonic Mean, Weighted Mean, Median and Mode with uses, advantages and limitations, Grouped Data, Arithmetic Mean, Median and Mode with uses, advantages and limitations, Measures of Location, Quartile, Percentile and Decile, Mathematical Problems, Measures of Dispersion, Meaning of dispersion, measures of dispersion, absolute measures of dispersion, Skewness & Kurtosis, Concept of Skewness, kurtosis and their measures.

Correlation: Bi-variate data, scattered diagram, simple correlation, calculation of correlation coefficient, Regression, Simple regression, Multiple regression with examples, related maths, Coefficient of determination, Forecast the future value using the regression equation, Calculate and interpret the confidence and prediction intervals,
Probability: Sample Space, Tree diagram, define probability, Laws of probability, Additional rules, multiplication rules, Marginal probability, Joint probability, Conditional probability and Bayesian Probability, Probability Distributions, Basic idea of Probability Distribution, Binomial distribution and Poisson distribution with maths, Test of Hypothesis, Define Hypothesis, basic concepts of Hypothesis, Mean test with related maths.

Resources:

Textbook(s):

[1] R. Walpole, R. Myers, S. Myers, and K. Ye, *Probability & Statistics for Engineers & Scientists*, 9th ed. Boston: Pearson, 2016.

[2] J. Schiller, R. A. Srinivasan, and M. Spiegel, *Probability and Statistics*, 4th ed. in Schaum's Outline Series. New York: McGraw Hill, 2012.

Reference(s):

[1] J. A. Rice, *Mathematical Statistics and Data Analysis*, 3rd ed. Cengage Learning, 2006.

[2] S. P. Gupta and M. P. Gupta, *Business Statistics*. S Chand & Sons, 2019.

OTHER ENGINEERING

0613-122: Programming I

Course Code : 0613-122 **Course Title** : Programming I
Credit : 1 **Contact Hours** : 2 Hours/ week **Pre-requisite** : None

Course Rationale:
In present times learning programming is very essential for engineering graduates. Considering that this course is structured to introduce students to basic C programming and data structure concepts. This course aims at enabling students to work with basic C programming syntaxes such as condition, loop, input-output, functions, and other program control statements. At the end of this course, student will develop sufficient knowledge regarding how to solve real life problems through programming language.

Course Objectives:
The objectives of this course are to -

- Make students understand the basic computational concepts and elementary data structures
- Introduce students to basic computer programming execution procedure
- Make the students familiar with various C programming syntax and operations

Course Contents:
Basic Programming Concepts: Programming languages; Language processors; Problem solving with computer - problem definitions, analysis, algorithms, flowcharts, pseudo code, coding, running the programs, debugging, testing, documentations.
C Programming Language: Overview of C; C fundamentals; Operators and expressions; Data input and output; Control statements; Program structure - storage classes, automatic variables, external (global) variables, static variables, multifile programs; Character strings; Arrays; Functions; Structures and unions; Pointers; Data files.
Introduction to Data Structure: Arrays, Strings, Stacks, Queues, Asymptotic analysis (Big-O notation)

Resources:
Textbook(s):
[1] H. Schildt, *Teach Yourself C*, 3rd ed. Berkeley: McGraw-Hill, 1997.
[2] T. S. Subeen, *Computer Programming*, 4th ed. Dhaka: Dimik Prokashoni, 2019.
Reference(s):
[1] H. Schildt, *C: The Complete Reference*, 4th ed. Berkeley: McGraw Hill, 2000.
[2] E. Balagurusamy, *Programming In Ansi C*, 8th ed. New Delhi: McGraw Hill India, 2019

0613-222: Programming II

Course Code : 0613-222 **Course Title** : Programming II
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
In this course following tasks will be carried on: hand-execute simple programs using python, showing how to input data is processed, output data is produced, and how the values of internal variables change; implement python programs for problem solving using basic Machine Learning techniques.

Course Objectives:
The objectives of this course are to -

- Introduce students to Python programming
- Enable students to implement python programming with basic Machine Learning techniques

Course Contents:
Python Programming Language: Overview of Python; Python fundamentals; Operators and expressions; Data I/O; Control statements; Character strings; Arrays; Functions; File I/O; Data files; object-oriented programming Python.
Python Implementation: Overview of Basic Machine Learning techniques, Introduction to Python libraries and frameworks, Basic Machine Learning models: Linear regression with one and multiple variables.

Resources:
Textbook(s):
[1] M. Urban and J. Murach, *Murach's Python Programming*. California: Mike Murach & Associates, 2016
[2] Y. Liu, *Python Machine Learning by Example*. Mumbai: Packt Publishing, 2017.
[3] P. Barry, *Head First Python: A Brain-Friendly Guide*, 2nd ed. Sebastopol, California: O'Reilly Media, 2016.
Reference(s):
[1] M. Lutz, *Learning Python: Powerful Object-Oriented Programming*, 5th ed. Cambridge: O'Reilly Media, 2013.
[2] A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 3rd ed Tokyo: O'Reilly Media, 2022.

0715-121: Basic Mechanical Engineering

Course Code : 0715-121 **Course Title** : Basic Mechanical Engineering
Credit : 3 **Contact Hours** : 3 Hours/week **Pre-requisite** : None

Course Rationale:
Knowledge of basic mechanical engineering is necessary for many areas of electrical & electronic engineering, such as – machine design, service drawing, mathematical modeling, control systems design, robotics etc. This course introduces students to the fundamental

concepts of mechanical engineering, such as, heat, energy, the concept of fluid mechanics, mechatronic appliances such as, air conditioner, refrigerator etc.

Course Objectives:
The objectives of this course are to –

- Enable students to identify the core areas of mechanical engineering.
- Learn to distinguish between types of fluid machinery, and incorporate the knowledge of conduction and convection from it.
- Make students understand the working principle of internal combustion engines, refrigeration and air conditioning.

Course Contents:
Introduction to sources of energy, Study of fuels, steam generating units with accessories and mountings, study of steam generators and turbines.
Types of fluid machinery, study of impulse and reaction turbines, Pelton wheel and Kaplan turbines, study of centrifugal and axial flow machines, pumps, fans, blowers and compressors, study of reciprocating pumps, Basics of conduction and convection, critical thickness of insulation.
Introduction to internal combustion engines and their cycles, study of SI engines, CI engines and gas turbines with their accessories.
Refrigeration and air conditioning: their applications, study of different refrigeration methods, refrigerants, refrigeration equipment, compressors, condensers, evaporators, expansion devices, other control and safety devices, Psychometrics, study of air-conditioning systems with their accessories, Nomenclature, Low Noise Type, ceiling Cabinet type, Floor Cabinet type, large air volume type, Cooling & Heating Capacity, Air Handling Unit.

Resources:
Textbook(s):
[1] B. Agarwal and C. M. Agarwal, *Basic Mechanical Engineering*, 1st ed. New Delhi: Wiley India, 2008.
[2] D. A. Low, *Heat Engines*. London: Longmans Green and Co, 1955.
Reference(s):
[1] A. W. Culp, *Principles of Energy Conversion*. New York: McGraw-Hill, 1990.
[2] R. K. Rajput, *Basic Mechanical Engineering*, 4th ed. New Delhi: Laxmi Publications, 2007.

0788-414: Industrial Automation and Robotics

Course Code : 0788-414 **Course Title** : Industrial Automation & Robotics
Credit : 1 **Contact Hours** : 2 Hours/week **Pre-requisite** : None

Course Rationale:
As the global manufacturing industry enters its fourth revolution, innovations such as robotics, automation and artificial intelligence (AI) are set to take over. The number of active industrial robots worldwide is increasing by approximately 14% year on year, and automation continues to create new types of robots with improved utility and function. For this the need for automation engineers started increasing. This Industrial Automation &

Robotics course makes students enable to design, maintain & troubleshoot industrial automation & robotic system.

Course Objectives:

The objectives of this course are to –

- Introduce industrial automation & robotic techniques.
- Make students able to design & implement automated system.
- Make students able to maintain & troubleshoot automated system.
- Prepare students to analyse the performance indicator & security of system automation.

Course Contents:

PLC Programming: Introduction to PLC, basics of logic circuits, Ladder diagrams, Ladder Programming: Ladder Programming Conventions, Logic Functions, Latching, Sequencing. Types of Instructions: Timer/Counter Instructions, Logical Instructions, Compare Instructions, Move Instructions, Program Control Instructions. Integration of sensors and actuators through the PLC program. Communication between PC and PLC: Serial Communication, Ethernet, IOT etc. Implementation of PLC on Automation production system, Motor Control, Central Heating System, Robot Control System

Controller and Final Control Element: Control Valves, Controller Configuration, System Control, Control Modes, PID and Digital Controllers, Velocity Control, Adaptive Control, Microprocessor and Microcontrollers-STM132/8051/AV/ PIC.

Robotics: Introduction to robotics, types & specification of robot, DOF, configuration, control resolution, spatial resolution, accuracy & repeatability, sensors, actuators and drives of robotics.

Digital Image Processing and Robot Vision: Introduction to Image Processing and Robot Vision, Applications of Image Processing, Differences between Image Processing, Image Analysis and Robot Vision, Application of Robot Vision: Vision-Based Estimation, Calibration and Localization. Vision-Based Robot Navigation.

Applications of machine learning: Applications in robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing.

Mobile Robotics: Introduction of Mobile Robotics, Types and Applications of Mobile Robots Remote Sensing: Different Types of Sensors used in Mobile Robots, Sensor Modelling. Mobile Robot Control: Heading and Speed Control, Reference Trajectory and Incremental Control.

Resources:

Textbook(s):

[1] F. D. Petruzella, *Programmable Logic Controllers*, 5th ed. New York: McGraw Hill, 2016.

[2] N. S. Kumar, M. Saravanan, and S. Jeevananthan, *Microprocessors and Microcontrollers, 2Ed*, 2nd ed. New Delhi: Oxford University Press, 2016.

[3] B. Z. Sandler, *Robotics: Designing the Mechanisms for Automated Machinery*, 2nd ed. San Diego: Academic Press, 1999.

Reference(s):

[1] B. C. Kuo, *Automatic Control Systems*, 8th ed. New York: John Wiley & Sons, 2003.

[2] B. K. P. Horn, *Robot Vision*. Cambridge: MIT Press, 1986.
[3] R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2002..
[4] E. Alpaydin, *Introduction to Machine Learning*, 4th ed. Cambridge: MIT Press, 2020.
[5] G. Cook, *Mobile Robots: Navigation, Control and Remote Sensing*, 1st ed. Hoboken, N.J: Wiley-IEEE Press, 2011.