Fourth Year First Semester

Course code	**EE/PC/B/T/411**
Category	Program Core
Course title	Power System Protection & Switchgear
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PC/B/T/411: Power System Protection & Switchgear	L	T
Analysis of asymmetrical faults in power system.	6	2
General requirements of circuit breakers. Auto- reclosing feature – three pole & single pole auto reclosing. Formation of electric arc. Arc build-up and quenching theory, recovery voltage and RRRV, Arc re-striking phenomena. Problems of capacitive and low inductive current interruptions.	5	1
Rating of circuit breakers and effect of transient current on it. Different types of arc quenching media and special devices for arc quenching.	2	1
Different types of circuit breakers - their relative merits and demerits. Specific field of usage. Testing of circuit breakers. D.C circuit breaking.	3	0
Fundamental principles of protective relays, their properties and block diagrams, Single input relays, overcurrent, earth fault and over voltage relays. Principle and application of directional overcurrent and earth fault relays	5	1
Distance relays their settings, errors and remedies to errors.	4	1
Differential relays current and voltage comparison, Generator Protection, Transformer Protection, Motor Protection	5	1
Different types of pilot protection wire, carrier and wireless pilot. Carrier aided distance protection. Carrier phase comparison schemes.	3	0

Reference Books:

1	The Art and Science of Protective Relaying: C. R. Mason, John Wiley
2	Protective Relays – Their Theory and Practice Vol. I & II: A. R. Van, C. Warrington, John Willey
3	Power System Protection: S. P. Patra, S. K. Basu & S. Choudhuri, Oxford & IBH
4	Power System Protection & Switchgear: B. Ravindranath & M. Chander, Willey Eastern
5	Switchgear & Protection: S. S. Rao, Khanna Publishers
6	Power System Protection, Vols. I, II & III: Electricity Council, Macdonald & Co.
7	The J & P Switchgear Book: Johnson & Philips Ltd., Newness Butterworths.
8	Power System Protection, Vols. I, II, III & IV: The Electricity Training Association

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Classify** and analyze asymmetrical faults. (K4).
CO2	**Explain** the construction, principle of operation, merits and demerits and application of different types of circuit breakers. (K2)
CO3	**Explain** the fundamental operating principles and application of different types of protective relays. (K2)
CO4	**Describe** the protection schemes for different power system components like generators, transformers, transmission lines and induction motors. (K2)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Power System Protection & Switchgear	CO1	2	3		2											
	CO2	3		2	1		2	1	1							
	CO3	3	2	1			1	1	1							
	CO4	3	2	2	1		1	1	1							

Course code	**EE/PC/B/T/412**
Category	Program Core
Course title	Principles of Communication Engineering & Computer Networks
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PC/B/T/412: Principles of Communication Engineering & Computer Networks	L	T
<u>Communication Engineering:</u> Review of Fourier Transform and Random Process, Power Spectral Density (PSD), Auto-Correlation and Cross-Correlation Functions, Geometric Representation of Signals, Analog and Digital Signal Transmission and Reception, Channel and Noise, White Noise, Baseband and Carrier Communications.	3	1
Analog Communication: Amplitude Modulation (AM), Modulation Index, Double-Sideband -Suppressed Carrier (DSB-SC) , Conventional Double Sideband (DSB) and Single Sideband (SSB) Modulation, Demodulation of AM Signals, Amplitude Modulators (Power-law Modulators, Switching Modulator, Ring Modulator) and Demodulators (Synchronous Demodulator, Rectifier Detector, Envelop Detector), Frequency Division Multiplexing (FDM), Angle Modulation: Frequency and Phase Modulations (FM & PM), Narrowband and Wideband FM, Frequency Modulators and Demodulators, Direct and Indirect FM, Balanced Discriminator, FMFB and PLL FM Demodulators, AM and FM Radio Broadcasting, Superheterodyne AM and FM Receivers.	7	2
Digital Communication: Digital Communication Systems, Communication Channels (AWGN, Bandlimited, Multipath and Fading Channels), Introduction to Baseband and Bandpass Digital Modulations, Concepts of Power Efficiency, Bandwidth Efficiency, Inter-Symbol Interference (ISI), Bit-Error Rate (BER), Formatting And Baseband Modulation, Messages, Characters, and Symbols, M-ary Communication, PAM, PDM, PPM, Pulse Code Modulation (PCM), Uniform and Non-Uniform Quantizations, Companding, Time-Division Multiplexing (TDM), Baseband Demodulation, Digital Bandpass Modulation & Demodulation (Detection), Coherent Detection, Non-Coherent Detection, Frequency Shift Keying (FSK), Binary FSK Signals (BFSK), Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), BFSK Modulators and Demodulators, Amplitude Shift Keying (ASK),Binary ASK Signals, Binary ASK Modulators and Demodulators, Phase Shift Keying (PSK), Binary PSK(BPSK) Signals, Binary PSK Modulators and Demodulators.	6	2

Spread-Spectrum (SS) Modulation: Direct-Sequence (DS) and Frequency-Hop (FH) SS, Concept of Pseudo-Noise (PN) Sequences, Generation of PN Sequences, SS Modulation for Baseband Transmission, DS SS with Coherent BPSK (DS/BPSK), DS/BPSK Transmitter and Receiver, Processing Gain, Slow Frequency Hopping and Fast Frequency Hopping.	2	1
Wireless Communications: Generations of Cellular Networks, Multiple-Access Techniques, FDMA, TDMA, CDMA. The Cellular Concept. Frequency Reuse. Mobility Management. Concepts of Channel Assignment, Handoff Management.	2	0
Computer Networks Introduction to Computer Networks: Analog vs. Digital Transmission, Nyquist and Shannon Limits, ISO/OSI Layered Architecture, OSI Reference Model. Basics of Digital Data Transmission and Media: UTP,STP, Coax, Fiber, Modems, RS-232C.	4	2
Error Detection and CRC Polynomial Codes, Encoding Schemes (NZ, NRZ, Manchester Encoding).	4	1
Local Area Networks (LAN), IEEE 802.3, 802.5 Standards, Token Ring, Token Bus, CSMA/CD, Ethernet, Hub, Switches and Bridges. Wireless LAN: IEEE 802.11x standard. Circuit Switching and Packet Switching, Digital Switching Concepts, ISDN, Virtual Circuits, X.25.	5	1
Network and Transport Layer, Routing and Traffic Control, Flow and Congestion Control, Internetworking, Routers and Gateways, Internet IP, Transport Protocols, TCP/IP, ATM. Network Security.	7	2

Reference Books:

1	Communication Systems Engineering: John G. Proakis and Masoud Salehi, 2nd Edition, Pearson Education, 2008.
2	Digital Modulation Techniques: Fuqin Xiong, Artech House, Boston, London, 2000.
3	Wireless Communications: Principles and Practice: Theodore S. Rappaport, 2nd Edition, Prentice Hall of India Edition, 2008.
4	Computer Networks: Tanenbaum, PHI.
5	Random Variables and Stochastic Processes: A. Papulis and S. Unnikrishna Pillai, Probability, 4th Edition, Tata McGraw-Hill, 2002
6	Communication Systems: Simon Haykin, 4th Edition, Wiley India Edition, 2008.
7	Digital Communication: Fundamentals and Applications: Bernard Sklar, 2nd Edition, Pearson Education, 2007.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Recall** Fourier Transform, notions of Random process and Noise; **Describe** Analog and Digital transmission; State Nyquist and Shannon Limits. (K1, K2)
CO2	**Describe** different Amplitude and Frequency modulation and demodulation schemes, ISO/OSI Layered Architecture, Protocol Architecture Models. (K1, K2, K3)
CO3	**Interpret** different digital modulation and demodulation schemes, Digital Data Transmission and Media, Error Detection and CRC Polynomial Codes and different Encoding Schemes.(K2, K3)
CO4	**Describe** and **Analyse** Spread-Spectrum techniques and basic principles of Wireless Communication, Local and Wide Area Networks with different architectures and standards. (K2, K3, K4)
CO5	**Explain** Routing, Flow and Congestion Control, Internetworking, Internet and Transport Protocols, ATM and issues related to Network Security. (K2, K3, K4)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Principles of Communication Engineering & Computer Networks[H]	**CO1**	**3**	**2**	**1**												**3**
	CO2	**2**	**3**	**1**	**1**											**3**
	CO3	**2**	**3**	**2**				**1**								**3**
	CO4	**2**	**3**	**2**	**1**		**1**	**1**	**1**				**1**			**3**
	CO5	**2**	**3**	**2**	**2**		**1**	**1**	**1**				**1**			**3**

Elective Paper-I

Course code	**EE/PE/B/T/413**
Category	Program Elective
Course title	Elective Paper-I
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;

Course code	**EE/PE/B/T/413A**
Category	Program Elective
Course title	Digital Control Techniques
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PE/B/T/413A: Digital Control Techniques	L	T
Introduction: Introduction, Advantages and disadvantages of digital control, Configuration of the basic digital control scheme, Examples of practical digital control systems.	1	0
Review of Signal Conversion and Processing: Comparative study of basic features of Continuous-time analog signal, Continuous-time quantized signal, Sampled-data signal, and Digital signal, Sampling, quantization and coding of analog signal, Sample-and-Hold devices and their characteristics: Sampling duration, Sampling period, Acquisition time, Aperture time, Settling time, and Hold mode droop, Choosing the minimum and maximum sampling frequency, Concept of Hold operation and Zero Order Hold (ZOH),Transfer function of ZOH, Ideal sampled signal, Discrete-time vs. Digital Control Systems, Block diagram representation of the various signals associated at different subsystems of a digital control system.	3	2
Modeling of Discrete-time Control Systems: Time-domain model-State variable model, Difference equation model, Impulse response model; Transfer Function model Pulse Transfer Function, Transfer Function of unit delayer, Derivation of equivalent Pulse Transfer Function of Open Loop and Closed Loop system by Block Diagram reduction techniques.	3	2
Time Domain Analysis and Design of Discrete-time Control System: Time response calculation of discrete time control systems (open loop and closed loop) for standard test input using Pulse Transfer Function model, Mapping between s-plane and z-plane, Stability analysis of closed-loop systems in the z-plane, Method of testing absolute stability-The Jury stability test, Transient and Steady State response of discrete-time systems -Transient response specifications, Static error constants; Discrete-time Control system design by Root-Locus method.	5	2
Frequency Domain Method of Analysis and Design of Discrete-time Systems: Bilinear transformation, Bode diagram of discrete-time system- Gain margin and Phase margin, Design of compensators using Bode diagram for discrete-time system, Design on the W-plane and W'-plane.	2	2
State-Space Analysis of Discrete Time Control System: Discrete-time state space equations, Canonical and Diagonal forms of state-space equations, Solving discrete-time state-space equations, Similarity transformation, Discretization of continuous-time state-space equations.	4	1

Digital PID Controller Design: Conventional design, Model based design.	1	1
Controllability and Observability of Discrete Time Systems: Definition of controllability for discrete-time system, Test for controllability for discrete-time system, Definition of observability for discrete-time system, Test for observability for discrete-time system.	2	1
Pole Placement and Observer Design for Discrete Time Systems: Design of a discrete-time state regulator by pole placement, Design of a discrete-time state feedback control system with reference input by pole placement, Design of full order and reduced order state observers, Compensator design by separation principle.	3	1
Advanced Digital Control Systems: Basic Principles of Intelligent Control: Fuzzy Logic Control, Artificial Neural Network based Control, Neuro-Fuzzy Control, Basic Principles of Embedded Digital Control System Design.	3	1

Reference Books:

1	Discrete-Time Control Systems: Katsuhiko Ogata, 2nd edition, Prentice Hall.
2	Digital Control Systems: Benjamin C. Kuo, Holt-Saunders International Edition.
3	Digital Control and State Variable Methods: M. Gopal, 2nd edition, Tata McGraw Hill.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Describe** different signal conversion techniques and **Obtain** discrete-time plant models of different topologies (K1).
CO2	**Describe** time-domain and frequency-domain behaviors of discrete-time systems and **Comprehend** the notion of stability in time-domain and frequency-domain. (K2)
CO3	**Describe** principles of Intelligent Control. (K2)
CO4	**Analyse** the discrete-time systems in state-space and **Examine** controllability and observability of discrete-time system (K3).
CO5	**Synthesize** Digital PID Controllers and compensators. (K4)
CO6	**Design** state-feedback controllers, for regulatory and tracking kind of problems. (K5)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Digital Control	**CO1**	**3**	**2**	**1**		**1**							**1**		**3**	

Techniques	**CO2**	**2**	**3**	**2**		**1**							**1**		**3**	
	CO3	**2**	**3**	**1**									**1**		**3**	
	CO4	**2**	**2**	**3**	**1**	**2**							**2**		**3**	
	CO5	**2**	**2**	**2**	**3**	**2**							**2**		**3**	
	CO6	**2**	**2**	**2**	**2**	**3**							**2**		**3**	

Course code	**EE/PE/B/T/413B**
Category	Program Elective
Course title	High Voltage Technique – I
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PE/B/T/413B: High Voltage Technique – I	L	T
Generation of charge particles in gaseous dielectrics. Electric breakdown mechanism. Paschen's law. Streamer mechanism of spark breakdown. Breakdown in non-uniform field.	4	1
Breakdown in gases: Corona. Polarity effect. Voltage time lag. Electronegative gases. Effect of placing barriers.	3	1
Breakdown in solid dielectrics. Intrinsic breakdown, Electromechanical breakdown.	2	1
Breakdown in solid dielectrics: Streamer breakdown, Thermal breakdown, Erosion breakdown, Partial discharges.	2	1
Breakdown in liquid dielectrics. Electronic breakdown, cavitations breakdown.	2	1
Breakdown in liquid dielectrics: Breakdown due to suspension particle mechanism.	1	1
Analytical method of electric field analysis. Conducting and dielectric cylinder and sphere in uniform field.	3	1
Electric field analysis by Finite Difference Method. Formulations for homogeneous and multi-dielectric media. Formulations in 2D, 3D and axis-symmetric systems. Concept of equal and unequal nodal distances in problem formulation.	3	2
Electric field analysis by Finite Element Method. Formulations for homogeneous and multi-dielectric media.	3	1
Electric Field Analysis by Charge Simulation Method. Basic formulations for homogeneous and multi-dielectric media. Types of charges and accuracy criteria.	3	1
Electric stresses and their consequences in high voltage system. Techniques of stress control.	2	1

Reference Books:

1	High Voltage Engineering: Edited by Alston.
2	High Voltage Engineering Fundamentals: Kuffel & Zaengl.
3	High Voltage Engineering: Razevig & Chourasia.
4	Electric Field Analysis: Sivaji Chakravorti.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:	
The students of the course should be able to	
CO1	**Describe** different types of breakdown mechanism in gases, liquids and solids (K2).
CO2	**Apply** the concept of electric field analysis by (i) FDM, (ii) FEM and (iii) CSM (K3).
CO3	**Analyse** the electric field of Cylinder and Sphere in uniform field (K4).
CO4	**Determine** the possibilities of (i) electric stress and their control (ii) Partial discharge phenomena (K4).

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
High Voltage Technique – I	**CO1**	**3**		**2**			**1**	**1**					**1**		**3**	
	CO2	**2**	**3**	**2**	**1**	**1**						**1**			**3**	
	CO3	**2**	**1**	**1**		**1**									**3**	
	CO4	**2**	**3**	**2**		**1**		**2**							**3**	

Course code	**EE/PE/B/T/413C**
Category	Program Elective
Course title	Special Electrical Machines & Drives
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PE/B/T/413C: Special Electrical Machines & Drives	L	T
Reluctance motor, Switched Reluctance motor, Brush-less DC motor, Hysteresis motor, Servo-motor, Stepper Motor. Electronic excitation schemes for these.	8	4
Permanent magnet dc machines. PM synchronous motor and generator, Linear Induction motors.	4	2
Energy efficient motors.	1	0
Induction regulators: Basic principles.	1	0
Study of the different characteristics for doubly-fed slip-ring induction machine as generator. Development equivalent circuit, power balance equations and converter control methodology as generator.	4	2
Method of grid synchronization.	2	0
Introduction to Microcontroller, DSP and PLC applications for Induction and synchronous motor drives.	3	2
Introduction to Artificial Intelligence and application to motor drives.	2	0
Feedback system components for drive application like tacho-generators, optical encoders, hall-effect sensors.	2	1
Voltage and current sensing with dc and variable frequency supply.	1	1

Reference Books:

1	Power Electronics and Motor Control: W. Shepherd, L. N. Hulley & D. T. W. Liang, Cambridge University Press.
2	Modern Power Electronics and AC Drives: B. K. Bose, Pearson Education Asia.
3	Electric Motor Drives: R. Krisnan
4	Principles of Electric Machines and Power Electronics: P. C. Sen, John Wiley & Sons
5	Electric machinery: Fitzgerald & Kingsley
6	Fractional & Sub-fractional Horsepower Motors: C. G. Veinott
7	Electrical machines: P. K. Mukherjee & S. Chakravorti
8	Permanent Magnet Motor Technology: J. Gieras
9	Permanent-Magnet and Brushless DC Motors: Kenjo & Nagamori, Clarendon Press, 1985
10	Design of Brushless Permanent-magnet Machines: Hendershoot & Miller, Motor Design Books, 2010

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Describe** the constructions of special electrical machines and other regulating devices (K1).
CO2	**Describe** the characteristics and basic principles of operation of special machines and **Explain** the control mechanisms of commonly used power electronic controllers used. (K2).
CO3	**Discuss** the modalities of Microcontroller, DSP, PLC applications to motor drives and **comprehend** the performance of energy efficient motors (K3).
CO4	**Analyse** the importance of using artificial intelligence to different electric drive systems (K3).
CO5	**Develop** the drive model for the special machines using different voltage and current sensing techniques (K3).
CO6	**Explain** The students should be able to **Explain** use of different feedback components and their implications in electric drive systems (K5).

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Special Electrical Machines & Drives	**CO1**	**3**	**2**	**1**				**1**					**1**		**3**	
	CO2	**1**	**3**	**1**				**1**					**1**		**3**	
	CO3	**1**	**2**	**3**	**1**			**1**					**1**		**3**	
	CO4	**1**	**2**	**1**	**3**			**1**					**1**		**3**	
	CO5	**1**	**3**	**2**				**1**					**1**		**3**	
	CO6	**1**	**3**	**2**	**1**			**1**							**3**	

Course code	**EE/PE/B/T/413D**
Category	Program Elective
Course title	Advanced Instrumentation-I
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PE/B/T/413D: Advanced Instrumentation-I	L	T
Waveform-synthesizer. vector voltmeter. lock-in amplifier.	3	1
Smart sensor systems. Sensor fusion, various levels, applications, feature extraction methods and classification of features related to fusion strategy.	5	2
Data Acquisition Systems for Distributed instrumentation and SCADA.	2	1
Time-frequency analysis of signals: Short-time Fourier transform, Wavelet transform and their applications.	4	2
Transducers for electromagnetic variables: Rogowskii coils, Hall-probes, flux-gate devices.	3	1
Force Balance Accelerometers, Tactile sensors. Digital Transducers.	2	0
Statistical analysis of quantization-noise in ADCs Special ADCs: Oversampling type without noise shaping, Sigma-Delta Modulator type, Full flash and Half-flash Architectures	6	1
Correlation methods of measurement	1	0
Signal Processing techniques in Instrumentation. Linear and Exponential Averagers, median filters.	2	1
System Identification techniques: deconvolution, Regression models: AR, MA and ARMA; applications: Lattice filters.	2	1

Reference Books:

1	Electronic Measurements & Instrumentation: B. M. Oliver & J. M. Cage
2	Probability, Random Variables and Random Signal Principles: P. Z. Peebles
3	Digital Signal Processing and Applications: Dag Stranneby and William Walker
4	The Data conversion Handbook: Walt Kester
5	Electrical Measurements: Fundamentals, Concepts, Applications: Martin U. Reissland
6	High Voltage Measurement Techniques: A. J. Schwab
7	Control Sensors and Actuators: Clarence W. de Silva
8	Digital Measurement Techniques: T. S. Rathore
9	Digital Signal Processing: Principles, Algorithms & Applications: J. G. Proakis and M. G. Manolakis
10	Mathematical Techniques in Multisensor Data Fusion: David L. Hall
11	Statistical Digital Signal Processing and Modeling: Monson H. Hayes
12	Transducers and Instrumentation: D. V. S. Murty
13	Wavelet Transform–Introduction to Theory & Applications: R. M. Rao & A. S. Bopardikar

Content Delivery Method :

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Describe** the operating principles of advanced instruments and transducers. (K1)
CO2	**Explain** various signal processing tools suitable for electrical instrumentation. (K2)
CO3	**Use** various components and methodologies involved in signal acquisition, processing and analysis related to electrical instrumentation. (K3)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Advanced Instrumentation-I	**CO1**	**3**	**1**												**3**	
	CO2	**3**	**2**	**1**											**3**	
	CO3	**2**	**3**	**1**	**2**	**2**									**3**	

Course code	**EE/PE/B/T/413E**
Category	Program Elective
Course title	Advanced Power Systems Analysis
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PE/B/T/413E: Advanced Power Systems Analysis	L	T
Load flow analysis: Formulation of the load flow problem. Solution of load flow problem by Newton Raphson methods. Incorporating tap changing transformers and phase shifters in load flow problem.	5	2
Economic operation: Characteristics of generating units, generation scheduling neglecting transmission loss, scheduling problems considering transmission loss and its solution by B-coefficient method, derivation of B-coefficients, introduction to hydro-thermal scheduling problem.	6	1
Unit commitment problem: Definition of the problem, different costs and constraints to be considered, solution of the problem using priority order approach and dynamic programming,	3	1
Multi-area Load Frequency Control: Modeling of Tie line, area control error, block-diagram representation of two-area load frequency problem.	1	1
Short circuit study: Formulation of bus impedance matrix, digital computer solution of symmetrical and unsymmetrical faults.	5	1
Transient stability: Multi machine transient stability, its mathematical formulation and solution, representation of excitation system and its inclusion in stability studies, methods of improving transient stability.	5	1
Introduction to dynamic stability: Small perturbation model of single machine connected to infinite bus, analysis of voltage regulator action, cause of negative damping, preliminary concept of dynamic stability and power system stabilizer.	3	1
Voltage stability problem – causes of voltage instability, Analysis of static voltage stability, Sub synchronous resonance in Power System.	2	1

Reference Books:

1	Computer Methods in Power System Analysis: Stagg & El-Abiad, Tata McGraw Hill
2	Computer Aided Power System Operation & Analysis: R. N. Dhar, Tata McGraw Hill
3	Electric Energy Systems Theory: O. I. Elgard, Tata McGraw Hill
4	Power Generation Operation And Control: A. J. Wood & B. F. Wollenberg, John Willey
5	Power System Engineering: I. J. Nagrath & D. P. Kothari, Tata McGraw Hill
6	Power System Analysis: A. R. Bergen & V. Vittal, Pearson education
7	Computer Aided Power System Analysis: G. L. Kusic, Prentice Hall India
8	Power System Stability and Control: P. Kundur, McGraw Hill

9	Power System Stability Operation and Control: A. Chakrabarti and Sunita Halder, PHI Learning System.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Describe, Formulate** and **Solve** power systems load flow problems (K1, K5, K3).
CO2	**Formulate, Solve** and **Analyze** various types of short circuit faults in power network (K5, K3, K4).
CO3	**Describe, Formulate** and **Solve** problems related to economic operation of power systems (K1, K5, K3).
CO4	**Describe, Formulate** and **Solve** power system transient stability problem (K1, K5, K3).
CO5	**Classify** and **Describe** different types of stability problems in power systems and to identify the causes for occurrence of those problems (K2, K1).

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Advanced Power Systems Analysis	**CO1**	**3**		**2**			**1**	**1**	**1**				**1**		**3**	
	CO2	**2**	**3**	**2**	**1**				**2**			**1**			**3**	
	CO3	**2**	**1**	**1**				**1**							**3**	
	CO4	**2**	**3**	**2**			**1**	**2**							**3**	
	CO5	**2**	**3**												**3**	

Course code	**EE/PE/B/T/413F**
Category	Program Elective
Course title	Illumination Science and Lighting Design
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PE/B/T/413F: Illumination Science and Lighting Design	L	T
Visual performance evaluation; external factors of vision-visual acuity, contrast sensitivity, time, luminance, color; visual perception; assessment of visibility level;	2	0
Biological factors of lighting-circadian system; blue light hazards;	1	0
Color science- additive and subtractive theory, color vision model, Colorimetry– visual basis of colorimetry, source color & object colour.	2	0
CIE chromaticity –XYZ and UCS color space, source and object color specification, dominant wavelength, purity; Munsellcolour system;	2	1
Grassmann's law of color mixing, CIE standard source and illuminant. colorimetric instrument –light source colorimetry and colorimetry of materials;	2	1
Correlated color temperature, color rendering index-its measurement; metamerism.	2	0
Photometry-types of detectors–characteristics, figures of merit etc.; Photometric measurements–C-Gama and B-Beta photometry; understanding of luminaire photometric test; sources of errors and correction;	2	0
Luminaire –design considerations, optical control schemes, design procedure of reflecting and refracting type of luminaire, testing of luminaire, Ingress Protection (IP) code, Luminaire standard –BIS recommendation.	2	0
LASER –characteristics, features and applications. Optical fiber –its construction as light guide, features and application.	2	0
Coloured LED & white LED –features and characteristics, features and applications;	1	0
Lamp materials-filament, glass, ceramics, gases, phosphors and other metals & nonmetals; theory of gas discharge phenomena; lamp design considerations;	3	0
characteristics of low & high pressure mercury-vapour& sodium-vapour lamps; modern energy saving lamps -comparative study;	2	0
Illuminance calculation-illuminance as vector quantity, direct illuminance from point, linear, area sources;	3	2
advanced methods of illuminance calculation, luminance, luminous exitance, non-planer illuminance –spherical, cylindrical etc.,interreflectedilluminance;	2	2
Ballasts &ignitors for different discharge lamps; design consideration of electromagnetic and electronic ballast for TL lamps; ballast materials.	2	1
Lighting controls–different control equipment-on/off switch, simple automatic switches, photocell, occupancy sensor, timer, lighting contactors, dimmer, low	2	0

voltage relays; communication links-line and low voltage hardware; different control strategies		

Reference Books:

1	Lamps and Lighting: Edited by J. R. Coaton and A. M. Marsden, 4th Edition.
2	Lighting for energy efficient luminous environments: Ronald N. Helms & M Clay Belcher.
3	Illumination Engineering: From Edison lamp to the LASER: J. B. Murdoch
4	Electric Discharge Lamps: John F. Waymouth
5	Human Factors in Lighting: P. R. Boyce
6	Lighting Control Handbook: Craig Dilovie

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Define** the visual performance parameters, non-planer illuminance metrics, colorimetric parameters and describe the biological factors of lighting. (K1)
CO2	**Discuss** and **illustrate** advanced illuminance computation procedures due to linear, area sources and computation procedures of CIE chromaticity for both the source colour and object colour. (K2)
CO3	**Recognise** the working principles of different electric lamps including ballast and other control gears and relate their operational characteristics with the materials, the lamp systems made of. (K1)
CO4	**Develop** the concept of Type-C (C-gamma) and Type-B (B-beta) photometric system and interpret photometric test reports of luminaire to predict its light distribution pattern as well as its applicability. (K3)
CO5	**Compare** different light control equipment, schemes and distinguish their operational characteristics to identify scope of applications. (K4)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Illumination Science and Lighting Design	**CO1**	**3**	**2**		**1**										**3**	
	CO2	**2**	**3**			**1**									**3**	
	CO3	**2**	**1**	**3**	**1**										**3**	
	CO4	**1**	**2**	**3**		**1**									**3**	
	CO5	**1**		**2**		**3**									**3**	

Course code	**EE/PE/H/T/414**
Category	Program Elective
Course title	Honours Paper III (Basket-3)
Scheme and Credits	L-T-P: 3-1-0; Credits: 4.0;

Course code	**EE/PE/H/T/414A**
Category	Program Elective
Course title	Introduction to Nano-Biotechnology
Scheme and Credits	L-T-P: 3-1-0; Credits: 4.0;
Pre-requisites (if any)	

EE/PE/H/T/414A: Introduction to Nano-Biotechnology	L	T
The fundamental science behind nanotechnology. Electron, atoms and ions, molecules. Metals. Bio-systems. Molecular recognition. Electrical conduction and laws. Quantum mechanics and ideas. Optics.	4	2
Tools for measuring nanostructures. Scanning probe instruments. Spectroscopy. Electrochemistry. Electron microscopy.	4	2
Tools to make nanostructures. Nanolithography. Molecular synthesis. Self assembly. Nanoscale crystal growth. Polymerization. Building blocks.	2	1
Smart materials. Self-healing structures. Recognition. Separation. Catalysis. Heterogeneous nanostructures and composites. Encapsulation. Consumer materials.	3	2
Sensors. Natural and man-made nanoscale sensors. Electromagnetic sensor. Biosensors. Electronic noses.	2	1
Optics and electronics. Optical control and manipulation. Electronics. Carbon nanotubes. Soft molecule electronics.	2	1
Introduction to nanoscience and nanotechnology, the “nano–bio” interface, nano-biotechnology, current status and future trends.	3	1
Reviewing major fields in nano-biotechnology, bio-molecular motors and devices.	2	0
Self-assembled structures- a key to nano-bio technology, biological research at the nanoscale, biomimetics, biotemplating, and newly-designed structures, DNA-based nanotechnology and nanoelectronics.	3	1
Applications of nano-bio technology in different fields of electronics, opto-electronics and related modern techniques.	3	1
History of nano-biotechnology, nanoscale and nanostructures, classification of nano materials, manufacturing approaches.	3	1
Nano-biotechnology and its clinical applications- drug delivery, treatment of neurodegenerative disorders, operative dentistry, ophthalmology, surgery, tissue engineering, antibiotics, nano pharmaceuticals, modified medicated textiles.	3	1
Biomedical applications of nanotechnology- introduction, biomedical nanotechnology , diagnostics, nanodrugs, prostheses and implants, potential risks.	3	1

Reference Books:

1	Nanotechnology: A Gentle Introduction to the Next Big Idea: Mark Ratner, Daniel Ratner, 2003, Pearson Education, Inc.

2	Nano Technology : Basic Science To Emerging Technology: Shalini Suri, 2006, Aph Publishing Corporation
3	Nano BioTechnology: BioInspired Devices and Materials of The Future: Oded Shoseyov, Ilan Levy, 2007, Humana Press

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Explain** the various terms related to nanotechnology (K2)
CO2	**Apply** the concept of nanotechnology for the formation of semiconductors. (K3)
CO3	**Point** out the bottom-up and top-down approaches (K4)
CO4	**Relate** the concept of nano-bio technology in modern engineering research (K4)
CO5	**Apply** the techniques of nano-bio interface in electrical and electronic systems (K3)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Introduction to Nano-Biotechnology	**CO1**	**3**											**1**			**3**
	CO2	**2**	**3**	**1**	**1**	**1**							**1**			**3**
	CO3	**3**		**2**									**1**			**3**
	CO4	**3**	**1**	**1**	**2**		**1**						**1**			**3**
	CO5	**3**	**1**	**2**	**1**	**1**							**1**			**3**

Course code	**EE/PE/H/T/414B**
Category	Program Elective
Course title	Solid State Lighting Systems
Scheme and Credits	L-T-P: 3-1-0; Credits: 4.0;
Pre-requisites (if any)	

EE/PE/H/T/414B: Solid State Lighting Systems	L	T
Materials-UV-VIS-IR LEDs; carrier recombination - radiative and non-radiative;	3	0
Carrier lifetime, current density; semiconductor junction- p-n homo-junction. hetero-junction, double hetero-junction;	3	0
LED device structure, white LED configuration and challenges, White LEDs-phosphor conversion, color mixing, color rendering; trade-off between efficiency and color rendering;	4	0
LED efficiency, construction, light extraction; escape cone; primary and secondary optics;	3	1
Current-voltage characteristics; thermal resistance; junction temperature, effect of ambient temperature on electrical and photometric parameters.	4	0
Basics of Organic LEDs- materials, electrical and optical properties;	4	0
LED Modules and Thermal Management	4	1
LED driving circuits-ac to dc; dc to dc conversion; over current protection; THD, driver efficiency, loss; LED module design.	4	2
Testing of LED chip and LED module – related Indian Standards; Electrical and photometric test reports.	4	2
Applications-Few Practical Examples like LED Flashlight, Light bulbs etc., PV battery-powered lighting system; LED replacement for filament lamp and fluorescent lamps in lighting design;	4	2
Dynamic façade lighting;	3	0
Visible Light Communication	4	0

Reference Books:

1	Light Emitting Diodes: E. F. Schubert; 3rd Edition, 2018
2	Understanding LED Illumination: M. Nisa Khan, CRC Press, 2014.
3	Photonic Devices: Jia Ming Liu; 2005; Cambridge University Press.
4	Introduction to Light Emitting Diode Technology and Applications: Gilbert Held; 2008. 1st Edition, Auerbach Publications.
5	Organic Light-Emitting Diodes: Luiz Pereira, Pan Stanford Publishing, 2012

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Define** and **describe** the physical processes involved in the light generation in LEDs. (K1)
CO2	**Discuss** and **illustrate** LED device structure and phosphor conversion process for white LEDs. (K2)
CO3	**Develop** the concept of LED Modules and Thermal Management scheme and interpret photometric test reports of LED module to predict its light distribution pattern as well as its applicability. (K3)
CO4	**Recognise** the working principles of LED driving circuits and thus propose design scheme based on desired operational characteristics. (K5)
CO5	**Compare** among LED lighting products and appraise their operational characteristics to identify scope of applications. (K6)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Solid State Lighting System	**CO1**	**3**	**2**		**1**			**2**								
	CO2	**2**	**3**													
	CO3	**2**	**1**	**3**	**2**											
	CO4	**1**	**2**	**3**		**2**										
	CO5	**1**		**2**		**3**										

Course code	**EE/PE/H/T/415**
Category	Program Elective
Course title	Honours Paper IV (Basket-4)
Scheme and Credits	L-T-P: 3-1-0; Credits: 4.0;

Course code	**EE/PE/H/T/415A**
Category	Program Elective
Course title	Principles of Software Engineering
Scheme and Credits	L-T-P: 3-1-0; Credits: 4.0;
Pre-requisites (if any)	

EE/PE/H/T/415A: Principles of Software Engineering	L	T
The Product: Introduction, Definition of Software, the evolving role of Software, Software characteristics, Software components, Software applications, Software myths, Software crisis, Summary.	3	0
Software Project Planning & Estimation: Project Planning, Milestones & Deliverables, Project Scheduling, -Bar Charts & activity network, Risk Management, Configuration Management, Independent Verification & Validation, Software Estimation Techniques-COCOMO Model, -The Software Equation, -Estimating Software Maintenance Cost, Summary.	5	1
Software Quality Assurance (SQA): Introduction to QA and Planning, Software Quality Assurance & Standards- Documentation Standards,. Process & Product Quality, Quality Planning, Quality Control- Quality Reviews, Software Measurements & Metrics- The Measurement Process, Product Metrics, Analysis of Measurements, Statistical Quality Assurance, Software Testing - Software Safety & Hazard Analysis, The SQA Plan, The ISO 9000 Quality Standard- The ISO Approach to QA Systems, The ISO 9001 Standard, Summary.	5	3
Real-Time Software Design: System Considerations, Real-Time Systems - Integration & Performance Issues, Interrupt Handling, Real-Time Databases, Real-Time Operating Systems-Executives Real-Time Languages, Task Synchronization Communication, Case Study- Data Acquisition System, Summary.	6	3
Requirements Engineering: Ward & Mellor methodology, Requirement Analysis, Requirement Elicitation, Requirement Validation, Generation of Software Requirement Specifications ,Formal Specification Techniques, State-Oriented Notations - State Chart, Mode Chart, Petri-Nets, Object-Oriented Notations- Use Case, UML, A Case Study, Summary.	7	4
Software Design: Fundamental Design Concepts -Abstraction - Information Hiding - Modularity - Concurrency, Modules & Modularization Criteria- Top-Down & Bottom-up Approach- Coupling & Cohesion, Structured Analysis & Design Techniques (SADT), Data Model - Data Dictionary - ERD (Entity-Relationship Diagram), Environmental Model - Context Diagram - Event List, Functional Model- Data flow diagram (DFD) - PSPEC (Process Specification), Behavioral Model- State Transition Diagram (STD) - CSPEC (Control Specification), Summary.	7	4

Distributed System Architectures: Case Study: Introduction to Client/Server systems, The Structure of C/S systems- Software Components for C/S systems - Distribution of Software Components - Linking C/S Software components - Middleware & Object Request Broker Architectures, Software Engineering for C/S Systems, Analysis, Modeling Issues, Designs for C/S Systems-Conventional design approaches, Database design, Process design iteration, Testing Issues-Overall C/S Testing Strategy- Process Design Techniques, Summary.	3	1

Reference Books:

1	Software Engineering- A Practitioner's Approach: R.S. Pressman, 4th Edition, McGRAW-HILL International Editions, 1997.
2	Software Engineering Concepts: Richard Fairley, Tata-McGRAW-HILL Edition, 1997.
3	Software Engineering: I. Sommerville, 6th Edition, Pearson Education, 2004
4	A Practical Guide to Real-Time Systems Development: S. Goldsmith, PH, 1993
5	Real-Time Systems Design and Analysis: Philip A. Laplante, 3rd Edition, Wiley-India, 2007.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Describe** the software life cycle development processes and concepts of distributed architecture; **Describe** different aspects of SQA (K1).
CO2	**Comprehend** the concepts of task scheduling in RTOS. (K2).
CO3	**Apply** Structured analysis and design (SASD) techniques towards the development and implementation of software solutions. (K3)
CO4	**Provide** solutions for real life problems using SASD tools. (K4).
CO5	**Design** software solutions for industrial problems using object oriented tools and techniques. (K5)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Principles of Software Engineering	**CO1**	**3**									**1**	**1**				**3**
	CO2	**1**	**3**	**2**							**2**	**2**				**3**
	CO3	**1**	**2**	**3**	**2**				**1**	**2**	**2**	**2**				**3**
	CO4	**1**	**2**	**2**	**3**		**1**		**1**	**2**	**2**	**2**	**1**			**3**
	CO5	**1**	**2**	**2**	**2**	**3**	**1**		**1**	**2**	**2**	**2**	**1**			**3**

Course code	**EE/PE/H/T/415B**
Category	Program Elective
Course title	Reliability Engineering
Scheme and Credits	L-T-P: 3-1-0; Credits: 4.0;
Pre-requisites (if any)	

EE/PE/H/T/415B: **Reliability Engineering**	L	T
Reliability Function; Repairable and Non-repairable Systems; Markov modeling; Two state models; Series , parallel and composite systems ; MTTF, MTTR, MTBF.	1	0
Generation system model: Generating unit unavailability; Capacity outage probability tables; Comparison of deterministic and probabilistic criteria; Recursive algorithm for capacity model building; Recursive algorithm for unit removal.	5	2
Loss of load indices (LOLE computation); Loss of energy indices (LOEE and EIR computation).	2	1
Frequency and duration method for generating capacity evaluation; State space diagram of frequency and duration method.	2	0
Reliability of Substation- Active and passive failures; Stuck condition of breakers; Effect of failure modes; Simulation of failure modes; Evaluation of reliability indices.	2	1
Reliability of Distribution systems - Customer oriented indices; Load and energy oriented indices; Application to radial systems; Effect of lateral distribution protection; Effect of disconnectors; Effect of protection failures; Method of network reduction; Temporary and transient outages; Inclusion of weather effects; Stochastic approach.	3	1
Reliability definitions and concepts. Reliability indices and criteria: failure distribution function, reliability function, hazard function, a posteriori failure distribution.	2	0
Probability distributions in reliability evaluation: Uniform, Gaussian, Exponential, Weibull, Lognormal, Rayleigh, Binomial and Poisson.	8	2
System reliability evaluation using probability distributions: Series systems, Parallel systems, partially redundant systems, standby systems. Effect of Preventive maintenance on reliability.	3	2
Reliability and Availability of Repairable Systems: Renewal Processes and Alternating Renewal Processes.	5	1
Life testing: Sequential testing (type-I censored data), Simultaneous testing (type-II censored data). Accelerated life testing of electronic components.	3	2

Reliability of electronic components: Resistors, Capacitors, and Semiconductor Devices. Failure mechanisms. Reliability prediction.	2	0
Reliability of Measurement Systems.	1	1

Reference Books:

1	Reliability Evaluation of Engineering Systems: Roy Billinton and Ronald N. Allan.
2	Reliability and Maintainability Engineering: Charles E. Ebeling.
3	Reliability Engineering: Alessandro Birolini.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Explain** the general concept of reliability, reliability indices, reliability function and probability distribution (K2)
CO2	**Distinguish** between the reliability indices of repairable and non-repairable systems (K4)
CO3	**Explain t**he life testing of engineering systems (K2)
CO4	**Calculate** reliability of electrical and electronic components (K4)
CO5	**Apply** the concept of general Reliability to evaluate reliability of Generating Systems, Distribution Systems and Substation (K3)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Reliability Engineering	**CO1**	**3**											**1**			**3**
	CO2	**3**	**2**													**3**
	CO3	**3**	**2**													**3**
	CO4	**2**	**3**													**3**
	CO5	**2**	**3**		**2**											**3**

Open Elective-I

Course code	*****
Category	Open Elective
Course title	Open Elective-I
Scheme and Credits	L-T-P: 3-0-0; Credits: 3.0;

*Course specific Code

Course code	**EE/PC/B/S/411**
Category	Program Core
Course title	Electrical Engineering Laboratory - V
Scheme and Credits	L-T-P: 0-0-3; Credits: 1.5;
Pre-requisites (if any)	

EE/PC/B/S/411: Electrical Engineering Laboratory - V	P
1. Circle diagram of a 3-phase Induction Motor	3
2. Magnetic measurement using Lloyd-Fisher Square	3
3. Study of staircase waveform generator	3
4. Study Of Power Transfer Control Using Series Voltage Injection	3
5. Study and calibration of Impulse Voltage Generator	3
6. Synchronization and V-curve of Synchronous Machine	3
7. Testing of Voltage Transformer (V. T.)	3
8. Study of speed control of DC Servo	3
9. Study of various system faults in a DC Network Analyser	3
10. Voltage distribution along a string of suspension disc insulators	3
11. Plotting of iso-lux diagram of a Street Light Luminaire	3
Arrear, Laboratory Examination	6

Content Delivery Method

- Class room lectures (Chalk and Board) (D1)
- Active learning (D4)
- Blended/Hybrid learning (D5)
- Discussions (D7)
- Case Studies (D9)

Course Outcomes:

The students of the course should be able to

CO1	**Identify** the instruments required to perform the experiment (K1, S1)
CO2	**Select** the range/ratings of the instruments identified (K2, S1)
CO3	**Comprehend** the objective of the experiment and **Relate** that with the acquired theoretical knowledge (K3, S2)
CO4	**Develop** the circuit duly connecting selected instruments and other devices (K2, S2)
CO5	**Interpret** the data and prepare a detailed report. (K2, S2)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

Electrical Engineering		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
	CO1	**3**	**2**	**1**						**2**				**3**		

Laboratory - V	**CO2**	**1**	**3**	**2**						**2**				**3**		
	CO3	**1**	**3**	**2**						**2**				**3**		
	CO4	**1**	**2**	**3**						**2**				**3**		
	CO5	**1**	**1**	**2**	**3**				**1**	**2**		**1**	**1**	**3**		

Course code	**EE/PS/B/S/412**
Category	Program Sessional
Course title	Elective Project & Computation-I
Scheme and Credits	L-T-P: 0-0-3; Credits: 1.5;
Pre-requisites (if any)	

EE/PS/B/S/412: Elective Project & Computation-I	P
Students, pertaining to each elective domain, have to execute projects and computation problems about some state-of-the-art topics related to that domain, and prepare reports. Evaluations are made based on class performance, viva-voce, and report submitted.	39

Content Delivery Method

- Active learning (D4)
- Blended/Hybrid Learning (D5)
- Discussions (D7)
- Case Studies (D9)
- Projects (D11)

Course Outcomes:

The students of the course should be able to

CO1	**Relate** and apply acquired knowledge of Electrical Engineering and identify the problem (K1, S1)
CO2	**Review** literatures and formulate the solution (K2, S1)
CO3	**Develop** the solution of the problem (K3,S2)
CO4	**Assess** the performance of the designed solution (K6, S3)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Elective Project & Computation -I	**CO1**	**3**	**2**	**1**					**1**	**2**					**3**	
	CO2	**3**	**2**	**1**					**1**	**2**					**3**	
	CO3	**1**	**1**	**3**	**1**				**1**	**2**					**3**	
	CO4	**2**	**1**	**1**	**1**	**3**			**1**	**2**					**3**	

Course code	**EE/PS/B/S/413**
Category	Program Sessional
Course title	Seminar-I
Scheme and Credits	L-T-P: 0-0-3; Credits: 1.5;
Pre-requisites (if any)	

EE/PS/B/S/413: Seminar-I	P
Students, pertaining to each elective domain, have to learn and gain knowledge about some state-of-the-art topics related to that domain, present those topics before a panel of teachers, and prepare reports on those topics. Evaluations are made based on presentation, discussion/viva-voce, and report submitted.	39

Content Delivery Method

- Active learning (D4)
- Blended/Hybrid Learning (D5)
- Discussions (D7)
- Case Studies (D9)

Course Outcomes:

The students of the course should be able to

CO1	**Relate** and apply acquired knowledge of Electrical Engineering and identify relevant topics of interest (K1, S1)
CO2	**Review** literatures on the topics of interest to gain knowledge about the state-of-the-art (K2, S1)
CO3	**Prepare** presentation based on the knowledge acquired (K3,S2)
CO4	**Explain** the subject to the teachers and their peers (K5, S3)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Elective Seminar-I	**CO1**	**3**	**2**		**1**				**2**	**2**					**3**	
	CO2	**3**	**2**		**2**	**2**			**2**	**2**			**1**		**3**	
	CO3	**1**	**1**		**2**	**2**			**3**	**2**	**2**		**1**		**3**	
	CO4	**2**	**1**		**2**				**2**	**3**	**3**				**3**	

Course code	**EE/PS/B/S/414**
Category	Program Sessional
Course title	Electrical Machine Design-II
Scheme and Credits	L-T-P: 0-0-2; Credits: 1.0;
Pre-requisites (if any)	

EE/PS/B/S/414: Electrical Machine Design-II	P
Design of Integral horse-power Direct Current Machines	30
Design of Lifting Magnet .	9

Reference Books:

1	A Course in Electrical Machine Design: A.K. Shawney
2	Electrical Machinery : S. K. Sen
3	Performance and Design of Alternating Current Machines: M. G. Say

Content Delivery Method

- Class room lectures (Chalk and Board) (D1)
- Active learning (D4)
- Blended/Hybrid learning (D5)
- Discussions (D7)
- Case Studies (D9)

Course Outcomes:

The students of the course should be able to

CO1	**Relate** acquired knowledge of Integral horse-power dc machine and Lifting Magnet (K1, S1)
CO2	**Estimate** dimensions of different parts of Integral horse-power dc machine and Lifting Magnet. (K2, S2)
CO3	**Assess** the performance of the designed solution and suitably **modify** the design to meet the set performance criteria. (K3, S3)
CO4	**Analyze** the overall performance of the designed machine. (K4, S3)
CO5	**Prepare** a comprehensive detailed design report. (K5, S3)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Electrical Machine Design-II	**CO1**	**3**	**2**	**1**						**1**						
	CO2	**1**	**3**	**2**						**1**						
	CO3	**1**	**2**	**3**					**1**	**1**						
	CO4	**1**	**2**	**2**	**3**		**2**	**2**	**1**	**1**						
	CO5	**1**	**2**	**2**			**1**		**2**	**1**		**3**	**1**			

Course code	**EE/PC/B/S/415**
Category	Program Core
Course title	General Viva-Voce
Scheme and Credits	L-T-P: 2-0-0; Credits: 2.0;
Pre-requisites (if any)	

EE/PC/B/S/415: General Viva-Voce	L	T
Based on the theory and sessional subjects covered under B. E. E. Programme.	26	0

Content Delivery Method

- Discussions (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Present** themselves in a credible manner before a board of interviewers. (K1).
CO2	**Communicate** effectively. (K2).
CO3	**Apply** the knowledge acquired in the general domain of Electrical Engineering over the four year programme to answer the questions posed by the board. (K3).

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
General Viva-Voce	**CO1**	**3**	**2**	**2**			**1**	**1**	**1**	**1**	**1**	**1**	**2**			
	CO2	**2**	**2**	**2**	**1**		**1**	**1**	**1**	**2**	**3**	**1**	**2**			
	CO3	**3**	**2**	**2**	**1**		**2**	**1**	**1**	**2**	**2**	**1**	**2**			