Syllabus for B. Tech Electrical Engineering 4th Year VII Semester

Subject: Power System Protection (**Code:** EET401)	**Year & Semester:** B. Tech Electrical Engineering 4th Year VII Semester		**Total Course Credit:** 3		
			L	T	P
			2	1	0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand the operating principles, functions and characteristics of various types of protective relays.

CO2: Identification and implementation of the transformer protection schemes.

CO3: Gain knowledge about the protection requirements and implementation of appropriate protection schemes for generators

CO4: Identify, apply and calculate settings for over current, directional over current, distance, differential and pilot protection schemes for transmission lines.

CO5: Study the structural and operational features of circuit breakers/fuses.

Module 1:Protective Relaying and Classification of Relays

Function of protective relaying, fundamental principles, primary and backup relaying, functional characteristics**,** Operating principles and characteristics of the following electromechanical relays: Current, voltage, directional, current balance, voltage balance, differential relays, and distance relays.

Module 2: Transformer Protection

Percentage differential relaying for power transformers (Y-Δ, Δ-Δ, Δ-Y configurations), unrestricted/restricted earth fault protection of transformers, transformer leakage protection, Buchholz relay.

Module 3: Generator Protection

Short- circuit protection of stator windings (Y-Δ configuration), protection against turn-to-turn fault, stator ground-fault protection, stator open circuit protection, field ground fault protection, Over-heating protection, Over-voltage protection, Loss of excitation protection, rotor overheating protection, Protection against vibration, protection against motoring over speed protection, protection against unbalancing.

Module 4: Transmission Line Protection and busbar/feeder protection

Transmission line protection using: Over current relays, Distance relays, Pilot relays

Over current relays: selection of time/current settings, protection of radial feeders, parallel feeders and ring mains.

Distance relays: use of impedance, reactance and mho relays for transmission line protection.

Pilot relays: use of wire pilot, carrier current pilot and microwave pilot for the transmission line protection.

Protection of busbars/feeders etc.

Module 5: Fuses and Circuit Breakers

Fusing element, classification of fuses, current carrying capacity of fuses, high rupturing capacity (H.R.C.) cartridge fuses, characteristics of H.R.C. fuses, selection of HRC fuses.

Types of circuit breakers, basic principle of operation, phenomena of arc, initiation of an arc, maintenance of arc, arc extinction, d. c. circuit breaking, a.c. circuit breaking, arc voltage and current waveforms in a.c. circuit breaking, restriking and recovery voltages, de-ionization and current chopping, ratings of circuit breakers, oil circuit breakers, air blast circuit breakers, SF6 Circuit breakers , Vacuum breakers.

Recommended Book:

S. No	**Name of Book**	**Author**	**Publisher& Edition**
1	Art and Science of Protective Relaying	Mason	John Wiley & Sons, 2nd Edition
2	Protective relaying, Principles and Applications	J. L Black Burn	CRC Press, 4th Edition
3	Power System Protection and Switchgear	Badri Ram	Tata McGraw-Hill Education, 2nd Edition

Course: High Voltage Engineering (Code: EET402)	**Year & Semester:** B. Tech Electrical Engineering 4^{th} Year VII Semester		**Total Course Credit: 3**		
			L	T	P
			2	1	0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Course Objective: To study and understand the complications and problems associated with the generation, measurement and use of high voltages and considerations for design of efficient insulation systems.

Course Outcomes (COs): Upon successful completion of the course, students should be able to:

CO1: Understand the significance of high voltage testing of power system equipment and study the various methods of generation of high ac, dc and impulse test voltages and high impulse test currents.
CO2: Understand the complications involved in the measurement of high voltages and study the various methods of measurement of high ac, dc and impulse test voltages and high impulse currents.
CO3: Describe the mechanisms of conduction and breakdown in gaseous dielectrics; effect of uniform and non-uniform-field gaps, breakdown under dc and ac fields, impulse breakdown.
CO4: Identify the breakdown mechanisms of solid and liquid dielectrics; describe the suitability of these dielectrics in high voltage equipment.
CO5: Understand the significance and procedures of non-destructive testing of HV equipment.

UNIT - I Conduction and Breakdown in Gases:
Insulation breakdown, Electric field and field stress, uniform and non-uniform fields, Ionization in gases, Current in a uniform-field gap, Townsend’s criterion for breakdown, Paschen’s law, Effect of temperature on breakdown voltage, Electronegative gases, Streamer breakdown mechanism, Corona discharges, Polarity effect, Surge-voltage time lags for breakdown, Breakdown under uniform ac field, Breakdown under impulse voltages, Practical gaseous dielectrics.

UNIT – II Conduction and Breakdown in Solid and Liquid Dielectrics:
Factors affecting breakdown of solid dielectrics, Breakdown mechanisms, Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Erosion breakdown, Breakdown due to tracking, Treeing, Conduction and breakdown in pure liquids and commercial liquids, Application of solid and liquid dielectrics.

UNIT - III Generation of High Voltages:
Applications of high voltages, High-voltage tests, Generation of high alternating voltages: High-voltage testing transformers, Transformer cascades, Series resonant circuits. Generation of high direct voltages: Rectifying circuits, Voltage multiplier circuits- Cockcroft-Walton voltage

multiplier, Electrostatic generation. Generation of high impulse voltages: Basic impulse generator, Multistage impulse generator circuits-Marx and Goodlet impulse generator, Triggering of impulse generator.

UNIT - IV Measurement of High Voltages:
Measurement of high ac, dc and impulse voltages, High ohmic resistor in series with ammeter, High ohmic resistive voltage divider, Ammeter in series with HV capacitor, Chubb-Fortescue method, Electrostatic voltmeter, Voltage dividing systems, Types of voltage dividers, Signal cable matching, Sphere gap measurement, Measurement of high impulse currents.

UNIT - V Non-Destructive Testing of High-Voltage Equipment:
Measurement of d.c. resistivity, dielectric constant and dissipation factor, Partial discharge measurement.

Text Books:

1. High Voltage Engineering Fundamentals, E. Kuffel, W.S Zaengl; Newnes.
2. High Voltage Engineering, C. L. Wadhwa; New Age International Publishers
3. An Introduction to High Voltage Engineering, Subir Ray; Prentice Hall of India

Reference Books:

1. High Voltage Engineering, M.S. Naidu, V. Karamraju; Tata McGraw-Hill
2. High voltage test techniques, Dieter kind, Kurt Feser; Newnes

<table>
<tr><td rowspan="3">Course: Power Systems - III
(Code: EET403)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
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<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
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Course Objective: The course is introduced to the students to enable them to give optimal performance and to tackle every challenge during professional experience

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Gain knowledge of load flow techniques, mathematical analysis, and their comparison.

CO2: Develop an overview of power system stability phenomenon.

CO3: Discuss Automatic Generation Control by developing various models and their control strategies

CO4: Understand and evaluation of generation and absorption of reactive power and study various voltage control methods.

CO5: Formulation and analysis of the economic operation of the power system.

Unit 1. Load Flows: (10hr) (CO1)

Nature and importance of the problem, Network model formulation, Algorithm for the formulation of Y_{bus} matrix, Formulation of Y_{bus} by singular transformation: by graph, by primitive network, and by bus incidence matrix, Load flow problem, Load flow equations, Bus classification – List of variables in load flow equations, Gauss - Seidel & Newton-Raphson method for solving load flow problem, Comparison of load flow methods, De-coupled & Fast de-coupled power flow method, Modeling of tap-changing transformers and phase-shifters.

Unit 2. Power System Stability: (8hr) (CO2)

Classification of power system stability, Dynamics of the synchronous machine and swing equation, Power angle equation, Node Elimination technique, Steady state and transient stability, Equal-area criterion of stability, Numerical solution of swing equation, Factors affecting transient stability.

Unit 3. Automatic Generation Control: (8hr) (CO3)

Real power balance and its effect on system frequency, Load frequency control of single area system – Turbine speed governing system, model of speed governing system, turbine and generator load model, Steady state analysis and dynamic response, proportional plus integral control, Economic dispatch control, Two area load frequency control.

Unit 4. Control of voltage and Reactive Power: (8hr) (CO4)

Generation and absorption of reactive power, Relation between voltage and reactive power, Reactive power flow and voltage control, mathematical formulation of voltage stability problem, Methods of voltage control – injection of reactive power, tap changing transformers, booster transformers, phase – shift transformers.

Unit 5. Economic Operation of Power System: (8hr) (CO5)

Introduction, system constraints, economic dispatch neglecting losses, penalty factor, economic dispatch with losses, transmission loss equation, automatic load dispatching.

Total contact hour: 42 hr

Text Books:

1. Power System Analysis J.J. Grainger and W.D Stevenson, Tata McGraw-Hill.
2. Electrical Power Systems B.M. Weedy and Cory John Wiley & sons.
3. Power Systems Engineering Nagrath and Kothari McGraw-Hill Education
4. Electric Power Systems C.L. Wadlhwa New Age Publications
5. Electric Energy System Theory O. I Elgard McGraw-Hill

Course: Electronic Measurements & Instrumentation (Code: ECT404)	Year & Semester: B. Tech Electrical Engineering 4th Year VII Semester		Total Course Credit: 3		
			L	T	P
			2	1	0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: To introduce the instrumentation system, to teach the construction, operation of various transducers, sensors, etc, to develop the concept of function generators, frequency counters, data acquisition systems, interfacing of micro controllers and basic GPIB techniques.

Course Outcomes:

CO1	To familiarize with measurement standards and systems with their responses
CO2	To get a detailed understanding of various analog meters
CO3	To introduce transducers, sensors and actuators used in measurements
CO4	To understand the working of wave generators, analyzers and digital meters and to get knowledge about data acquisition system and interfacing with microcontrollers

Details of Syllabus:

S. No.	Particulars
1.	**Measurement System and Standards:** Instrumentation System and its classification, Primary and secondary standards, Standards of various electrical quantities, IEEE standards, Static and Dynamic response, Errors, and accuracy of an instrumentation system.
2.	**Measurement of Basic Parameters:** Galvanometer and its principle, Moving Coil, Moving iron meters, true rms meter, Bridge measurements, Q meters, Measurement of Voltage, Current, Power, Energy. Measurement of Resistance, Capacitance, Inductance.
3.	**Transducers, Sensors, and Actuators:** Active and Passive, Transducers types: Resistive, Inductive, capacitive, Piezoelectric, Optical, Photo diodes; Measurement of Physical, Physiological, And chemical quantities: (Temperature, pH, Luminescence, Flow, Pressure, Torque, Speed, acceleration, Rotation, Stress, Strain, etc,), Sensors for hostile environments, Actuators: Relays, Solenoids, Stepper motors.
4.	**Signal Generators and Analyzers:** Function generators, RF Signal Generator, Sweep Generator, Frequency synthesizer, Wave Analyzers for Audio and radio frequency waves. Measurement of harmonic distortion. Spectrum analysis, RF Power measurement.

5.	**Digital Instrumentation:** Comparison of analog and digital techniques, Digital voltmeter, Digital multimeter, Frequency counter, Measurement of frequency and time interval, extension of frequency range, Measurement errors.
6.	**Data Acquisition System:** Components of data acquisition system, Interfacing of transducers, Single Channel and Multi-channel system, Multiplexing, interfacing with micro controllers, IEEE 488 Bus, Automated data acquisition,
7.	**Advanced topics:** Virtual Instrumentation, Low level measurements and Noise rejection, GPIB based measurement techniques. Measurements using MEMS
8.	**Measurement System and Standards:** Instrumentation System and its classification, Primary and secondary standards, Standards of various electrical quantities, IEEE standards, Static and Dynamic response, Errors, and accuracy of an instrumentation system.

Recommended Books:

1.	**Electronic Measurements**	**W Cooper**
2.	**Electrical & Electronic Measurements**	**A K Sawhney**

Subject: Advanced Power Electronics (Code: EET405)	**Year & Semester:** B. Tech Electrical Engineering 4th Year VII Semester		**Total Course Credit: 4**		
			L	T	P
			3	1	0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand three phase voltage source and current source inverters and their modulation strategies.

CO2: Understand the operation of non-isolated DC-DC Converters

CO3: Understand the operation of isolated DC-DC converter.

CO4: Perform comparative assessment of different modulation techniques

CO5: Understand the applications of power electronics in appliances such as Power conditioners and UPS.

Module 1:
Three phase Voltage source inverters in square wave mode. 120 and 180degree modes of conduction. Three phase Current Source Converter
Module 2:
Different modulation strategies- Sine PWM, Hysteresis Current Control Technique, Selective Harmonic Elimination, Space Vector Modulation.
Module 3:
Non Isolated D.C to D.C converters in CCM and DCM, Boundary conditions, Non-Ideal Behavior, Design of Passives for: Buck, Boost, Buck-Boost and Cukconverter circuits.
Module 4:
Isolated DC-DC converters: Flyback converter, Forward converter, Push-Pull converter, Half-Bridge converter and Full-Bridge converter
Module 5:
Power line disturbances and their effect on equipment, Power conditioners, offline and online UPS

Text Books

1. Power Electronics by Daniel W Hart, Tata Mc Graw Hill
2. N. Mohan, T.M. Undeland& W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989
3. Fundamentals of Power Electronics, Erickson and Macsimovic

References

1. Power Electronics: Devices, Drivers, Applications, and Passive Components by Barry Williams
2. Modern Power Electronics and AC motor Drives By Bimal K Bose- Pearson Publishers.
3. Referred Journal/Conference publications.

<table>
<tr><td rowspan="3">Subject: Power Station Practice
(Code: EET405)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
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Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: To understand the economics of power generation

CO2: To study various power factor improvement methods

CO3: To study different types of tariffs and various types of grounding systems

CO4: To understand an overview of power stations and substations

Module 1: Economic Aspects of Power Generation
Economics of generation, factors affecting the cost of generation, reduction of costs by interconnection of stations, curves useful in system operation, choice of size and number of generating units.

Module 2: Power Factor Improvement
Power factor, disadvantages of low power factor, methods of improving power factor, location of power factor improvement apparatus, economics of power factor improvement.

Module 3: Power Tariff and Neutral Grounding
Cost of generating station, fixed capital, running capital, annual cost, running charges, fixed charges, factors influencing the rate of tariff, designing tariff, different types of tariff, flat rate tariff, block rate tariff, two part tariff, maximum demand tariff, power factor tariff.

Neutral grounding, solid grounding, resistance grounding, reactance grounding, arc suppression coil grounding, earthing transformers

Module 4: Overview of different Types of Power Stations and their Auxiliaries
Thermal power plants, hydroelectric stations, nuclear power stations, diesel power stations, gas turbine plants.

Module 5: Overview of Substations and Substation Equipment
Introduction, type of substation, civil and electrical works in a substation, bus bars, layout, drawings.

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	A Course in Electrical Power	Soni, Gupta and Batnagar	Dhanpat Rai and Sons
2	Elements of Power Station	Deshpande	Prentice hall
3	The Art and Science of Utilization of Electric Energy	H. Pratab	Dhanpat Rai and Sons
4	Substation Design and Equipment	Satnam	Dhanpat Rai and Sons

Subject: Electrical Power Systems **(Code: EET406)**	**Year & Semester:** 4th Year VII Semester		**Total Course Credit: 3**		
			L	**T**	**P**
			2	**1**	**-**
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**		
	30 Marks	**10 Marks**	**60 Marks**		

Objective: To introduce the concept of power systems, AC & DC distributors, transmission lines and to develop the concept of mechanical design of transmission lines.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Explain the knowledge of power systems generation, transmission & distribution.
CO2: Explain the knowledge of overhead line insulators and string efficiency.
CO3: Explain the modelling, design, capacity and various parameters of transmission lines.
CO4: Acquire knowledge of sag and tension calculations of overhead Transmission lines.
CO5: Explain concept of corona and its effect on line design.

Details of the syllabus:

S. N.	Particulars
1.	**DC and AC Distribution System:-** Introduction to a power system, definition and classification of distribution systems, connection schemes, various types of DC and AC distributors, voltage drop calculations.
2.	**Overhead AC Transmission lines: -** Line Parameters and their calculations, types of conductors, skin effect and proximity effect, classification of overhead AC transmission lines, performance of transmission lines.
3.	**Insulators for overhead lines:-** Overview of insulators and materials used, types of insulators and their uses, potential distribution over a string of suspension insulators, string efficiency, methods for equalizing the potential.
4.	**Interference of power lines with communication circuits**:- Electrostatic and electromagnetic effect, definition and theory of Corona formation, factors affecting corona, critical disruptive and visual critical voltage, power loss due to corona, methods of reducing corona effect.
5.	**Mechanical design of transmission lines**. Sag and tension calculations, effect of wind and ice loading, stringing charts.

Recommended Books:

S. N.	Name of Book	Author (s)
1.	Elements of Power System Analysis	W. D. Stevenson
2.	Transmission & Distribution of Electrical Energy	H. Cotton & Barber
3.	Power System Engineering	Nagrath & Kothari
4.	Electrical Power Systems	C. L. Wadhwa

Subject: Principles of Management (Code: HST454)	Year & Semester: B. Tech Electrical Engineering 4th Year VIII Semester		Total Course Credit: 3		
			L	T	P
			2	1	0
Evaluation Policy	Mid-Term	Internal Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Objectives:

COB 1: To familiarize students with the basic concepts, principles and definitions of management.

COB 2: To facilitate students in understanding specific theories related to perception, motivation, leadership, job design, and organizational change.

COB 3: To help the student in understanding the contemporary issues in management.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Interpret basic concepts and theories of management.

CO2: Outline plans and different organization structures.

CO3: Classify different leadership styles in cross cultural environment.

CO4: Develop rationale decision making and Problem-solving abilities.

CO5: Cite contemporary issues and approaches to management.

UNIT 1:

Introduction of Management: Management: Definition– Importance– Managerial Roles– Functions of management – Classical theory – Scientific management - Administrative theory – Behavioral Theory – Management science – Integrative perspective – System theory – Socio – technical theory – Contingency theory – Comparing theories

UNIT 2:

Planning and Organizing: Nature and Definition of Planning – Principles of Planning – Objectives of planning – Planning process – Types of plans – Benefits and pitfalls of planning. Principles of organizing – Organization levels – Organizational designs and structure – Line and staff organizations – Approaches – Delegation of authority – Factors affecting delegation of authority – Span of management – Centralization and decentralization of Authority.

UNIT 3:

Directing and controlling: Definition of Co-ordination–Significance and principles of Co-ordination– Leadership behavior and styles – Leadership in cross cultural environment. Nature and importance of controlling– Controlling process– Requirements of effective control– Establishing controlling system – Controlling techniques.

UNIT 4:

Decision making: Meaning of decision – types of decisions – Rationale decision making process –Models of decision making – Problem solving and decision making – increasing participation in decision making – Vroom's Participative decision-making model – challenges and problems in decision making

UNIT 5:

Contemporary issues in Management: MBO-Management by Walking Around–Out of the Box Thinking– Balanced Score Card –Time Management–BPOs – Stress Management causes and remedies – JIT – TQM – Six Sigma – CMM levels

Relevant cases have to be discussed in each unit, and in examination case is compulsory from any unit.

Suggested Books:

1. Kumar, Rao, Chhalill: Introduction to Management Science. Cengage Publications, New Delhi
2. Dilip Kumar Battacharya, Principles of Management, Pearson, 2012.
3. Harold Koontz, Heinz Weihrich, A.R. Aryasri, Principles of Management, TMH, 2010.
4. V. S. P. Rao, Management Text and Cases, Excel, Second Edition, 2012.
5. K. Anbuvelan, Principles of Management, University Science Press, 2013.
6. Neeta Baporikar, Case Method – Cases in Management, Himalaya Publishing House (HPH) 2009.
7. Deepak Kumar Bhattacharyya, Principles of Management-Text and Cases, Pearson, 2012.

Subject: Power System Protection Lab **(Code:**EEL401**)**	**Year & Semester:** B. Tech Electrical Engineering 4th Year VII Semester	**Total Course Credit: 1**		
		L	T	P
		0	0	2
Evaluation Policy	**Class Assessment** (40 Marks)	**End-Term** (60 Marks)		

Course Objective:
To familiarize the students about various protection schemes of electrical systems.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Gain the practical knowledge of various types of relays and characteristics of different types of relays.

CO2: Visit to an electric Sub-station to understand various types of protective schemes circuit breakers and differential protection schemes.

CO3: Study of structural and operational characteristics of circuit breakers/fuse wires

List of Experiments:

S. No.	Name of the experiment
1	Study of constructional details of various types of relays.
2	Characteristics of fuse wires of different materials.
3	Time current characteristics of an over current relay.
4	Study/simulation of differential relay.
5	Study of an oil circuit breaker.
6	Time/current grading of an over-current relay for distance protection.
7	Visit to an Electric Sub-station to study various protective schemes.

<table>
<tr><td rowspan="3">Subject: High Voltage Engineering Lab
(Code: EEL402)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
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<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
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Course Objective:
To familiarize the students with the generation and measurement of high voltages, and high voltage testing of power-system equipment.

Course Outcomes (COs): Upon successful completion of the course, students should be able to:

CO1: Handle equipment for generation and measurement of high ac, dc and impulse voltages.

CO2: Carry out breakdown withstand tests and flashover tests on high-voltage equipment according to standards.

CO3: Understand the effect of electrode geometry on the breakdown characteristics of gaseous gaps.

CO4: Determine the breakdown voltage of insulating liquids according to standards.

List of Experiments:

S. No.	Name of the experiment
1	To test the breakdown voltage of insulating liquids according to standards.
2	To carry out one-minute power-frequency withstand test and flashover test on 11kV / 33 kV pin insulator.
3	To determine the string efficiency of a three-unit suspension insulator.
4	To carry out breakdown studies of gaseous gaps using different electrode configurations.
5	To study the polarity effect of the point electrode of a point-plane gap on the breakdown characteristics of the gaseous gap.
6	To study the effect of front resistance, tail resistance, generator capacitance and load capacitance of an impulse generator on the impulse voltage wave shape.
7	To carry out impulse voltage withstand test on a pin insulator /string insulator as per international specifications.
8	To determine the 50% impulse flashover voltage of a pin insulator / suspension insulator.

Elective Subjects for B.tech Electrical Engineering 4th Year

Subject: Advanced Control Theory (Code: EET050)	**Year & Semester:** B. Tech Electrical Engineering 4th Year		**Total Course Credit: --**		
			L	T	P
			-	-	-
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Course Outcomes (COs):

CO1: To get started with nonlinear systems.

CO2: To obtain linear approximation of a nonlinear system.

CO3: To understand nonlinear phenomenon and stability analysis.

CO4: Extend modelling principles to discrete-time systems.

CO5: Analyze and synthesize discrete-time control systems using the z-transform.

Module 1: Introduction to nonlinear systems:

Nonlinear system behavior. Types of nonlinearities. characteristic features of nonlinear systems, linearization and local stability.

Module 2: Analysis of nonlinear systems:

Phase plane analysis of linear and nonlinear systems, Existence of limit cycles. Describing function analysis, stability analysis using Lyapunov's method. Lyapunov's direct method, Invariant set theorems, Lyapunov analysis of LTI systems.

Module 3: Introduction to Digital Control:

Continuous versus digital control, hardware elements of a digital control system, sampling theorem, ZOH, effect of sampling rate, calculus of difference-equations, modelling discrete-time systems using pulse transfer function.

Module 4: Understanding Z-transform:

Frequency domain analysis, Z- transform, inverse Z-transform, difference equations, Relationship (in frequency domain) between s-plane (continuous-time) and z-plane (discrete-time).

Module 5: State Variable Analysis of Digital Control Systems, State space approach: Controllability, Observability, digital filter properties. PID controller, introduction to reduced order modelling

Recommended Book:

S. No	Name of Book	Author	Publisher & Edition
1	Digital Control and State Variable Methods	M. Gopal	Tata McGraw-Hill
2	Automatic Control Systems	B. C. Kuo	Prentice-Hall
3	Advanced Control Engineering	R. S. Burns	Butterworth Heinemann
4	Nonlinear Systems	H. K. Khalil	Prentice-Hall
5	Modern Control Engineering	K. Ogatta	Prentice-Hall

<table>
<tr><td rowspan="3">Course: Mechatronics
(Code: EET051)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
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Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Explain the architecture of various mechatronics systems.

CO2: Select and integrate various sensors and actuators to meet a mechatronic product requirement.

CO3: Determine and analyze the dynamic response of the zero, first and second order mechatronic systems

CO4: Understand modern control architectures for Mechatronic systems.

Module 1: Fundamentals of Mechatronics:
Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. Review of fundamentals of electronics. Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers.

Module 2: **Microprocessor and Microcontrollers:**
Microprocessors controllers and PLCs. 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions. Introduction to Microcontroller Interfacing and applications

Module 3: Sensors and Actuators:
Brief overview of measurement systems, classification, characteristics and calibration of different sensors. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors, smart sensor. Optical encoder, tactile and proximity, ultrasonic transducers, opto-electrical sensor, gyroscope.

Module 4: Modelling and Simulation of Mechatronic Systems:

Mechanical and electrical systems, physical laws. Modelling paradigms for mechatronic system, Block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, mechanical rotational system, electrical-mechanical coupling. Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation. Modelling of sensors and actuators

Module 5: Control of Mechatronic Systems:

Solution-time criterion, control-area criterion, performance indices; zero steady state step error systems; modern control performance index: quadratic performance index, Ricatti equation.

Recommended Book:

S. No	**Name of Book**	**Author**	**Publisher & Edition**
1	Mechatronics	HMT Ltd.	Tata Mcgraw-Hill, New Delhi, 1988
2	Fundamentals of Mechatronics	Musa Jouaneh	Cengage Learning, 2012
3.	Measurement, Instrumentation, and Sensors Handbook	John G. Webster	CRC Press (1999)
4.	Modeling of Dynamical Systems	L. Ljung, T. Glad	Prentice Hall Inc. (1994).

<table>
<tr><td rowspan="3">Course: Renewable Sources of Electrical Energy
(Code: EET052)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives:

1. To Understand the Importance, Scope and Potential of Renewable Energy Resources.
2. To Impart Knowledge on the Technology and Applications of Renewable Energy.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Assess different energy resources; Understand energy, environment and need for renewables.

CO2: Understand, analyze and apply the concepts of wind energy, solar energy: solar thermal & solar PV technology.

CO3: Understand and analyze the principle of energy extraction from Ocean energy (Tidal, Wave, OTEC).

CO4: Understand the energy conservation and future energy sources.

Module 1: Introduction

Review of Conventional & Renewable Energy resources, Energy problem, Energy & environment, Need for renewable, Rural Energy.

Module 2: Solar Energy – Basics & Technologies

Solar Energy Basics - Solar radiation and its measurement – Solar collectors – Energy Balance Equation and Collector Efficiency – Solar Cell Principles – Conversion Efficiency and Power Output – Photovoltaic system and Solar-Thermal system for Power Generation – Solar Cell Modules - Solar Energy Storage - Applications of Solar Energy.

Module 3: Wind Energy

Wind Energy profile - Basic Principles - Wind Energy Estimation – WEC System - Basic Components - Collectors - Rotor Types – Wind Turbine Types - Blade Forces – Aerodynamic Force – Braking systems – Tower - Control and Monitoring System – Performance of Wind Machines.

Module 4: Other Renewable Energy sources
Electric Power Generation from Tidal, Ocean Thermal and Geothermal energy. Simple power plant based on Tidal / OTEC / Geothermal.

Module 5: Energy conservation & Hybrid energy system:
Energy conservation in transport sector. Energy efficient buildings. Energy audit.
Concept of hybrid energy systems and explore new energy sources.

Text Books

1. B. H. Khan, "Non-Conventional Energy Resources", Tata McGraw-Hill, 2006.
2. John F. Walker & Jenkins. N, "Wind Energy Technology", John Wiley and Sons, 1997.

Reference

1. G.D. Rai, "Non-Conventional Energy Sources", First Edition, Khanna Publishers, Delhi, 1999.
2. Agarwal M.P., "Future Sources of Electrical Power", S. Chand Co. Ltd., New Delhi, 1999.
3. Van Overstraeton and Mertens R.P., "Physics, Technology and Use of Photovoltaics", Adam Hilger, Bristol, 1996.

<table>
<tr><td rowspan="3">Subject: Electric Drives
(Code: EET053)</td><td rowspan="3" colspan="2">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

CO1: To understand the operation of AC-DC Converter Controlled DC Motor Drives

CO2: To understand the operation of Chopper Controlled DC Motor Drives

CO3: To understand the operation of Voltage Source Inverter Fed Induction Motor Drives

CO4: To understand the operation of Current Source Inverter Fed Induction Motor Drives

CO5: To understand the Rotor Side Control of Induction Motor Drives

Module 1:
Introduction to Electric Drives, Electric Drive Systems versus Mechanical Drive Systems.
Converter Controlled Dc Motor Drives: Steady state analysis of semi-controlled and fully controlled converter fed series and separately excited D.C motor drives: Continuous and discontinuous conduction mode, open /closed loop control.

Module 2:
Chopper Controlled Dc Motor Drives: Four quadrant chopper circuit – closed loop control of chopper fed dc drive –Steady state analysis of chopper controlled DC motor drives.

Module 3:
Voltage Source Inverter Fed Induction Motor Drives: Scalar control- Voltage fed Inverter control-Open loop volts/Hz control-Speed control with slip regulation-Speed control with torque and Flux control-Current controlled voltage fed Inverter Drive**.**

Module 4:
Current Source Inverter Fed Induction Motor Drives: Current-Fed Inverter control-Independent current and frequency control-Speed and flux control in Current-Fed Inverter drive-Volts/Hz control of Current-Fed Inverter drive-Efficiency optimization control by flux program.

Module 5:
Rotor Side Control Of Induction Motor: Rotor resistance control- fixed resistance control, variable resistance control-converter controlled rotor resistance control, Slip power recovery schemes- Static Kramer drive-Phasor diagram-Torque expression-Speed control of a Kramer drive-Static scherbius drive-Modes of operation

Recommended Book:

S. No	**Name of Book**	**Author**	**Publisher& Edition**
1	Modern Power Electronics and AC drives	B.K.Bose	Pearson
2	Control of Electric Drives	Werner Leonhard	Springer
3	Power Electronics and Motor Control	Shepherd, Hulley, Liang	Cambridge University Press
4	Electric Motor Drives Modeling, Analysis and Control	R. Krishnan	Prentice-Hall

<table>
<tr><td rowspan="3">Subject: Microcontroller and their Applications
(Code: EET054)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 03</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

CO1: To get started with Microcontrollers

CO2: To understand the hardware features of 8051 Microcontroller

CO3: To understand the addressing modes and instruction set of 8051 Microcontroller

CO4: To understand memory interfacing and data communication with 8051 Microcontroller

CO5: To understand the basic concepts of embedded systems.

Module 1:
Microcontrollers– Introduction to different types of Microcontrollers, Hardware features, architecture and memory types**.**

Module 2:
Detailed study of 8051 Processor architecture and Memory organization, External memory Interfacing

Module 3:
Addressing modes of 8051 and Instruction Set – Data movement instruction, arithmetic instruction, Logic instruction, Branch group Instruction and Bit manipulation Instructions

Module 4:
8051 software and programming memory interfacing and address decoding, programming Input/ Output port/ timer/ ADC/DAC, interrupts controller and Serial data communication controller for different application with respect to instrumentation & control.

Module 5:
Embedded System Hardware, Embedded system software, Introduction to embedded development tools like cross assembler, simulator, HLL Cross compiler & in circuit emulator for system development

Recommended Book:

S. No	**Name of Book**	**Author**	**Publisher& Edition**
1	The 8051 Microcontroller & Embedded System	M. A. Mazidi& J. G. Mazid	Pearson
2	Design with Micro-controllers	John. B. Pitman	Mc-GrawHill
3	8051 Microcontroller Hardware, software and applications	V Udayashankara and Mallikarjunaswamy	Tata Mc-GrawHill

Course Code: EET055	Course Title: Maintenance and Design of Electrical Substations		Course Credit: 3		
Semester:	**Session:**		**Contact Hours**		
Minor Exam	**Class Assessment**	**Major Exam**	**L**	**T**	**P**
30 (Marks)	10 (Marks)	60 (Marks)	3	0	0

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO:

1. To understand the planning and design of electrical substation.
2. To understand the design considerations of substations.
3. To explain the overall layout of substations.
4. To impart knowledge about the concept of substation grounding.
5. To understand protective relaying, substation automation and auxiliary systems.

UNIT-I Introduction

Purpose and scope; relationship of substation to overall power system; importance of adequate substation planning and engineering; types of substations: general, distribution substations, transmission substations, switching substations.

UNIT-II General design considerations

Initial and ultimate requirements; site considerations; environmental considerations; interfacing considerations; reliability considerations; operating considerations; safety considerations; maintenance considerations.

UNIT-III Physical Layout

Layout considerations; typical bus configuration; protection of substation insulation; substation insulators; electrical clearances; bare conductors; rigid bus design; strain bus design; application of mobile transformers and substations.

UNIT-IV Grounding

Definitions; soil resistivity measurements; area of ground grid; ground fault currents, ground conductor; safety considerations; tolerable touch and step voltages; protective surface material and reduction factor; design of substation grounding.

UNIT-V Protective relaying, substation automation and auxiliary systems

Fundamental considerations; basic relay types; relay schemes, Automation: Introduction; open vs proprietary systems; substation automation architecture; data acquisition and control elements, AC and DC auxiliary systems, Maintenance, uprating and expanding existing substations.

Text Books:

1. United States Department of Agriculture, *Design Guide for Substations*, Issued June 2001
2. The Aluminum Association, *Aluminum Electrical Conductor Handbook*, New York: The Aluminum Association, 1971.

Course Code: EET056	**Course Title: Power System Transients**		**Course Credit: 3**
Semester:	**Session:**		**Contact Hours**
Mid Term	**Int. Assessment**	**End Term**	**L T P**
30 (Marks)	10 (Marks)	60 (Marks)	3 0 0

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO:

6. To give overview of nature of power system transients
7. To understand the switching transients
8. To explain the phenomenon of switching surges and lightning surges and its modeling.
9. To impart knowledge about the concept of traveling waves
10. To understand transient in integrated power system

UNIT-I Introduction and survey

Origin and nature of transients and surges, lumped and distributed circuit representations. Line energisation and de-energisation transients, current chopping, short-line faults, trapped charge effects, effect of source, control of transients, Lightening, effect of tower footing resistance, travelling waves, insulation coordination, circuit breakers duty, surge arresters, overvoltage limiting devices, Source of transients, various types of power systems transients, effect of transients on power systems, importance of study of transients in planning.

UNIT-II Switching Transients

Introduction; circuit closing transients: RL circuit with sine wave drive, double frequency transients; observations in RLC circuit and basic transforms of the RLC circuit; Resistance switching: Equivalent circuit for the resistance switching problems, equivalent circuit for interrupting the resistor current; Load switching: Equivalent circuit, waveforms for transient voltage across the load, switch; normal and abnormal switching transients; Current suppression; current chopping; effective equivalent circuit; capacitance switching, effect of source regulation, capacitance switching with a restrike, with multiple restrikes, illustration for multiple restriking transients, ferro resonance.

UNIT-III Lightning Transients

Causes for over voltage, lightning phenomenon, charge formation in the clouds, rate of charging of thunder clouds, mechanisms of lightning strokes, characteristics of lightning strokes; factors contributing to good line design, protection afforded by ground wires, tower footing resistance. Interaction between lightning and power system: Mathematical model for lightning.

UNIT-IV Travelling Waves on Transmission Line Computation of Transients

Computation of transients: Transient response of systems with series and shunt lumped parameters and distributed lines. Travelling wave concept: step response, Bewely's lattice diagram, standing waves and natural frequencies, reflection and refraction of travelling waves.

UNIT-V Transients in Integrated Power System

The short line and kilometric fault, distribution of voltage in a power system: Line dropping and load rejection; voltage transients on closing and reclosing lines; over voltage induced by faults; switching surges on integrated system; EMTP for transient computation.

Text Books:

1. Allan Greenwood, Electrical Transients in Power Systems, Wiley-Blackwell; 2nd Edition edition, 1991.
2. Pritindra Chowdhuri, Electromagnetic Transients in Power Systems (High-Voltage Power Transmission), 2nd edition, PHI Learning.

<table>
<tr><td rowspan="3">Course: Distribution System Automation
(Code: EET057)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand and analyses the basic fundamentals and advance terminology for distribution system

CO2: Analyze and evaluate the function of automated distribution system

CO3: Understand and model the modern real time system for distribution system

CO4: Understand and analyze the communication media for automation of distribution systems.

Module 1: Analysis of Distribution Systems (DS)

Distribution substation; Major components of DS: High side and low side switching, voltage transformation, voltage regulation, Protection, Metering; Radial feeder; Definition of nature of loads; Individual customer load: Demand, Maximum demand, Average demand, Load factor; Distribution transformer loading; "K" factor for voltage drop and voltage rise; Load flow analysis of balanced and weakly mesh distribution systems.

Module 2: Distribution Automation Functions:

Concept of distribution automation; Definition of automated devices preparedness; Components in automation systems; Functional scope of distribution management systems (DMS) and energy management systems (EMS); Steady state performance of DMS/EMS; Dynamic performance of DMS/EMS; Distribution topology; Architecture of distribution automation and control.

Module 3: Real Time Control System:

Illustrations of SCADA (Supervisory control and data acquisition); Function of SCADA: Supervisory control, Data acquisition and processing, Sequence of events (SOEs) registry, Mis-operation revision, Tagging, Alarm processing, Historical information system; System architecture.

Synchrophasors: Definition, Application of PMUs (phasor measurement units); Line parameter calculations; State estimation; Transmission line thermal monitoring; Voltage instability.

Module 4: Commination Systems:

Data communication; Type of telecommunication media; Communication modulation indices; Asynchronous and synchronous communications; Communication network; Local area network and metropolitan area network; Interconnection standard and regulation; Distribution network protocols.

Recommended Book:

S. No	Name of Book	Author	Publisher & Edition
1	Electric Power Distribution, Automation, Protection, And Control	James A. Momoh	CRC Press, Tylor and Francis group.
2	Control And Automation Of Electrical Power Distribution Systems	James Northcote-Green and Robert Wilson	CRC Press, Tylor and Francis group
3.	Distribution System Analysis and Automation	Juan M Gers	IET Power And Energy Series 68
4	Distribution System Modeling and Analysis	William H. Kersting	CRC Press, Tylor and Francis group

<table>
<tr><td rowspan="3">Course: Industrial Process Instrumentation & Telemetry (Code: EET058)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4ThYear VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
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<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand the meaning and scope of telemetry and remote control systems.

CO2: Learn about the fundamentals, theory and applications of telemetry in real time systems.

CO3: Understand the working principles and design of controllers for industrial process equipment's.

CO4: Develop the comprehensive understanding and applicability of PLCs, distributed and supervisory controls.

Module 1:Introduction to Telemetry

Meaning and importance of telemetry, remote control and remote signaling/supervision, Messages and signals; signal formation, conversion and transmission.

Signal transmission and transmission media: Physical and radio links; communication lines and operational paths of undertakings used for communications; noise in transmission channels, reliability and efficiency of transmission.

Module 2: Telemetry and SCADA system

Telemetry error, dc, pulse and digital telemetry methods and systems: Multichannel telemetry schemes. Remote control and Remote signaling: Principal of independent messages and combinatorial principle; Multi-wire FDM and TDM schemes. Layout, functions and operation of SCADA system.

Module 3:Review of Concepts of system response and control

Response of first order systems involving forcing functions, non-interacting and interacting systems. Basic concepts and working principles of sensors and transducers for various measuring process variables. Controller Principles; process characteristics; control system parameters; Discontinuous, continuous and composite controller modes. Analog and digital controllers; General features and design considerations.

Module 4:Control Characteristics, Equipment and Final Control Elements

Control system configuration; Multivariable control system; Control system quality and stability; Process loop tuning. Details of controllers including measurement unit, comparator, actuator and final control elements; Pneumatic, hydraulic and electric actuators; Control valve characteristics; Pneumatic to electric and electric to pneumatic converters, hydraulic and pneumatic power supply system.

Module 5: PLCs, Distributed and Supervisory Controls

Relays controllers and ladder diagrams; Relay sequences; PLC operation and programming.

Distributed control; Hardware components of distributed control; Introduction and necessity of supervisory control; Master control station and remote terminal units

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	Handbook of Telemetry and Remote Control	Gruenberg E. L	McGraw-Hill International Book Company
2	Electronic Communication Systems: Fundamentals	Tomasi W	5th Ed., Pearson Education
3	Advanced Control System Technology	Chemsmond C. J	Viva Books
4	Process Control Analysis and Control	Coughanowr D. R	2nd Ed., McGraw-Hill International Book Company
5	Process Control Instrumentation Technology	Johnson C. D	8th Ed., Prentice Hall of India

POWER SYSTEM RELIABILITY

Course Code: EET059

L	T	P	C
3	0	0	3

Co. No:	Course Outcomes	PO/PSO	BTL
CO 1	Understand the system reliability concepts	a, f, g	2
CO 2	Apply the frequency and duration techniques for component repairable system.	a, f, g	3
CO 3	Apply the network reliability concepts to generation system reliability analysis.	a, f, g	3

CO 4	Apply the network reliability concepts to transmission and distribution system reliability analysis.	a, f, g	3

Module-I

Network Modelling and Reliability Analysis: Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bath tub curve - reliability measures MTTF, MTTR, MTBF.

Module-II

Frequency & Duration Techniques: Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one , two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering of merged states.

Module-III

Generation System Reliability Analysis: Reliability model of a generation system– recursive relation for unit addition and removal – load modeling - Merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE. Transmission System Reliability Analysis**:** System and load point reliability indices – Weather effects on transmission lines – Weighted average rate and Markov model.:

Module IV

Distribution System Reliability Analysis: Basic Techniques – Radial networks – Evaluation of Basic reliability indices, performance indices - Load point and system reliability indices – Customer oriented, loss and energy oriented indices – Examples. Parallel Configuration: Basic techniques – Inclusion of bus bar failures, scheduled maintenance – Temporary and transient failures – Weather effects –Evaluation of various indices – Examples.

Text Books:

1. R. Billinton, R.N.Allan, “Reliability Evaluation of Power systems” second edition, Springer.
2. Charles E. Ebeling, “An Introduction to Reliability and Maintainability Engineering”, TATA Mc Graw - Hill – Edition.

Reference Books:

1. R. Billinton, R.N.Allan, “Reliability Evaluation of Engineering System”, Plenum Press, New York.
2. Eodrenyi, J., “Reliability modelling in Electric Power System”, John Wiley, 1980

Course Code: EET060	Course Title: Utilization & Traction		Course Credit:3		
Semester: 8th	**Session:** Spring		**Contact Hours**		
Mid Term Exam	**Internal Assessment**	**End Term Exam**	**L**	**T**	**P**
30 (Marks)	10 (Marks)	60 (Marks)	3	0	0

Course Objective: To understand the basic principle and types of lighting schemes, electric heating, electric welding, electric drives and electric traction system.

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Select a proper lighting system and implement it in real life applications.

CO2: Recognize different process of utilizing electric energy for heating and welding purposes in commercial and domestic applications.

CO3: Apply the knowledge of drives and use them effectively.

CO4: Choose proper traction systems depending upon application.

CO5: Differentiate between conventional and alternate energy vehicles.

UNIT-I Illumination:

Introduction, terms used in photometry and their units, laws of illumination, various types of lighting scheme, illumination at a point due to one and several points sources, street lighting, flood lighting, various types of lamps: incandescent, fluorescent, vapour, CFL and LED.

UNIT-II Electric Heating & Welding:

Electric heating: Advantages of electric heating, direct and indirect resistance heating, properties and design of heating element, electric oven, induction heating, dielectric heating, high frequency eddy current heating.

Electric welding: Arc welding: metal arc welding and carbon arc welding, welding equipments, welding machine.

UNIT-III Electric Drives:

Definition, advantages of electric drives, components of electric drives, four quadrant operation of Lift, electric braking, characteristic of different types of mechanical load, steady state stability of motor load system.

UNIT-IV Electric Traction:

Advantages and disadvantages of electric traction, types of railway electrification, overhead equipments, speed-time curve, tractive effort, accelerating force, specific energy consumption, specific energy output, types of railway services: urban, sub-urban, and main lines with their speed-time curves.

UNIT-V Electric & Hybrid Electric Vehicles:
Conventional vehicle and its components, concept of electric vehicle and its components, concept of hybrid electric vehicles (HEVs) and its components, architectures of HEVs: series HEVs, parallel HEVs and complex HEVs.

Text Books:

6. H. Partap, Art and Science of Utilization of Electrical Energy, Dhanpat Rai & Sons.
7. J. B. Gupta, Utilization of Electric Power & Electric Traction, S. K. Kataria & Sons.
8. G. K. Dubey, Fundamentals of Electric Drives, Narosa Publications, New Delhi.
9. Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals” CRC Press.

Reference Books:

1. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design” CRC Press.

Subject: Switched Mode Power Conversion (Code: EET064)	**Year & Semester: 4^{th}&8^{th}**		**Total Course Credit: 3**		
			L	**T**	**P**
			3	**0**	**0**
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**		
	30 Marks	**10 Marks**	**60 Marks**		

Objective: To introduce the concepts of switch mode power conversion using power electronic devices.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: To understand the physics of operation of power semi-conducting devices.
CO2: To understand the functioning of different types of gate driver circuits and protection circuits.
CO3: To understand the analysis and design of isolated and non-isolated DC-DC converters.
CO4: To understand the operation of different topologies of improved power quality converters.

Details of the syllabus:

S. N.	Particulars
1.	Introduction to power switching devices such as Thyristors, GTO, MOSFETs, BJT, IGBT, MCTs and Wide Band Gap HEMTs
2.	Basic Concepts of Gate driver circuits. Triggering techniques, optical isolators, bootstrap circuits and isolation transformers. Subber design and protection circuits.
3.	Basic circuit analysis and design of non-isolated and isolated DC-DC converters. DCM/CCM modes of conduction, design of passives.
4.	Improved power quality converters, Front-end converters, PWM rectifiers
5.	Multi-level and multi-pulse configurations for improved power quality AC-DC converters

Recommended Books:

S. N.	Name of Book	Author (s)
1.	Fundamentals of Power Electronics	Erickson and Macsimovic
2.	Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989	N. Mohan, T.M. Undeland& W.P. Robbins
3.	Power Electronics: Devices, Drivers, Applications, and Passive Components	Barry Williams
4.	Power Electronics, Tata McGraw Hill	Daniel W Hart