

Zeal Education Society's

ZEAL COLLEGE OF ENGINEERING & RESEARCH, PUNE – 41

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

NBA Accredited, NAAC Accredited with A+ Grade / ISO 21001:2018



DEPARTMENT OF ELECTRICAL ENGINEERING

Curriculum Structure and Syllabus of T.Y. B. Tech. – Electrical Engineering (With effect from - Academic Year 2026- 27) (2024 Course)

VISION OF THE INSTITUTE

To be a premier institute in technical education by imparting academic excellence, research, social and entrepreneurial attitude.

MISSION OF THE INSTITUTE

- To achieve academic excellence through innovative teaching and learning process.
 - To imbibe the research culture for addressing industry and societal needs.
 - To inculcate social attitude through community engagement initiatives.
 - To provide conducive environment for building the entrepreneurial skills.



DEPARTMENT OF ELECTRICAL ENGINEERING

VISION:

To be premier institute in technical education by imparting academic excellence, research, social and entrepreneurial attitude.

MISSION:

- M1:** To achieve academic excellence through innovative teaching and learning process
- M2:** To imbibe the research culture for addressing industry and societal needs.
- M3:** To inculcate social attitude through community engagement initiatives.
- M4:** To provide conducive environment for building the entrepreneurial skills.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

- PEO1:** Graduates will be able to apply their technical skill sets and knowledge to solve engineering-based problems in industry, academic and diverse fields of Electrical Engineering.
- PEO2:** Graduates will demonstrate ethical and social responsibility while engaging in research, innovative practices and entrepreneurial activities, contributing positively to society and technological advancement.
- PEO3:** Graduates will embrace lifelong learning and adaptability, staying updated with emerging technologies, industry trends and advancements in electrical engineering.

PROGRAM OUTCOMES (POs):

- PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.
- PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)
- PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).



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- PO6: The Engineer and the World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).
- PO8: Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
- PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSOs):

- PSO1:** To apply knowledge to build ability to design analyses and solve problems in the field of electrical engineering through power systems, electrical machines, control systems, electronics and automation.
- PSO1:** To develop solution to real time problems through appropriate techniques, modern engineering hardware and software tools related Electrical engineering.



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LIST OF ABBREVIATIONS

Abbreviation	Description
BSC	Basic Science Course
ESC	Engineering Science Course
PCC	Program Core Course
PEC	Program Elective Course
MDM	Multidisciplinary Minor
OE	Open Elective - Other than a particular program
VSEC	Vocational and Skill Enhancement Course
AEC	Ability Enhancement Course
ENTR	Entrepreneurship
EC	Economics
MC	Management Courses
IKS	Indian Knowledge System
VEC	Value Education Courses
RM	Research Methodology
CEP	Community Engagement Project
FP	Field Project
PROJ	Project
INT	Internship
OJT	On Job Training
CC	Co-curricular Courses
HSSM	Humanities Social Science and Management
ELC	Experiential Learning Course
B. Tech	Bachelor of Technology
L	Lecture
P	Practical
T	Tutorial
H	Hours
CR	Credits
CIE	Continuous Internal Evaluation
ETE	End Term Evaluation
TW	Term Work
OR	Oral
PR	Project



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Department of Electrical Engineering															
Sem V															
Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)							Evaluation Scheme					
			L	P	T	H	CR			C I E	E T E	TW	PR	OR	Total
							TH	PR/ Tut	Total						
EEPC508	PCC	Power System-II	3	-	-	3	3		3	40	60	-	-	-	100
EEPC508P	PCC	Power System-II Lab	-	2	-	2	-	1	1	-	-	-	50	-	50
EEPC509	PCC	Theory of Electrical Machines-II	3	-	-	3	3	-	3	40	60	-	-	-	100
EEPC509P	PCC	Theory of Electrical Machines-II Lab	-	2	-	2	-	1	1	-	-	-	50	-	50
EEPC510	PCC	Control System Engineering	3	-	-	3	3	-	3	40	60	-	-	-	100
EEPC510P	PCC	Control System Engineering Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
EEPE501	PEC	Program Elective Course-I*	4	-	-	4	4	-	4	40	60	-	-	-	100
EEMD503	MDM	Project Management System- II	-	2	-	2	-	1	1	-	-	25	-	-	25
EEAE506	AEC	Seminar	-	-	1	1	-	1	1			25			25
ALOE503	OE	Open Elective - III #	2	-	-	2	2	-	2	-	-	50	-	50	100
EEIN504	ELC-INT	Internship - IV	4 Weeks				-	2	2	-	-	25	-	-	25
Total			15	8	1	24	15	7	22	160	240	125	100	75	700

BoS Chairman



Director

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* - Select any one course from the given Program Elective Courses		
Course Code	Course Type	Program Elective-I
EEPE501A	PEC	Electrical Installation, Maintenance & Testing
EEPE501B		Power Quality
EEPE501C		Utilization of Electrical Energy

# - Select any one course from the given Open Elective Courses		
Course Code	Course Type	Open Elective - III
ALOE503A	OEC	Data Analytics
ALOE503B		Green Building
ALOE503C		Electric Mobility
ALOE503D		Introduction to Stock Market
ALOE503E		Patent Law for Engineers & Scientist

BoS Chairman

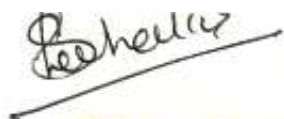


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Department of Electrical Engineering															
Sem VI															
Course Code	Course Type	Course Name	Teaching Scheme (hrs/Week)							Evaluation Scheme					
			L	P	T	H	CR			C I E	E T E	TW	PR	OR	Tot
							TH	PR/ Tut	Tot						
EEPC611	PCC	Power System Protection	4	-	-	3	4	-	4	40	60	-	-	-	100
EEPC611P	PCC	Power System Protection Lab	-	2	-	2	-	1	1			50	25		75
EEPC612	PCC	Electrical Machine Design	3	-	-	3	3	-	3	40	60		-		100
EEPC612P	PCC	Electrical Machine Design Lab	-	2	-	2	-	1	1			25	-	25	50
EEPE602	PEC	Program Elective Course-II *	3		-	3	3	-	3	40	60	-	-		100
EEPE603	PEC	Program Elective Course-III *	3		-	3	3	-	3	40	60	-	-		100
EEMD603	MDM	Electric & Hybrid Vehicle	3	-	-	3	3	-	3	40	60	-	-	-	100
EEMD603P	MDM	Electric & Hybrid Vehicle Lab	-	2	-	2		1	1			25		-	25
EEVS606	VSEC	Quality Management System - III	-	2	-	2	-	1	1	-	-	25	-	-	25
EEIN605	ELC - INT	Internship - V	4 Weeks				-	2	2	-	-	25	-	-	25
Total			16	8	-	24	16	6	22	200	300	150	25	25	700



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* - Select any one course from the given Program Elective Courses		
Course Code	Course Type	Program Elective-II
EEPE602A	PEC	Advance Control System
EEPE602B		IoT for Smart Energy Systems & Smart Grid
EEPE602C		High Voltage Engineering

* - Select any one course from the given Program Elective Courses		
Course Code	Course Type	Program Elective-III
EEPE603A	PEC	Advance Electrical Drive Systems
EEPE603B		Advanced Microcontroller
EEPE603C		HVDC and FACTS Devices

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SYLLABUS

SEMESTER - V



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Program: B-Tech. (Electrical Engineering)							Semester: V		
Course: Power System II							Code: EEPC508		
Teaching Scheme:				Evaluation Scheme:					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Power System, Electrical Machines									
Course Objectives: The objectives of this course are									
1. To understand the modeling and performance of long transmission lines using ABCD Constants									
2. To introduce the concept of EHVAC and HVDC System.									
3. To apply load flow analysis techniques for planning and operation of power systems.									
4. To analyze the power system under symmetrical and Unsymmetrical fault conditions.									
Course Outcomes: After completion of this course, students will able to									
CO1	Analyze the performance of long transmission lines using ABCD parameters								
CO2	Evaluate the performance of EHVAC transmission lines.								
CO3	Perform load flow analysis using Gauss-Seidel, Newton-Raphson, and Fast Decoupled methods with power system software.								
CO4	Analyze the symmetrical faults in power systems.								
CO5	Analyze unsymmetrical faults in power systems.								
CO6	Apply HVDC transmission concepts to select suitable control methods.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Performance of Transmission line: Evaluation of ABCD constants and equivalent circuit parameters of Long transmission line. Concept of complex power, power flow using generalized constants, surge impedance loading, Line efficiency, Regulation and compensation, Numerical based on ABCD constants of Long transmission line, Power flow.								7
2	EHVAC Transmission: Role of EHV-AC transmission, standard transmission voltages, average values of line parameters, power handling capacity and line losses, phenomenon of corona, disruptive critical voltages, visual critical voltages, corona loss, factors and conditions affecting corona loss, Numerical Based on Corona, Corona loss and power handling capacity.								7
3	Load Flow Analysis: Introduction to Load Flow analysis, Bus Classification, Formation of bus admittance matrix, Power flow equations, Load flow solution methods: Guess Seidal, Newton Raphson method, Convergence characteristics, Applications of load flow analysis, Numericals based on load flow solution methods. Introduction to power system software used for load flow analysis.								7
4	Symmetrical Fault Analysis 3-phase short-circuit analysis of unloaded alternator, sub-transient, transient and steady								7

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	state current and impedances, D.C. Offset, and effect of the instant of short-circuit on the waveforms, selection of circuit-breakers and current limiting reactors and their location in power system, Numerical Based on symmetrical fault analysis.	
5	Unsymmetrical Fault Analysis Symmetrical components, transformation matrices, power in terms of symmetrical components, sequence impedance of transmission line and zero sequence networks of transformer, solution of unbalances by symmetrical components, L-L, L-G, and L-L-G fault analysis of unloaded alternator and simple power systems with and without fault impedance. Numerical based on symmetrical components and unsymmetrical fault calculation.	7
6	HVDC Transmission Classification and components of HVDC system, advantages and limitations of HVDC transmission, comparison with HVAC system, introduction to HVDC control methods - constant current, constant ignition angle and constant extinction angle control, HVDC systems in India, recent trends in HVDC system.	7
TOTAL		42
Industrial Visit: Compulsory visit to EHV-AC substation/ HVDC substation		
Text Books:		
1. I. J. Nagrath & D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi. 2. B R Gupta, “Power System Analysis and Design”, S. Chand. 3. Ashfaq Hussain, “Electrical Power Systems”, CBS Publication 5th Edition. 4. J. B. Gupta. “A course in power systems” S.K. Kataria Publications. 5. P. S. R. Murthy, “Power System Analysis”, B.S. Publications		
Reference Books:		
1. H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi. 2. Rakash Das Begamudre, “Extra High voltage A.C. Transmission Engineering”, New age publication. 3. Stevenson W.D., Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi. 4. K. R. Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi. 5. P. Kundur, Power System Stability And Control, McGraw Hill		
E-Resources:		
1. NPTEL Course on power system engineering: Debpriya Das https://nptel.ac.in/courses/108/105/108105104/ 2. NPTEL Course on power system analysis By Dr. A.K. Sinha https://nptel.ac.in/courses/108/105/108105067/ 3. NPTEL Course on power system analysis By Dr. Debpriya Das https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee72/		

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Program: B-Tech. (Electrical Engineering)							Semester: V		
Course: Power System II Lab							Code: EEPC508P		
Teaching Scheme:				Evaluation Scheme:					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	-	50	50
Prerequisites:									
Power System, Electrical Machines									
Course Objectives: The objectives of this course are									
1. To develop practical skills in analysis and performance evaluation of transmission lines using ABCD parameters, circle diagrams and VAR compensation techniques.									
2. To familiarize students with power system modeling and analysis, including Y-bus formulation, load flow and fault analysis using utility software.									
3. To develop the ability to determine synchronous machine reactances and analyze power system behavior under normal and fault conditions.									
Course Outcomes: After completion of this course, students will able to									
CO1	Determine and analyze transmission-line and synchronous-machine parameters using experimental methods.								
CO2	Simulate and analyze power-system performance, including load flow, faults, VAR compensation, and HVDC transmission using utility software.								
CO3	Interpret experimental and simulation results to evaluate power-system performance								
List of Experiments: To perform any eight experiments from the following list									
Group A: Compulsory experiments:									
1. Measurement of ABCD parameters of a medium transmission line.									
2. Measurement of ABCD parameters of a long transmission line.									
3. Plotting of receiving end circle diagrams to evaluate the performance of medium transmission lines.									
4. Performance of the effect of VAR compensation using capacitor bank on the transmission line.									
5. Formulation and calculation of Y- bus matrix of a given system using utility software.									
6. Measurement of sub-transient direct axis and quadrature axis synchronous reactances using slip test.									
Group B: Optional Experiments:									
1. Measurement of positive, negative and zero sequence reactance of salient pole alternator.									
2. Simulation of Symmetrical and Unsymmetrical fault of single machine connected to infinite bus.									
3. Measurement of sub-transient reactance of a salient-pole alternator using static test.									
4. Perform Load flow analysis using Newton–Raphson method in comparison with Gauss–Seidel using utility software.									
5. Simulation of Basic HVDC Transmission System									
Text Books:									
6. I. J. Nagrath & D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi.									
7. B R Gupta, “Power System Analysis and Design”, S. Chand.									
8. Ashfaq Hussain, “Electrical Power Systems”, CBS Publication 5th Edition.									
9. J. B. Gupta. “A course in power systems” S.K. Kataria Publications.									
10. P. S. R. Murthy, “Power System Analysis”, B.S. Publications									



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Reference Books:
6. H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi. 7. Rakash Das Begamudre, “Extra High voltage A.C. Transmission Engineering”, New age publication. 8. Stevenson W.D., Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi. 9. K. R. Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi. 10. P. Kundur, Power System Stability And Control, McGraw Hill

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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Theory of Electrical Machine II							Code: EEPC509		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic Electrical Engineering, Theory of Electrical Machines-I									
Course Objectives:									
1. To study the applications of different machines in industrial, commercial & social sectors. 2. To determine the performance indices of AC series & single phase motors by experimentation Learn construction & working principle of three phase synchronous machines and 1-ph induction motors. 3. To calculate voltage regulation of Alternator by different methods									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Analyze the performance of single-phase induction motors.								
CO2	Describe the construction, working principle, and applications of special purpose motors.								
CO3	Explain the constructional details of synchronous machines.								
CO4	Analyze the performance of Synchronous Generator.								
CO5	Evaluate the voltage regulation of an alternator and explain the parallel operation of alternators.								
CO6	Explain the performance characteristics of synchronous motors, including V-curves and hunting remedies.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Single Phase Induction Motor Double revolving field theory; Equivalent circuit and torque-slip characteristics on the basis of double revolving field theory; Starting methods and types of Single phase Induction motor: their working principle and applications.								7
2	Special Purpose Motors Single phase A.C. series motor, Servo motors, Linear Induction Motor; Single phase synchronous motors- hysteresis motor, reluctance motor. Repulsion motor, stepper motor, switched reluctance.								7
3	Synchronous Machine Construction and Performance Constructional details: Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings –distribution, pitch and winding factors. (Numerical)								7
4	Synchronous Generator Principle of operation and excitation systems, EMF equation and winding factor, Armature reaction and its effects, Circuit model and phasor diagram, Open circuit and short-circuit tests, Short-circuit ratio, Power flow diagram, losses, and efficiency. (Numerical)								7
5	Voltage Regulation and Parallel Operation of Alternator Determination of voltage regulation by emf, mmf, and Zero Power Factor or Potier								7

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	method. Parallel Operation of Alternator: Necessity conditions, Load sharing between two alternators in parallel (Descriptive treatment only). Process of synchronizing alternator with infinite bus-bar by lamp method (one dark & two equally bright lamp method) and by the use of synchroscope (Numerical on parallel operation)	
6	Synchronous Motors Principle of operation. Methods of starting. Equivalent circuit, significance of torque angle, Losses, efficiency and Power flow chart. Operation of 3-phase Synchronous motor with constant load and variable excitation ('V' curves and 'inverted V' curves). Phenomenon of hunting and its remedies. Applications of 3-phase synchronous motors.	7
TOTAL		42
Industrial Visit: Compulsory visit to synchronous machines manufacturing company		
Text Books:		
1. Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill. 2. S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill. 3. A.S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill 4. P. S. Bimbhra, Electric Machinery, Khanna Publications.		
Reference Books:		
1. M.G. Say, Performance & design of AC machines, CBS publishers & distributors, Delhi, 3rd edition 2. A.E. Clayton & N.N. Nancock, The Performance & design of DC machines CBS publications & distributors, Delhi, 3rd edition 3. M V Deshpande, Electrical Machines, Prentice Hall of India		
E-Resources:		
1. NPTEL Course on Electrical Machine II By Prof. Tapas Kumar Bhattacharya https://youtu.be/exfUnnxnGEw?list=PLbRMhDVUMngcDrGXlt-hX-ekpldUIC2b6		

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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Theory of Electrical Machine II Lab							Code: EEPC509P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	-	50	50
Prerequisites:									
Basic Electrical Engineering, Theory of Electrical Machines-I									
Course Objectives:									
1. To develop practical skills in identification, testing and performance evaluation of AC machines through laboratory experiments. 2. To familiarize students with load testing, voltage regulation methods and performance characteristics of induction motors, synchronous motors and alternators. 3. To develop the ability to determine machine parameters, analyze experimental characteristics and interpret test results using standard laboratory methods.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Identify different types of AC machines, determine their ratings and perform basic insulation testing.								
CO2	Conduct and analyze load and performance tests on single-phase induction motors, single-phase series motors and synchronous motors.								
CO3	Determine and evaluate the voltage regulation and performance of alternators using EMF, MMF, slip test, Potier and direct loading methods.								
List of Experiments: To perform any eight experiments from the following list									
Group A (Compulsory Experiment)									
1. Identification of Various Types of A.C. Machines with Rating determination and Insulation Testing. 2. Load test on Single -phase induction motor. 3. Load test on Single-phase series motor. 4. Determination of voltage regulation of cylindrical rotor alternator by a) EMF method b) MMF method. 5. V and inverted V curve of synchronous motor at constant load.									
Group B (Optional)									
6. Determination of voltage regulation of salient pole alternator by slip test. 7. Determination of voltage regulation of cylindrical rotor alternator by Potier method. 8. Determination of voltage regulation of alternator by direct loading. 9. Load test on three phase synchronous motor. 10. No load and blocked-rotor test on a single phase Capacitor-start induction motor and Determination of its equivalent circuit parameters.									
Text Books:									
1. Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill. 2. S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill. 3. A.S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill 4. P. S. Bimbhra, Electric Machinery, Khanna Publications.									
Reference Books:									
1. M.G. Say, Performance & design of AC machines, CBS publishers & distributors, Delhi, 3rd edition									



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- | |
|---|
| <ol style="list-style-type: none">2. A.E. Clayton & N.N. Nancock, The Performance & design of DC machines CBS publications & distributors, Delhi, 3rd edition3. M V Deshpande, Electrical Machines, Prentice Hall of India |
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**DEPARTMENT OF ELECTRICAL ENGINEERING**

Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Control System Engineering							Code: EEPC510		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Laplace Transform, Ordinary differential equations									
Course Objectives:									
1. To introduce the basic concepts of the classical control theory and modeling 2. To model physical systems mathematically. 3. To analyze behavior of system in time and frequency domain 4. To analyze Stability of system in time and frequency domain 5. To introduce the concept of PID controllers.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Classify the control systems and will be able to represent the system in block diagram form and in signal flow graph form								
CO2	Design mathematical model of physical systems.								
CO3	Analyze time response of first and second order systems								
CO4	Investigate the stability of system in time domain.								
CO5	Analyze the systems in frequency domain and investigate stability.								
CO6	Analyze the response of the system by PID controller.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Introduction to Control System Engineering Introduction, Concepts of control systems, Types of systems-Linear and Non-linear Systems, Time-invariant and Time variant systems; Classification of control systems - Open-loop and closed-loop control systems; Examples of control systems. Concept of transfer function, Introduction to block diagram, block diagram reduction rules. Numerical Introduction to Signal flow graph, terminologies used in signal flow graph, conversion of block diagrams to signal flow graph, Mason's gain formula. Numerical.								7
2	Mathematical Modelling of Physical Systems Representation of: Electrical, mechanical (Linear and Rotational) with differential equations and transfer functions; F-V and F-I Analogy. Development of mathematical models of electromechanical (DC Motor), Thermal, Hydraulic and Pneumatic systems.								7
3	Time Response Analysis of Linear Control System Concept of transient and steady state response, standard test signals: step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit impulse, unit step input, time domain specifications of second-order under-damped system for unit step input, concept of pole and zero, dominant poles, steady state error and static error coefficients								7

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4	Stability Analysis of Linear Control System Concept of stability: BIBO, nature of system response for various locations of poles in S-plane. Routh- Hurwitz criterion, cases of Routh-Hurwitz criteria, applications of Routh- Hurwitz Criterion. Numerical, Root Locus: Introduction, Angle and magnitude condition, Basic properties of root locus. Construction of root locus, Stability analysis using root locus. Numerical	7
5	Frequency Response Analysis: Introduction, Frequency domain specifications, correlation between time and frequency domain specifications, polar Plot. Introduction to Bode plot, Asymptotic approximation: sketching of Bode plot, stability analysis using Bode plot	7
6	Basic control actions and PID Controllers: On-Off Control Action, Proportional (P) Control Action, Integral (I) Control Action, Derivative (D) Control Action, Combined Control Actions: PI Controller, PD Controller, PID Controller, Effect of P, I and D actions on system performance, Tuning of PID controllers using Ziegler-Nichol Methods. (Numerical)	7
TOTAL		42
Text Books:		
1. Nagrath I.J, and Gopal M, Control Systems Engineering, 2017, 6th edition, New Age International Publishers. 2. Katsuhiko Ogata, “Modern control system engineering”, Prentice Hall, 2010. 3. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson 4. Control Systems - A. Ananad Kumar, PHI.		
Reference Books:		
1. Norman S Nise, Control Systems Engineering, 2018, 7th edition, John Wiley and Sons, Inc. 2. Benjamin C. Ku, Farid Golnaraghi, Automatic Control Systems, 2017, 10th edition, McGraw-Hill Education 3. Richard C Dorf and Robert H Bishop, “Modern control system”, Pearson Education, 12th edition, 2011. 4. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.		
E-Resources:		
1. https://nptel.ac.in/courses/107106081 2. https://nptel.ac.in/courses/108106164		

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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Control System Engineering Lab							Code: EEPC510P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	25	-	25
Prerequisites:									
Laplace Transform, Ordinary differential equations									
Course Objectives:									
1. To develop practical skills in modeling, analysis and experimental study of control systems using physical systems and simulation software. 2. To familiarize students with time response, root locus, frequency response and stability analysis of control systems. 3. To develop practical understanding of PID-based control and performance improvement of systems such as DC servo motor, temperature control and position control systems.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Determine and analyze the mathematical models and transfer functions of practical control systems such as DC servo motor and two-tank systems.								
CO2	Analyze time response, root locus, Bode plot and stability of control systems using experimental methods and simulation software.								
CO3	Design and analyze PID-based control systems and evaluate their performance for temperature and position control applications.								
List of Experiments: perform any Eight experiments from the following list									
Group A: Compulsory experiments: 1. Experimental determination of DC servo motor parameters for mathematical modeling and transfer function 2. Experimental study of time response characteristics of R-L-C second order system. Validate the results using software simulation. 3. Analysis of Effect of addition of pole-zero on root locus of the second order system using any software. 4. Stability analysis using Bode plot using software. 5. PID control of Temperature control system Group B: Optional experiments: 1. Experimental determination of transfer function of Two Tank System. 2. Analysis of effect of addition of dominant and non-dominant poles for step response of second order system using software 3. Simulation of Transfer functions of first and second order System on software and observe time response for unit step and unit ramp input 4. Time response of Undamped, under damped, over damped and critically damped response of second order system using software 5. Find steady state error of Type 0, 1, 2 systems for unit step, ramp and unit parabolic system using software 6. Analysis of closed loop DC position control system using PID controller.									
Text Books:									
1. Nagrath I.J, and Gopal M, Control Systems Engineering, 2017, 6th edition, New Age International									



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Publishers.

2. Katsuhiko Ogata, “Modern control system engineering”, Prentice Hall, 2010.
3. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson
4. Control Systems - A. Ananad Kumar, PHI.

Reference Books:

1. Norman S Nise, Control Systems Engineering, 2018, 7th edition, John Wiley and Sons, Inc.
2. Benjamin C. Ku, Farid Golnaraghi, Automatic Control Systems, 2017, 10th edition, McGraw-Hill Education
3. Richard C Dorf and Robert H Bishop, “Modern control system”, Pearson Education, 12th edition, 2011.
4. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.

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**DEPARTMENT OF ELECTRICAL ENGINEERING**

Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Electrical Installation, Maintenance & Testing							Code: EEPE501A		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
04	-	-	04	40	60	-	—	—	100
Prerequisites:									
Basic Electrical Engineering, Power System, Electrical Machines									
Course Objectives: The objectives of this course are									
1. To enable students to design earthing system for residential and industrial premises									
2. To demonstrate the importance and necessity of the maintenance of the electrical equipment.									
3. To enable students to classify different types of distribution supply systems and determine the economics of the distribution system.									
4. To empower students to carry out estimation and costing of internal wiring for residential and commercial installations.									
Course Outcomes: At the end of the course, Student will be able to -									
CO1	Compare and classify various substations, bus-bars and earthing systems.								
CO2	Explain the constructional features, functions, and applications of indoor and outdoor substations in power transmission and distribution systems.								
CO3	Explain the principles of system and equipment earthing, maintenance strategies, and condition monitoring techniques used in electrical systems.								
CO4	Analyze and estimate voltage drops in distribution systems, determine optimal conductor size using Kelvin’s Law, and evaluate material requirements for installations								
CO5	Apply standard testing procedures to assess insulation resistance, earth resistance, and performance of transformers, cables, and electrical installations.								
CO6	Describe the procedure for : Preparation of tender notice ,Submission of tenders ,Opening and evaluation of tenders, Estimate and Costing of residential and industrial premises								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Earthing and Substation: Necessity of earthing, Types of earthing system (Equipment and Neutral): objective, types of earth electrodes, earthing in extra high voltage & underground cable, earthing resistance – factors affecting, determination of maximum permissible resistance of earthing system, Different electrode configurations (Plate and Pipe electrode), Measurement of earth resistance: voltmeter-ammeter method, earth tester method, ohm meter method & earth loop tester method, comparison between equipment earthing & system grounding, Substation: Introduction to substation, Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams. Tolerable step and touch voltages, Steps involved in the design of the substation Earthing grid as per IEEE standard 80- 2013.								10
2	Maintenance, Condition Monitoring and Testing:								9

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	Maintenance: Importance and necessity of maintenance, different maintenance strategies like breakdown maintenance, planned/preventive maintenance and condition-based maintenance. Planned and preventive maintenance of transformer, Induction motor and Alternators. Polarization index, dielectric absorption ratio. Condition Monitoring: Thermography, Dissolved gas analysis, Induction motor fault diagnostic methods – Vibration Signature Analysis, Motor Current Signature Analysis.	
3	Testing of Electrical Equipment: Understanding CAT Ratings & Using CAT rated Instrument, Electrical Installation Testing Procedures- Insulation resistance test. Portable Appliance Tester and Earth resistance test. Testing of Power cables – Causes of cable failure, fault location methods and Remedial actions. Testing of the Transformer - Type tests and Routine tests.	9
4	Economics of Distribution Systems: Classification of supply systems (State Only) (i) DC, 2-wire system, (ii) Single phase two wire ac system, (iii) Three phase three wire ac supply system, iv) Three phase four wire ac supply system. Comparison between overhead and underground systems (For above mentioned systems) based on volume requirement for the conductor. AC Distribution System: Types of primary and secondary distribution systems, calculation of voltage drops in AC distributors (Uniform and Non-Uniform Loading) (Numerical). Economics of power transmission: Economic choice of conductor (Kelvin's law) (Derivation and Numerical). Distribution Feeders: Design considerations of distribution feeders; radial and ring types of primary feeders' voltage levels, energy losses in feeders.	10
5	Electrical Installation and Estimation: Electrical installations in residential, commercial & industrial, Internal distribution of Electrical Energy. Methods and types of wiring. Estimation: Introduction, HT, LT overhead lines and underground cables, cable sizing, Estimating data (only theory), Estimation and conductor size calculations of internal wiring for Residential and Commercial installations (Numericals) and estimate for underground LT service lines	9
6	Contracts, Tenders and IE Rules: Purpose of estimating and costing, qualities of good estimator, essential elements of estimating and costing, tender, guidelines for inviting tenders, quotation, price catalogue, labor rates, schedule of rates and estimating data (only theory), IE rules related to electrical installation, work to permit.	9
TOTAL		56

Text Books:

1. B. R. Gupta- Power System Analysis and Design, 3rd edition, Wheeler's Publication.
2. S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna Publishers.
2. S. L. Uppal - Electrical Power - Khanna Publishers, Delhi.
3. Handbook of condition monitoring by B. K. N. Rao, Elsevier Advanced Tech., Oxford



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| 4. S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House.
5. B. V. S. Rao – Operation and Maintenance of Electrical Equipment – Asia Publication |
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Reference Books:

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| 1. P.S. Pabla –Electric Power Distribution, 5th edition, Tata McGraw Hill.
2. S. L. Uppal, Electrical Wiring and Costing Estimation, Khanna Publishers, New Delhi.
3. Surjit Singh, Electrical wiring, Estimation and Costing, Dhanpat Rai and Company, New Delhi.
4. Raina K.B. and Bhattacharya S.K., Electrical Design, Estimating and Costing, Tata McGraw Hill, New Delhi. |
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E-Resources:

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| 1. nptel.ac.in/courses/108107112
2. Preview: BME-025: Condition Monitoring and Maintenance Management SWAYAM
3. Preview: Maintenance and Testing of Electrical Machines SWAYAM
4. nptel.ac.in/courses/108107112
5. https://youtu.be/Cbh8N3R8EhE?si=6CBOORQaQsDfITS
6. nptel.ac.in/courses/129106006 |
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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Power Quality							Code: EEPE501B		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
04	-	-	04	40	60	-	—	—	100
Prerequisites:									
Power Systems, Power Electronics.									
Course Objectives: The objectives of this course are									
1. To understand the fundamentals and importance of power quality in electrical power systems.									
2. To analyze major power quality issues such as voltage disturbances, harmonics, and power factor problems.									
3. To learn techniques for power quality improvement, monitoring, and mitigation including reactive power compensation and power factor correction.									
4. To apply IEEE/IEC standards for improving power system performance and reliability.									
Course Outcomes: At the end of the course, Student will be able to -									
CO1	Explain and classify major power quality disturbances such as transients, voltage variations, interruptions, imbalance, and flicker, and assess their effects on electrical equipment								
CO2	Analyze RMS voltage variations, voltage regulation, reactive power, voltage flicker, and transient over-voltages in electrical power systems.								
CO3	Analyze voltage sag, swell, and interruption characteristics and evaluate equipment sensitivity using CBEMA, ITIC, and SEMI F47 curves.								
CO4	Analyze harmonic distortion, inter-harmonics, resonance, and harmonic sources, and select suitable harmonic mitigation techniques and filters as per applicable IEEE standards								
CO5	Evaluate power factor and reactive power compensation requirements and select appropriate compensation techniques for industrial electrical systems.								
CO6	Conduct and interpret power quality monitoring and assessment using suitable instruments, measurement techniques, power quality indices, and relevant standards.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Basics of Power Quality Importance of power quality, power quality terminology as per IEEE Std. 1159-2019, transients, short and long duration voltage variations, voltage interruptions, voltage fluctuations, imbalance and flicker. Symptoms and impacts of poor power quality. Grounding terminology, purpose of grounding, grounding practices, grounding related power quality issues and noise control.								9
2	RMS Voltage variations, Flickers and Transient Over-Voltages RMS voltage variations, voltage regulation, per-unit system, complex power and voltage drop concepts. Reactive power management and devices used for voltage regulation. Causes and effects of voltage flicker, flicker reduction techniques and flicker monitoring. Transient over-voltages, impulsive and switching transients, surge impedance and transient voltage control.								9
3	Voltage Sag, Swell and Interruption Voltage sag, swell and interruption concepts, causes and effects of voltage sag, fault								9

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	related voltage sag characteristics, phase angle jumps and sag classification. Equipment sensitivity assessment using CBEMA, ITIC and SEMI F47 curves. Voltage sag measurement techniques and voltage sag indices. Mitigation methods using UPS, DVR, CVT and utility solutions.	
4	Harmonics and Harmonic Mitigation Harmonics, inter-harmonics and sub-harmonics. Causes and effects of harmonics, voltage and current distortion, Fourier analysis and harmonic indices. Harmonic sources including SMPS, transformers, drives, FACTS devices and arc furnaces. Series and parallel harmonic resonance and their effects. Harmonic control principles, harmonic study procedures and harmonic source identification. Passive, notch, tuned, broadband and active filters. IEEE Std. 519-2014 and IEEE Std. 1531 for harmonic control.	10
5	Power Factor Improvement and Reactive Power Compensation Concept of power factor, causes and effects of low power factor, advantages of power factor improvement. Reactive power compensation techniques using static capacitors, synchronous condensers and FACTS devices. Automatic power factor correction (APFC), capacitor bank selection and rating. Power factor correction in industrial systems. Effect of harmonics on power factor correction equipment and protection issues.	10
6	Power Quality Monitoring and Assessment Need and objectives of power quality monitoring, site survey and monitoring requirements. Power quality instrumentation and analyzer specifications as per EN50160 standards. Selection of monitoring equipment, monitoring location and transducers. Harmonic, transient and flicker monitoring. Power quality indices and assessment standards.	9
TOTAL		56
Text Books:		
1. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, Electrical Power Systems Quality, McGraw-Hill. 2. Arindam Ghosh, Gerard Ledwich, Power Quality Enhancement Using Custom Power Devices, Springer. 3. J. Arrillaga, N. R. Watson, Power System Harmonics, John Wiley & Sons. 4. S. S. Rao, Power Quality in Power Systems and Electrical Machines, Academic Press.		
Reference Books:		
1. Arrillaga, M. R. Watson, "Power System Harmonics", John Wiley and Sons. 2. Bollen M. H. J., <i>Understanding Power Quality Problems</i>, IEEE Press. 3. G. J. Heydt, "Electric Power Quality", Stars in Circle Publications. 4. IEEE Std. 1159-2019 – <i>Recommended Practice for Monitoring Electric Power Quality</i>. 5. IEEE Std. 519-2014 – <i>Recommended Practice and Requirements for Harmonic Control in Electric Power Systems</i>. 6. IEEE Std. 1531 – <i>Guide for Application and Specification of Harmonic Filters</i>.		
E-Resources:		
1. NPTEL Course: <i>Power Quality</i> – IIT Kharagpur https://nptel.ac.in/courses/108105067 2. NPTEL Course: <i>Power System Dynamics and Control (includes power quality topics)</i> – IIT Madras https://nptel.ac.in/courses/108106022		

DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B-Tech. (Electrical Engineering)							Semester: V		
Course: Utilization of Electrical Energy							Code: EEPE501C		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
04	-	-	04	40	60	-	-	-	100
Prerequisites:									
Basic Electrical Engineering, Power System, Electrical Machines.									
Course Objectives: After completing this course, students will be able to:									
1. To understand the principles, methods, and industrial applications of electric heating systems and analyze their performance characteristics. 2. To explain the working principles, equipment, and applications of electric welding processes used in industrial practice. 3. To develop knowledge of refrigeration and air-conditioning systems, including electrical circuits, components, and operational analysis. 4. To study the fundamentals of electrolysis and evaluate various electrolytic processes used in industrial and commercial applications. 5. To understand the basic principles of illumination, photometric terms, and different types of lighting sources used in practice. 6. To estimate illumination requirements for residential and industrial installations and design suitable lighting schemes based on standards and energy efficiency considerations									
Course Outcomes: After completion of this course, students will be able to									
CO1	Analyze electric heating for industrial application								
CO2	Demonstrate electric welding for industrial application								
CO3	Inspect Electric circuit for refrigeration and conditioning								
CO4	Evaluate the various electrolytic process techniques								
CO5	Understand basic principles of illumination								
CO6	Estimate the lighting requirements for household Lighting and industrial lighting needs and its design								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Electric Heating Advantages of electrical heating. Heating methods: Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, domestic water heaters and other heating appliances and thermostat control circuit. Induction heating; principle of core type and coreless induction furnace. Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace. Dielectric heating applications in various industrial fields. Infra-red heating and its applications. Microwave heating, Power electronics application in heating system.								10
2	Electric Welding								9

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	Advantages of electric welding. Principles of resistance welding, types – spot, projection seam and butt welding and welding equipment used. Principle of arc production, electric arc welding, characteristics of arc, carbon arc, metal arc, hydrogen arc welding method of and their applications. Power supply required. Advantages of using coated electrodes, comparison between AC and DC arc welding, welding control circuits, welding of aluminum and copper. Introduction to TIG, MIG Welding, Power electronics application in welding system	
3	Refrigeration & Air Conditioning Introduction, Refrigeration systems, domestic refrigerator, Types of air conditioning systems, central air conditioning system, heating of buildings, calculation of rating of electrical equipment, Modern and efficient refrigeration and air conditioning system.	9
4	Electrolytic Process Need of Electro-deposition, Law of Electrolysis, Process of electro deposition- Clearing, operation, deposition of metals, polishing, buffing, equipment and accessories for electroplating, factor affecting electro deposition, principle of galvanizing and its application, principle of anodizing and its application	9
5	Illumination Nature of light, units, sensitivity of the eye, luminous efficiency, glare. Production of Light; Incandescent lamps, arc lamps gas discharge lamps- fluorescent lamps polar curves, effect of voltage variation on efficiency and life of lamps, Distribution and control of light, lighting calculations, solid angle, inverse square and cosine laws	9
6	Design of lighting schemes Design procedure of lighting schemes, reflecting and refracting luminaires, types of lighting fixtures, reflectors and refractors, luminaire standards (IEC 60598-Part 1). Selection of lamp fittings, illumination calculations, indoor and outdoor lighting design, recommended illumination levels, and requirements of good lighting (glare control, contrast, and shadow reduction).	10
TOTAL		56

Text Books:

1. H. Partab, Art and Science of Utilization of Electrical Energy, Dhanpat Rai & Co, 2017.
2. R. K. Rajput, Utilization of Electrical Power, Laxmi publications, 1st Edition, 2007.

Reference Books:

1. Open Shaw, Taylor, Utilization of electrical energy., Orient Longmans, 1962.
2. Gupta, J. B., Utilization of Electrical Energy and Electric Traction, S. K. Kataria and sons, 10th Edition, 1990.
3. E. O. Taylor, Utilization of Electric Energy, Orient Blackswan, 1971
H. S. Mamak, "Book on Lighting", Publisher International lighting Academy
4. Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002

E-Resources:

1. NPTEL video lectures on electric heating
<https://youtu.be/p3PkcLjNUhI?si=trgBojOv8xZY4Icc>
2. NPTEL video Lectures on Welding
<https://youtu.be/mmKy5PbndQI?si=gY4Cc1-A3av825iL>
3. NPTEL video lectures on refrigeration and air conditioning
<https://youtu.be/nlsNmhiID74?si=EFo2KKhdGGAXbGAI>



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| <ol style="list-style-type: none">4. NPTEL video lectures on Electrolytic process
https://youtu.be/PH1DR0c-jqw?si=rq__wlr9GYOSfz_Y5. NPTEL video lectures on Illumination
https://youtu.be/fQrZMMWo1mA?si=uaHR6bkj7QAHztbW6. NPTEL video lectures on design of lighting schemes
https://youtu.be/gWv4lx6y2Qw?si=4aW9GCd4BBZGvbOh |
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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Project Management System – II							Code: EEMD503		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	25	-	-	25
Prerequisites:									
Project Management System - I									
Course Objectives:									
1. To curate all project tasks to meet the needs of the company, consumers, and stakeholders.									
2. To schedule and divide different tasks and work among team members.									
3. To set the quality standard in a project.									
4. To use various PMS Software’s as per specific domain.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain various lifecycle models used in project management.								
CO2	Perform feasibility analysis and apply CPM & PERT Techniques.								
CO3	Understand project audit methodologies and scrum scheduling using Delphi Technique.								
CO4	Learn various project management software’s like JIRA, MSP, Teamwork.com, Trello etc.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Project Life cycle Management: Traditional project activity planning, agile project planning, coordination through integration management, project feasibility analysis, estimating project budget, project risk management, CPM, PERT, resource loading, resource leveling								08
2.	Project execution: Planning-monitoring-controlling cycle, earned value analysis, agile tool for tracking project, methods of project controlling, project audit, essentials of audit, evaluation, project closure, benefit realization, change management.								08
3.	Industry trends and software’s in project management: Enterprise project management, project success factor, standish factor of success, talent triangle, project governance, Change management, PMI’S code of conduct, software for project management, simulations software for project management.								10
TOTAL								26	
Text Books:									
1. Gary Richard Son, Brad Jackson, "Project Management Theory & Practice" CRC Press.									
2. John M. Nicholas, Herman Steyn, "Project Management for business engineering and technology", Elsevier.									
3. Arun Kanda, "Project Management: A Lifecycle Approach", PHI.									
Reference Books:									



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| <ol style="list-style-type: none">1. “A Guide to the Project Management Body of Knowledge (PMBOK Guide)”, Project Management Institute.2. B. B. Goel, “Project Management: Principles and Techniques”, Deep & Deep Publications Pvt. Ltd. |
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E-Resources:

- | |
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| <ol style="list-style-type: none">1. Dr. Nimisha Singh, “Introduction to Project Management: Principles & Practices”, NPTEL Course - https://onlinecourses.swayam2.ac.in/imb25_mg167/preview2. Prof. Raghu Nandan Sengupta, “Project Management”, NPTEL Course - https://onlinecourses.nptel.ac.in/noc25_mg78/preview3. Project management for beginners by Ramesh Kumar
https://youtu.be/gnkjcRDQkw0?list=PLLy_2iUCG87CBuNhvti0h6W54ZmqrSDMJ |
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**DEPARTMENT OF ELECTRICAL ENGINEERING**

Program: B-Tech. (Electrical Engineering)							Semester: V		
Course: Seminar							Code: EEAE506		
Teaching Scheme:				Evaluation Scheme:					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	-	01	01	-	-	25	-	-	25
The "Seminar" course is a critical milestone designed to bridge the gap between structured classroom learning and independent research. It prepares students for Final Year Projects by developing literature survey, technical analysis, presentations, and report writing skills in emerging electrical engineering domains.									
Course Objectives: The objectives of this course are									
1. To develop research orientation and technical communication skills in emerging Electrical Engineering domains									
2. To enable students to critically review, analyze, and synthesize contemporary research papers, white papers, patents, and technical standards.									
3. To promote interdisciplinary thinking aligned with NEP-2020 multidisciplinary philosophy.									
4. To inculcate ethical awareness, sustainability perspective, and societal impact analysis of electrical systems and technologies									
5. To prepare students for industry, higher education, entrepreneurship, and innovation ecosystems.									
Course Outcomes: After completion of this course, students will able to									
CO1	Identify and select emerging and relevant technical topics through literature surveys.								
CO2	Analyze and synthesize information from research papers, journals, and credible sources.								
CO3	Demonstrate effective technical communication skills through oral presentation								
CO4	Prepare a structured technical report following academic writing standards.								
CO5	Use modern tools for seminar preparation, referencing, plagiarism checking, and presentation.								
Guidelines for Conduct of Technical Seminar									
1. Topic must be from emerging Electrical Engineering domains (preferably last 3–5 years).									
2. Suggested domains include Smart Grid, Renewable Energy Systems, Electric Vehicles, Power Electronics, Industrial Automation, Energy Storage Systems, High Voltage Engineering, AI applications in Power Systems, IoT in Electrical Systems, and Sustainable Energy Technologies.									
3. The seminar must involve a minimum of 5 recent research papers from IEEE, Springer, Elsevier, ACM, or other reputed sources.									
4. Students should summarize the papers by understanding the objectives, methodology, results, advantages, and limitations of the proposed approaches.									
5. Practical sessions on how to read, analyse and summarize research papers should be arranged.									
6. Topics should not be a basic textbook topic.									
7. Must include, Problem statement, State-of-the-art analysis, Comparative study, Ethical & societal impact, Interdisciplinary themes aligned with NEP encouraged.									
8. Topic should be approved by a faculty panel/ Seminar coordinator/ Head of the department.									
Seminar Process									
• Orientation, Topic Finalization and Guide allocation (Week 1–2)									
1. Conduct an orientation session explaining: Objectives of the technical seminar, Evaluation criteria and expected outcomes									
2. Each student must submit: Title of the seminar, Problem statement, Relevance to current									

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technology trends. Approval by guide is mandatory before proceeding

3. The precise topic is finalized and approved by a departmental seminar committee.

• **Literature Survey & Problem Understanding (Week 2–4)**

1. Students must: Refer minimum 5–8 recent research papers (IEEE, Springer, Elsevier, or other reputed sources).
2. Use scholarly databases like IEEE Xplore, Google Scholar, ScienceDirect
3. Prepare a literature survey matrix, including: Author/year, Methodology used, Key findings, Limitations
4. Identify: Research gaps and Challenges in existing approaches.

• **Synopsis Preparation & Presentation (Week 4–5)**

1. Submit a 2–3 page synopsis including: Introduction, Literature insights, Objectives, Proposed seminar scope
2. Conduct a Synopsis Presentation (5–7 minutes): Evaluate clarity of understanding, Receive feedback for improvement
3. Approval required before proceeding to full report

• **In-depth Study & Content Development (Week 5–8)**

1. Students should: Deeply analyze concepts, models, architectures, or case studies, Include diagrams,
2. flowcharts, and comparative tables
3. Weekly review meetings with guide: Track progress, Ensure conceptual clarity.
4. Emphasis on: Critical analysis (not just description), Real-world applications

• **Draft Report Submission & Review (Week 8–10)**

1. Submit first draft of the report
2. Guide provides feedback on: Technical content quality, Structure and coherence, Referencing and plagiarism,
3. Students must revise based on suggestions by the guide

• **Pre-Seminar Presentation (Mock Evaluation) (Week 10–11)**

1. Conduct a mock presentation simulating final evaluation
2. Focus on: Presentation skills, Time management, Handling questions.
3. Peer and faculty feedback should be incorporated

• **Final Report Submission (Week 11–12)**

1. Submit: Final hard copy (if required), Soft copy (PDF format)
2. Ensure: Proper formatting, Plagiarism compliance (<20%), Correct referencing using reference managers like Zotero and Mendeley Desktop

• **Final Seminar Presentation & Viva Voce (Week 12–13)**

1. Presentation duration: 10–15 minutes, Followed by Q&A session (5–10 minutes)
2. Evaluation based on: Depth of understanding, Analytical ability, Communication skills

Method of Evaluation

1. During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for duration of about 12 to 15 minutes
2. Each student is expected to present at least twice during the semester, and the student is evaluated based on that.
3. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report.
4. A Faculty guide is to be allotted, and he / she will guide and monitor the progress of the student and maintain attendance.

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Seminar Report

The final technical report should be highly structured (20 to 25 pages), strictly technical, and clear of marketing Jargon. The recommended structure includes

- **Cover Page & Certificates:** Standard institutional format.
- **Abstract:** A single, dense paragraph (200–250 words) capturing the domain background, problem identified, state-of-the-art solutions analysed, and key takeaways.
- **Chapter 1:** Introduction, overview of technology, historical context, motivation, and scope
- **Chapter 2:** Literature Survey: A comprehensive critical analysis of the referred papers. It is highly recommended to synthesize this into a structured matrix, tabular form
- **Chapter 3:** System Architecture / Technical Core: Detailed breakdown of algorithms, mathematical formulations, protocols, or structural pipelines.
- **Chapter 4:** Comparative Analysis / Applications: Deep dive into current real-world deployment challenges, performance metrics (latency, accuracy, scale), and limitations.
- **Chapter 5:** Conclusion & Future Scope: Summarizing the insights gleaned and highlighting concrete pathways for prospective final-year project extensions.

Rubrics for Technical Seminar Assessment

Content	Does not meet Criterion (0)	Meets criterion somewhat (1)	Meets criterion fully (2)
Background/Intro is sufficient to understand how this project fits into larger field	0	1	2
Description of methodology is sufficient for audience to understand the procedure	0	1	2
Explanations are understandable/clear	0	1	2
Conclusions stated are supported to topic	0	1	2
References/Sources are cited correctly	0	1	2
Audience questions are answered honestly (i.e. no bluffing or guessing)	0	1	2
Presentation Quality			
Speaking is understandable/clear	0	1	2
Speaker can answer questions professionally	0	1	2
Speaker makes eye contact with audience	0	1	2
Speaker uses professional body language	0	1	2
Visuals/PPT are clear and readable	0	1	2
PPT have appropriate amount of text, diagrams	0	1	2
Visuals/PPT are free of errors/typos	0	1	2
Report Writing			
Abstract is meaningful	0	1	2
Graphs/diagrams are labelled completely	0	1	2
References/Sources are cited correctly	0	1	2
At least one reference is from a journal	0	1	2
Grammar is correct	0	1	2



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Spelling is correct	0	1	2
Report format is clear	0	1	2
Total	____/40 (convert to 25)		

Reference Books:

1. Raman, M., & Sharma, S. (2015). Technical Communication: Principles and Practice (3rd ed.). Oxford University Press.
2. Kothari, C. R. (2014). Research Methodology: Methods and Techniques (3rd ed.). New Age
3. IEEE Xplore Digital Library – Research Articles in Electrical Engineering.
4. NPTEL and SWAYAM Courses related to Smart Grid, Electric Vehicles, Renewable Energy, and Power Electronics.

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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Open Elective – III (Data Analytics)							Code: ALOE503A		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
Basic knowledge of Mathematics and Statistics, Fundamentals of Computer Science									
Course Objectives:									
1. To introduce the types and applications of data analytics across domains. 2. To apply descriptive statistics and visualization techniques to summarize data. 3. To apply inferential statistics and hypothesis testing for decision-making. 4. To analyze relationships in data using correlation, regression, and ANOVA. 5. To build predictive models using classification and clustering techniques. 6. To familiarize students with prescriptive analytics and Big Data concepts.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the types of data analytics and their applications across domains.								
CO2	Apply descriptive statistics and visualization techniques to summarize data.								
CO3	Analyze data using inferential statistics and hypothesis testing methods.								
CO4	Apply correlation, regression, and ANOVA techniques for data-driven decisions.								
CO5	Design predictive models using classification and clustering approaches.								
CO6	Evaluate prescriptive analytics approaches and Big Data platforms for applications.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Data Analytics: Types of analytics — descriptive, diagnostic, predictive, and prescriptive; Analytics vs. reporting; Key applications across domains: business, healthcare, finance, and marketing; Overview of analytics tools landscape: Excel, Python, R, and Power BI (comparative overview); KPIs and metrics for decision-making.								04
2.	Descriptive Analytics: Frequency distributions, outliers; Measures of central tendency and dispersion; Interquartile range; Skewness and kurtosis; Normal distribution and z-scores; Data visualization principles: bar chart, histogram, box plot, scatter plot, and heat map.								05
3.	Inferential Statistics: Population vs. sample, random sampling; Sampling distribution, standard error; Hypothesis testing: null and alternate hypothesis, z-test, t-test; One-tailed and two-tailed tests; Confidence intervals and level of confidence; Type I and Type II errors.								05
4.	Correlation, Regression & ANOVA:								04

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	Correlation and scatter plots; Simple linear regression, least squares method; Multiple regression; Coefficient of determination (R^2); One-way and two-way ANOVA; Chi-square test of independence.	
5.	Predictive Analytics: Introduction to predictive modeling; Classification techniques: logistic regression, decision trees; Clustering: k-means; Model evaluation: accuracy, confusion matrix; Time series analysis basics: moving averages, trend analysis.	04
6.	Prescriptive & Big Data Analytics: Prescriptive analytics: optimization and simulation for decision-making; Introduction to Big Data: the 5 V's, sources of big data; Overview of the Big Data ecosystem: Hadoop, Spark (conceptual only); Applications: business analytics, web analytics, and social media analytics.	04
TOTAL		26

Term Work:

Sr. No.	Title	Proposed Tutorial Activities
1	Introduction to Data Analytics	Identify descriptive, diagnostic, predictive, and prescriptive analytics using real-world case studies. Compare Excel, Python, R, and Power BI for analytics tasks.
2	Descriptive Statistics – I	Calculate mean, median, mode, range, variance, and standard deviation using a given dataset in Excel/Python.
3	Descriptive Statistics – II	Detect outliers using IQR and visualize distributions using histograms and box plots.
4	Data Visualization	Create bar charts, scatter plots, heat maps, and box plots. Interpret insights from visualizations.
5	Sampling & Probability	Perform random sampling, calculate standard error, and differentiate between population and sample using datasets.
6	Hypothesis Testing	Perform z-test and t-test for given scenarios and interpret Type I and Type II errors.
7	Correlation & Regression	Calculate correlation coefficients, build simple linear regression models, and interpret R^2 values.
8	ANOVA & Chi-Square	Perform one-way ANOVA and Chi-square tests using statistical software and interpret results.

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9	Predictive Analytics	Build basic classification models (Logistic Regression/Decision Tree) and perform K-Means clustering using Python.
10	Model Evaluation	Evaluate predictive models using confusion matrix and accuracy metrics.
11	Time Series Analytics	Apply moving averages and identify trends in time-series datasets.
12	Big Data & Prescriptive Analytics	Explore Hadoop and Spark concepts through case studies and discuss optimization-based decision-making.

Text Books:

1. Anil Maheshwari, "Data Analytics", McGraw Hill Education
2. Robert S. Witte and John S. Witte, "Statistics", Wiley Publications
3. U. Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", Wiley India

Reference Books:

1. Seema Acharya and Subhashini Chellappan, "Big Data and Analytics", Wiley India
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press

E-Resources:

1. NPTEL Course on "Introduction to Data Analytics" (IIT Madras Track)
Link: nptel.ac.in
2. NPTEL Course on "Data Analytics with Python" (IIT Roorkee Track)
Link: <https://nptel.ac.in/courses/106107220>
3. NPTEL Course on "Business Intelligence & Analytics" (IIT Madras Track)
Link: https://onlinecourses.nptel.ac.in/noc25_cs09/preview
4. NPTEL Course on "Business Analytics for Management Decision" (IIT Kharagpur Track)
Link: <https://nptel.ac.in/courses/110105089>
5. Coursera: "Google Data Analytics Professional Certificate" Link: [coursera.org](https://www.coursera.org)
6. edX: "Data Science: Statistics and Machine Learning" by Harvard University
Link: edx.org

EBooks

1. Allen B. Downey – Think Stats: Exploratory Data Analysis in Python (Open Access)
Link: greenteapress.com
2. EMC Education Services – Data Science and Big Data Analytics (Open Academic Archive)
Link: archive.org

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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Open Elective – III (Green Building)							Code: ALOE503B		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
Basic environmental engineering, building materials & construction, engineering chemistry/ environmental science, basic knowledge of energy and sustainability concepts									
Course Objectives:									
1. To equip students with the principles of sustainable building design, resource-efficient construction, and green building practice-s. 2. To provide students with knowledge of energy-efficient technologies, water and waste management, sustainable materials, and green building rating systems.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the concepts, principles, benefits, and environmental impacts associated with green buildings and sustainable development.								
CO2	Assess building orientation, climate-responsive planning, landscaping, green roofs, and green walls for improving environmental performance.								
CO3	Evaluate building energy consumption and recommend energy-efficient strategies, HVAC optimization, renewable energy systems, and conservation measures.								
CO4	Design suitable water conservation, rainwater harvesting, greywater recycling, waste management, and sustainable drainage solutions for buildings.								
CO5	Select appropriate sustainable building materials and assess indoor environmental quality based on thermal comfort, indoor air quality, lighting, and acoustics.								
CO6	Compare major green building rating systems such as IGBC, GRIHA, and LEED and apply their principles to assess building sustainability.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Green Buildings: Definition, concept, and need of green buildings, Sustainable development principles, Environmental impacts of conventional buildings, Benefits of green buildings.								05
2.	Sustainable Planning & Architecture: Sustainable planning, Orientation and climate-responsive design, Landscape planning, Green roofs and walls.								05
3.	Energy Efficiency in Buildings: Energy consumption in buildings, Energy-efficient building design, HVAC optimization, Renewable energy systems (solar, wind), Energy audit and conservation techniques.								04
4.	Water & Waste Management: Water conservation techniques, Rainwater harvesting systems, Greywater								04

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	recycling, Waste management in buildings, Sustainable drainage systems.	
5.	Sustainable Materials & Indoor Environmental Quality: Eco-friendly building materials, Low embodied energy materials, Recycled and locally available materials, Indoor air quality (IAQ), Thermal comfort, lighting, and acoustics.	04
6.	Green Building Rating Systems & Regulations: Overview of rating systems: Indian Green Building Council (IGBC) Green Rating for Integrated Habitat Assessment (GRIHA) Leadership in Energy and Environmental Design (LEED)	04
TOTAL		26
Teamwork : (Any 10)		
1. Study any IGBC/GRIHA certified building and identify the sustainable features adopted. 2. Study how sustainable development principles have been implemented in any residential, commercial, or institutional building. 3. Study a construction project and identify its environmental impacts. Suggest green alternatives to reduce these impacts. 4. Analyze building designed using passive architectural principles. 5. Study the site planning of a green campus, township, or commercial complex. 6. Study an existing building incorporating green roofs or vertical gardens. 7. Study an energy-efficient building and identify passive design strategies adopted. 8. Study a building utilizing renewable energy systems and evaluate their benefits. 9. Analyze an energy audit report (or published case study) and summarize the recommended energy-saving measures. 10. Study water conservation measures implemented in any green building. 11. Study a residential or institutional building with rainwater harvesting and grey water reuse systems. 12. Study the waste management practices of a smart city, residential township, or institutional campus. 13. Study a building that has extensively used sustainable building materials. 14. Perform a literature review on the life cycle assessment of one construction material. 15. Study an office, hospital, educational building, or green building focusing on indoor environmental quality improvements. 16. Compare two certified buildings, each evaluated under different rating systems (e.g., IGBC vs LEED or GRIHA vs IGBC). 17. Study the certification journey of an IGBC or GRIHA certified building.		
Text Books:		

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1. K.S. Jagadeesh, "Alternative Building Materials and Technologies", New Age International.
2. C.J. Kibert, "Sustainable Construction: Green Building Design and Delivery", Wiley.
3. Charles J. Kibert, "Green Buildings: Principles and Practices", Island Press.

Environmental Legislations & Standards:

Indian Regulations

1. Environment (Protection) Act, 1986
2. Energy Conservation Act, 2001
3. National Building Code (NBC) of India
4. Eco-Niwas Samhita (Energy Conservation Building Code – Residential)

Standards & Guidelines

1. Energy Conservation Building Code (ECBC)
2. GRIHA & IGBC rating guidelines
3. LEED certification standards
4. Bureau of Energy Efficiency (BEE) norms

Reference Books:

1. O.H. Koenigsberger, "Manual of Tropical Housing and Building", Orient BlackSwan
2. G.Z. Brown and Mark DeKay, "Sun, Wind & Light", Wiley
3. Laurie Baker, "Building with Earth", Centre for Science and Environment
4. Indian Green Building Council, "IGBC Manuals and Guidelines", CII – Indian Green Building Council

E-Resources:

1. Indian Green Building Council - <https://igbc.in>
2. Green Rating for Integrated Habitat Assessment - <https://grihaindia.org>
3. U.S. Green Building Council - <https://usgbc.org>
4. NPTEL Green Building courses - <https://nptel.ac.in>
5. Ministry of Environment, Forest and Climate Change - <https://moef.gov.in>

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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B.Tech. (Electrical Engineering)							Semester: V		
Course: Open Elective – III (Electric Mobility)							Code: ALOE503C		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
2	-	-	2	-	-	50	50	-	100
Prerequisites:									
Basic Electrical and Electronics Engineering									
Course Objectives:									
1. To apply fundamental principles of electric mobility to interpret EV architectures, components and applications. 2. To utilize energy storage and battery management concepts to evaluate battery performance, charging, and safety. 3. To implement basic concepts of EV powertrains, electric drives, regenerative braking, and charging infrastructure. 4. To integrate smart charging, vehicle-to-grid, IoT, and emerging technologies for sustainable electric mobility.									
Course Outcomes: At the end of the course, Student will be able to -									
CO1	Explain the concepts, architecture, and applications of Electric and Hybrid Electric Vehicles.								
CO2	Identify the suitable energy storage systems used in electric vehicles.								
CO3	Illustrate battery charging methods, battery management systems and SoC estimation techniques.								
CO4	Interpret hybrid powertrain configurations, operating modes and regenerative braking.								
CO5	Demonstrate the use of electric drives, charging levels, charging standards and EV charging equipment.								
CO6	Describe EV charging technologies and grid integration concepts such as G2V, V2G, V2H, V2B and V2V.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Introduction to Electric Mobility – Need for electric mobility, evolution of EVs, advantages and challenges, environmental and economic aspects, EV vs conventional vehicles, types of EVs: BEV, HEV, PHEV and fuel-cell vehicles, basic EV architecture and major components.								4
2	Energy Storage Systems – Energy storage requirements, battery terminology and specifications, Li-ion batteries and their types, basic battery characteristics, battery alternatives: solid-state, Aluminium-air, fuel cell and supercapacitor, battery–supercapacitor hybrid system, selection of energy storage system.								5

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3	Battery Charging and Management – EV charging basics, AC and DC charging, charging methods and levels, charging time and factors affecting charging, Battery Management System (BMS), functions of BMS, State of Charge (SoC), State of Health (SoH), cell balancing, battery thermal management and safety.	5
4	EV Powertrain and Electric Drives – EV powertrain architecture, energy flow in EVs, vehicle performance and basic tractive effort, electric motors used in EVs: BLDC and PMSM, motor selection, basic drive control, regenerative braking and its benefits.	4
5	EV Charging Infrastructure – EV charging infrastructure, charging levels, AC/DC chargers, EVSE, charging connectors and standards: CCS, CHAdeMO, SAE J1772, Bharat AC/DC, basic charging station components, installation and safety considerations.	5
6	Smart and Emerging Electric Mobility – Grid-to-Vehicle (G2V), Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), Vehicle-to-Building (V2B), Vehicle-to-Vehicle (V2V), smart charging, wireless charging, battery swapping, energy management, IoT and digital technologies in EVs, future trends and challenges.	5
TOTAL		28

Teamwork :

1. Study the architecture of an Electric Vehicle (EV) and identify the functions of major components such as battery, BMS, motor, inverter, charger, controller and sensors.
2. Compare 3–5 EVs available in India based on battery capacity, motor power, driving range, charging time, efficiency, cost and other key specifications.
3. Study and compare different energy storage technologies such as Li-ion batteries, solid-state batteries, fuel cells and supercapacitors based on energy density, charging time, life, cost, safety and applications.
4. Visit an EV charging station and study the charger type, AC/DC charging, charging level, connector/standard, power rating, and charging time and safety provisions.
5. Prepare a basic layout of an EV charging station showing charging points, power supply, protection system, parking area, cable routing, safety provisions and user facilities.
6. Study smart EV charging and Vehicle-to-Grid (V2G) concepts, including G2V, V2G, V2H and V2B, and identify their applications in smart grids and buildings.
7. Collect and analyze EV performance or charging data using Excel/Python/MATLAB and study parameters such as battery capacity, range, charging time and energy consumption.
8. Design a conceptual IoT-based EV monitoring system showing sensors, communication network, cloud platform and user interface for monitoring SoC, temperature, charging status and energy consumption.
9. Study regenerative braking in EVs and prepare an energy-flow diagram. Analyze energy recovery under different braking conditions using numerical calculations or simulation.
10. Study an emerging EV technology such as battery swapping, wireless charging, solid-state batteries, autonomous EVs, solar charging or second-life batteries and evaluate its technical, economic and environmental benefits.



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Text Books:
1. “Electrical Vehicle”, James Larminie and John Lowry, John Wiley & Sons, 2012. 2. “Electric and Hybrid-Electric Vehicles”, Ronald K. Jurgen, SAE International Publisher. 3. “Energy Systems for Electric and Hybrid Vehicles”, K T Chau, The institution of Engineering and Technology Publication 4. “Batteries for Electric Vehicles”, D.A.J Rand, R Woods & R M Dell, Research studies press Ltd, New York, John Willey & Sons 5. Electric & Hybrid Vehicles-Design Fundamentals, CRC press
Reference Books:
1. “Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and Design”, Mehrdad Ehsani, Yimin Gao and Ali Emadi. CRC Press, 2009. 2. “Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid”, Junwei Lu & Jahangir Hossain et al (eds), IET Digital Library. 3. “Automobile Electrical and Electronic systems”, Tom Denton, SAE International publications. 4. “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011. 5. The Electric Vehicle Conversion handbook –Mark Warner, HP Books, 2011.
E-Resources:
1. https://www.theiet.org/resources/books/transport/vehicle2grid.cfm 2. https://www.sae.org/publications/books/content/pt-143.set/ 3. http://nptel.ac.in/courses/108103009/

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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Open Elective – III (Introduction to Stock Market)							Code: ALOE503D		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
- Basic knowledge of economics and financial systems. - Familiarity with percentage calculations and simple mathematics. - Interest in investing and financial markets.									
Course Objectives:									
- To understand the structure and functioning of financial and stock markets along with investor psychology. - To apply candlestick patterns and indicators for identifying market trends. - To understand the fundamentals of option trading and option pricing concepts. - To develop short-term and long-term investment strategies using fundamental and technical analysis.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the functioning of financial markets using fundamental analysis								
CO2	Analyze stock price movements using candlestick patterns for trading decisions.								
CO3	Analyze stock price movements using technical indicators for trading decisions.								
CO4	Describe the concepts of derivatives and option trading.								
CO5	Apply the strategies for option trading.								
CO6	Apply investment strategies based on market analysis.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Fundamental Analysis and Investor Psychology: Introduction to Financial Markets, Primary and Secondary Markets, Market Participants, Stock Exchanges, SEBI and Regulatory Framework, Investment vs Trading, Understanding Business Models, Reading Financial Statements (Balance Sheet, Profit & Loss Account, Cash Flow Statement), Fundamental Ratios (EPS, PE Ratio, PB Ratio, ROE, ROCE, Debt-Equity Ratio), Sector Analysis, Economic Indicators, Investor Psychology, Market Emotions (Fear & Greed), Behavioral Biases, Risk Management Principles.								06
2.	Technical Analysis using Candlestick Charts: Introduction to Technical Analysis, Dow Theory, Support and Resistance, Trend Analysis, Price Action Concepts Candlestick Anatomy: Single Candlestick Patterns (Doji, Hammer, Shooting Star, Marubozu, Spinning Top), Double Candlestick Patterns (Bullish & Bearish Engulfing, Harami, Piercing Pattern, Dark Cloud Cover), Triple Candlestick								04

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	Patterns (Morning Star, Evening Star, Three White Soldiers, Three Black Crows), Gap Analysis, Trend Reversal and Continuation Patterns.	
3.	Technical Analysis using Indicators: Technical Indicators : Moving Averages (SMA, EMA), MACD, RSI, Stochastic Oscillator, Bollinger Bands, VWAP, ADX, ATR, Volume Analysis, Fibonacci Retracement, Pivot Points, Trend Confirmation, Indicator-Based Trading Strategies, Combining Multiple Indicators, Entry and Exit Rules, Backtesting Concepts.	04
4.	Introduction to Derivatives and FNO: Introduction to Derivatives, Futures and Options, Types of Options (Call and Put), Option Terminology (Strike Price, Expiry, Premium, Lot Size, Open Interest), Intrinsic and Time Value, ITM, ATM, OTM Options, Option Chain Analysis, Greeks (Delta, Gamma, Theta, Vega, Rho - Basic Concepts), Option Pricing Factors, Option Expiry and Settlement Process.	04
5.	Introduction to Option Trading Strategies: Option Buying vs Option Selling, Risk and Reward Analysis, Long Call, Long Put, Covered Call, Cash Secured Put, Bull Call Spread, Bear Put Spread, Bull Put Spread, Bear Call Spread, Iron Condor (Basic Concept), Straddle and Strangle (Introduction), Position Sizing, Stop Loss Techniques, Capital Management, Risk Management in Options Trading.	04
6.	Short-Term and Long-Term Trading & Investment Strategies: Swing Trading, Positional Trading, Intraday Trading (Overview), Momentum Trading, Breakout Trading, Trend Following Strategies, Portfolio Building, Value Investing, Growth Investing, Dividend Investing, SIP in Equity, Asset Allocation, Diversification, Trading Plan Development, Trading Journal, Performance Evaluation, Common Mistakes Made by Traders and Investors, Ethics in Financial Markets.	04
Total		26

Term Work:

Perform Any 10:

Sr No	Title	Proposed Activities
1	Stock Market Basics & Trading Platform	Introduction to NSE & BSE, SEBI, Demat & Trading Accounts, Market Participants, Creating a Paper Trading Account.
2	Fundamental Analysis – I	Reading Financial Statements, EPS, PE Ratio, Book Value, Market Capitalization, Sector Analysis
3	Fundamental Analysis – II & Investor Psychology	Company Comparison, Economic Indicators, Market Cycles, Fear & Greed, Trading Discipline
4	Candlestick Analysis – I	Candlestick Anatomy, Doji, Hammer, Shooting Star, Marubozu, Trend Identification

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5	Candlestick Analysis – II	Bullish/Bearish Engulfing, Morning Star, Evening Star, Support & Resistance using Charts
6	Technical Indicators – I	SMA, EMA, Volume Analysis, Trend Identification using TradingView
7	Technical Indicators – II	RSI, MACD, Bollinger Bands, VWAP, Indicator-based Entry & Exit
8	Option Trading Fundamentals	Call & Put Options, Strike Price, Premium, Expiry, Option Chain Analysis
9	Option Buying Strategies	Long Call, Long Put, Break-even Calculation, Risk & Reward Analysis
10	Option Selling Strategies	Covered Call, Cash Secured Put, Bull Call Spread, Bear Put Spread
11	Short-term Trading Strategies	Intraday (Concept), Swing Trading, Breakout Trading, Risk Management
12	Long-term Investment Strategies	Value Investing, Growth Investing, Dividend Investing, Portfolio Diversification

Students should spend most of the session on:

- Live chart analysis using TradingView or similar platforms.
- Analyzing real companies using NSE/BSE financial data.
- Paper trading (no real money involved).
- Maintaining a trading journal.
- Presenting and reviewing trading decisions.

Reference Books:

1. John J. Murphy, "Technical Analysis of the Financial Markets", Pearson.
2. Benjamin Graham, "The Intelligent Investor", Harper Business.
3. Martin J. Pring, "Technical Analysis Explained", McGraw-Hill.
4. Sheldon Natenberg, "Option Volatility and Pricing", McGraw-Hill.
5. Aswath Damodaran, "Investment Valuation", Wiley.
6. Alexander Elder, "Trading for a Living", Wiley.

E-Resources:

1. National Stock Exchange (NSE) Learning Portal – <https://www.nseindia.com> learn tab
2. Bombay Stock Exchange (BSE) Investor Education – <https://www.bseindia.com>
3. SEBI Investor Education – <https://investor.sebi.gov.in>
4. NISM (National Institute of Securities Markets) – <https://www.nism.ac.in>
5. Zerodha Varsity – <https://zerodha.com/varsity>
6. Investopedia – <https://www.investopedia.com>

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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Open Elective – III (Patent Law for Engineers and Scientists)							Code: ALOE503E		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
Basic understanding of engineering/scientific concepts and technological innovation, Basic skills in technical reading, documentation, and report writing.									
Course Objectives:									
1. To understand the importance of Intellectual Property Rights (IPR) and patents. 2. To identify patentable and non-patentable inventions based on patentability criteria. 3. To conduct prior-art and patent searches using public patent databases. 4. To draft a basic patent specification, including claims and abstract. 5. To understand and apply the complete patent filing, examination, and granting process in India. 6. To analyze engineering case studies involving patents, innovation, and commercialization.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply the provisions of the Indian Patent Law to engineering inventions.								
CO2	Perform prior-art and patent searches using standard patent databases.								
CO3	Analyze the patentability, filing, examination, and grant process under the Indian Patent Act.								
CO4	Evaluate patent infringement, licensing, technology transfer, and commercialization issues.								
CO5	Draft a patent specification, including claims and abstract, in compliance with patent law.								
CO6	Develop a patent application for an innovative engineering solution following legal and procedural requirements.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Intellectual Property Rights and Patents: Introduction to Intellectual Property Rights (IPR), significance of IPR in engineering, innovation and entrepreneurship, types of IPR, concept and objectives of patents, patentability criteria (novelty, inventive step and industrial applicability), patentable and non-patentable inventions under the Indian Patent Act, 1970, patents versus research publications and products, role of patents in technology commercialization and startup ecosystem. Case Study: Patentability analysis of a simple engineering innovation.								05
2.	Indian Patent Law and Prior-Art Search: Overview of the Indian Patent Act, 1970 and its amendments, objectives and scope of patent law, rights and duties of inventors, overview of WIPO, Patent Cooperation Treaty (PCT) and international patent systems, prior-art search techniques, patent classification systems, patent search using Google Patents, InPASS, Espacenet, and WIPO PATENTSCOPE Novelty assessment and patent								04

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	landscape analysis. Case Study: Prior-art search and novelty analysis of an engineering invention.	
3.	Patent Drafting: Structure and components of a patent specification including title, field of invention, background, prior art, problem statement, objectives, summary of invention, brief description of drawings, detailed description, claims, abstract, and drawings. Principles of claim drafting, dependent and independent claims, patent drafting guidelines, common drafting errors, and patent documentation for engineering innovations. Case Study: Drafting of a patent specification for a smart engineering product.	05
4.	Patent Filing, Examination and Grant: Patent filing procedure in India, provisional and complete specification, online filing process, statutory forms, publication of patent application, request for examination, First Examination Report (FER), response to objections, hearing process, patent grant, renewal, restoration, opposition, and maintenance of patents under the Indian Patent Act. Case Study: Patent filing and grant timeline of an Indian engineering patent.	04
5.	Patent Commercialization and Legal Issues: Patent ownership, licensing, assignment, technology transfer, patent valuation, startup and university patents, patent infringement, remedies and dispute resolution, freedom-to-operate (FTO), patent analytics, commercialization strategies, and ethical issues in patent protection. Case Study: Commercialization of a patented engineering innovation.	04
6.	Emerging Technologies and Patent Case Studies: Patents in Artificial Intelligence, Machine Learning, Internet of Things (IoT), Robotics, Semiconductor Technology, Biotechnology, Software, Green Technologies, and Industry 4.0, AI-generated inventions, recent developments in patent law, international patent trends, patent portfolio management, and innovation-driven entrepreneurship. Case Study: Analysis of landmark patent disputes such as Apple vs Samsung or an Indian engineering innovation, along with preparation of a basic patent draft for an engineering solution.	04
Total		26
Term Work: Students shall complete the following practical, activity-oriented assignments based on a selected engineering innovation/project: 1. Identify suitable IP protection for an engineering innovation and assess basic patentability criteria. 2. Conduct patent searches using Google Patents, IP India, WIPO PATENTSCOPE and Espacenet and analyze the novelty of the selected innovation.		

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3. Identify a copyrightable work such as software, technical content or digital work and prepare/undertake the copyright registration process.
4. Develop a product/start-up brand, conduct trademark search, identify the appropriate class and prepare a basic trademark application.
5. Identify protectable visual features of an engineering product, conduct design search and prepare a basic design registration application.
6. Prepare a basic patent specification including title, background, objectives, description, drawings, abstract and claims for an engineering innovation.
7. Prepare a mock provisional/complete patent application and study the filing, publication, examination, FER, response and grant process in India.
8. Study the PCT route and prepare a mock PCT application based on the selected engineering invention.
9. Analyze patents in a selected emerging technology area and identify major patent holders, technology trends and basic FTO considerations.
10. Develop an IP portfolio for the selected innovation covering patent, copyright, trademark/design and propose a basic commercialization strategy.

Text Books:

1. P. Narayanan, "Patent Law", Eastern Law House.
2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw-Hill.
3. N. S. Gopalakrishnan and T. G. Agitha, "Principles of Intellectual Property", Eastern Book Company.
4. Government of India, "The Patents Act, 1970 (as amended) and The Patents Rules, 2003 (as amended)", Government of India.

Reference Books:

1. David Pressman, "Patent It Yourself", NOLO Publications.
2. WIPO, "WIPO Intellectual Property Handbook: Policy, Law and Use", World Intellectual Property Organization.
3. Indian Patent Office, "Manual of Patent Office Practice and Procedure", Office of the Controller General of Patents, Designs & Trade Marks (CGPDTM), Government of India.
4. Alexander I. Poltorak and Paul J. Lerner, "Essentials of Intellectual Property", John Wiley & Sons.

E-Resources:

1. **Patent Law for Engineers and Scientists** – NPTEL (IIT Madras):
<https://nptel.ac.in/courses/110106081>
7. **Intellectual Property** – NPTEL (IIT Madras): <https://nptel.ac.in/courses/109106137>

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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Internship – IV							Code: EEIN504		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	-	-	02	-	-	25	-	-	25
Preamble:									
Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.									
Course Objectives:									
1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry. 2. Learn to implement the technical knowledge in real industrial situations.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.								
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.								
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.								
Internship Requirements									
1. Internship Duration: It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 3 to 5 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW). 2. Internship Opportunities: Students can explore various opportunities for internships at: a. Industries b. Research labs or organizations c. Collegiate clubs d. In-house research projects e. Online internships 3. Support and Assistance: Students can seek assistance for securing internships from: a. The Training and Placement cell, along with departmental coordinators b. Department or institute faculty members c. Personal contacts d. Directly connecting with industries or organizations 4. Request Letter: Once an industry, research organization, or collegiate club is identified,									

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students must obtain a request letter from the concerned department or placement office. This letter, in the standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.

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Zeal Education Society's

ZEAL COLLEGE OF ENGINEERING & RESEARCH, PUNE – 41

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DEPARTMENT OF ELECTRICAL ENGINEERING

SYLLABUS

SEMESTER - VI

DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B-Tech. (Electrical Engineering)							Semester: VI		
Course: Power System Protection							Code: EEPC611		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
04	-	-	04	40	60	-	-	-	100
Prerequisites:									
Power System, Electrical Machines.									
Course Objectives: The objectives of this course are									
1. To introduce the fundamentals of power system protection, types of faults, and protection schemes. 2. To develop understanding of arc interruption phenomena and circuit breaking principles. 3. To study the construction, operation, and selection of various circuit breakers and switchgear components. 4. To impart knowledge of static and numerical relays and their applications in power system protection. 5. To analyze protection schemes for major power system equipment such as transformers, generators, and motors. 6. To understand transmission line protection schemes and modern protection practices.									
Course Outcomes: After completion of this course, students will able to									
CO1	Explain the fundamentals of protective relaying, types of faults, and protection schemes.								
CO2	Analyze arc interruption phenomena and restriking voltage (RRRV) in circuit breakers.								
CO3	Compare the construction, operating principles, characteristics, and applications of air, SF ₆ , and vacuum circuit breakers.								
CO4	Apply the principles of static and numerical relays in power system protection.								
CO5	Analyze differential protection schemes for transformers, alternators, and induction motors.								
CO6	Apply transmission line protection schemes including distance protection and three-step protection.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Fundamentals of protective relaying Need for protective system, Nature and Causes of fault, Types of faults (symmetrical & unsymmetrical), Zones of protection, Primary and Backup protection, Evolution of protective relaying, Essential qualities of protective relaying, Classification of relays classification of relays, Trip circuit of circuit breaker and basic protection scheme. Basic protection principles: over current, directional over current, differential, distance. Relay settings and characteristics: Plug Setting Multiplier (PSM), Time Setting Multiplier (TSM) Operating time of relay, Numerical on TSM , PSM and operating time of relay.								9
2	Arc Interruption and Circuit Breaking Phenomena Electric arc formation, Arc interruption theories, Methods of Arc Interruptions: high and low resistance, Arc voltage and Recovery voltage, Restriking voltage and RRRV: definition and derivation, Current chopping, Resistance switching,								9

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	Numerical on RRRV, current chopping and resistance switching.	
3	Circuit Breaker Different ratings of circuit breaker (rated voltage, rated current, rated frequency, rated breaking capacity: symmetrical and unsymmetrical breaking, making capacity, operating duty and sequence, short time rating). Classification of high voltage circuit breakers. Working and constructional features of ACB, SF6, VCB- advantages, disadvantages and applications. Auto reclosing, Testing of circuit breakers. Introduction to GIS, its advantages over conventional substation	9
4	Static, Numerical & Digital Relaying Static relay: Overview, block diagram, operation, merits and demerits. Numerical Relays: - Architecture and block diagram, operation, merits and demerits. Applications for implantation of various numerical relays. Introduction to protection algorithms, sampling, digital filtering and phasor estimation	9
5	Protection of Power System Equipment Power Transformer Protection: Types of faults, Percentage differential protection, Earth fault protection, Buchholz relay, Protection against other Abnormal conditions. 3 Phase Induction Motor Protection: Faults and abnormal conditions, Overload and Short circuit protection, Single phasing protection, Synchronous Generator (Alternator) Protection: Various faults in Alternator, Stator faults and protection: Percentage differential Protection and Transverse percentage differential Protection. Rotor faults and abnormal conditions, Protection against loss of excitation, loss of prime mover, unbalance loading, over speeding.	10
6	Transmission Line Protection & Modern Trends: Over current protection, Distance protection, Impedance relay, Reactance relay, Mho relay and their characteristics, Relay setting, Three stepped distance protection. Communication-Based Protection: Carrier current protection (PLCC), Introduction to communication-assisted protection schemes. Wide Area Monitoring Systems (WAMS), synchro phasor and PMU-based protection. Protection challenges in smart grids, renewable energy systems and microgrids.	10
TOTAL		56
Industrial Visit:		
Industrial visit to switchgear/relay manufacturing unit or 220 kV substation or other substation.		
Text Books:		
1. Y. G. Paithankar and S. R. Bhide, “ <i>Fundamentals of Power System Protection</i> ”, PHI Learning, 2nd Edition, 2010. 2. Bhavesh Bhalja, R.P. Maheshwari, N.G. Chothani,” Protection and Switchgear”, Oxford University Press, 2011 Edition. 3. Badri Ram and D. N. Vishwakarma, “ <i>Power System Protection</i> ”, McGraw Hill Education, 2nd Edition, 2011. 4. J.B.Gupta “ Switchgear and Protection”, S.K. Kataria and Sons. 5. C. L. Wadhwa, “ <i>Electrical Power Systems</i> ”, New Age International Publishers, 6th Edition, 2010.		



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Reference Books:
1. S. Rao, “Switchgear Protection and Power Systems”, Khanna Publications 2. Arun G. Phadke and James S. Thorp, “Synchronized Phasor Measurements and Their Applications”, Springer, 1st Edition, 2008. 3. Stanley H. Horowitz and Arun G. Phadke, “Power System Relaying”, Wiley-IEEE Press, 4th Edition, 2014. 4. Gerhard Ziegler, “Numerical Differential Protection: Principles and Applications”, Siemens Publicis Corporate Publishing, 4th Edition, 2011. 5. Alexander Apostolov, “Smart Grid Protection and Control”, CRC Press, 1st Edition, 2014.
E-Resources:
1. Power System Protection, Online NPTEL Course, by Prof. Ashok Kumar Pradhan Indian Institutes of Technology (IIT Kharagpur). Link: nptel.ac.in/courses/108105167 2. Power System Protection and Switchgear, Online NPTEL Course, By Prof. Bhavesh kumar R. Bhalja, IIT Roorkee. Link: http://digimat.in/nptel/courses/video/108107167/L26.html 3. Siemens Energy Automation Resources, Technical documents on numerical relays and protection systems, available at: https://www.siemens.com.

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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B-Tech. (Electrical Engineering)							Semester: VI		
Course: Power System Protection Lab							Code: EEPC611P		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	50	-	25	75
Prerequisites:									
Power System, Electrical Machines.									
Course Objectives: The objectives of this course are									
1. To develop an understanding of switchgear, protective devices, and protection schemes used in electrical power systems.									
2. To provide hands-on experience in testing and evaluating MCBs, MCCBs, contactors, relays, and digital/numerical protective relays.									
3. To develop skills in analyzing and implementing transformer and transmission-line protection schemes using hardware and MATLAB/Simulink.									
Course Outcomes: After completion of this course, students will able to									
CO1	Test and evaluate the performance of switchgear and protective devices such as MCBs, MCCBs, contactors, and overload relays.								
CO2	Determine and analyze the operating characteristics of overcurrent, differential, distance, and digital/numerical protection relays.								
CO3	Implement and analyze transformer and transmission-line protection schemes using hardware and MATLAB/Simulink simulation tools.								
List of Experiments:									
Group A: Compulsory experiments:									
1. Introduction to Switchgear Testing Kit									
2. Testing and Performance Evaluation Miniature Circuit Breaker (MCB).									
3. Testing and Performance Evaluation of Contactors.									
4. Testing and Performance Evaluation of Moulded Case Circuit Breaker (MCCB).									
Group B: Minimum four experiments from the following list									
1. Testing and Performance Evaluation of Thermal Overload Relay for Induction Motor Protection.									
2. Determination and Plotting of Characteristics of IDMT Type Induction Overcurrent Relay.									
3. Study and Testing of a Digital Protective Relay.									
4. Study and Configuration of a Digital/Numerical Protective Relay.									
5. Percentage Differential Protection of Transformer (Merz–Price Protection).									
6. Transmission Line Protection Using Impedance Relay.									
7. Simulation of Differential Protection Scheme for Transformer Using MATLAB/Simulink.									
8. Simulation of Distance Protection Scheme for Transmission Line Faults Using MATLAB/Simulink.									
Text Books:									
1. Y. G. Paithankar and S. R. Bhide, “Fundamentals of Power System Protection”, PHI Learning, 2nd Edition, 2010.									
2. Bhavesh Bhalja, R.P. Maheshwari, N.G. Chothani,” Protection and Switchgear”, Oxford University Press, 2011 Edition.									
3. Badri Ram and D. N. Vishwakarma, “Power System Protection”, McGraw Hill Education, 2nd Edition, 2011.									



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| <ol style="list-style-type: none">4. J.B.Gupta “ Switchgear and Protection”, S.K. Kataria and Sons.5. C. L. Wadhwa, “<i>Electrical Power Systems</i>”, New Age International Publishers, 6th Edition, 2010. |
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Reference Books:

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| <ol style="list-style-type: none">1. S. Rao, “Switchgear Protection and Power Systems”, Khanna Publications2. Arun G. Phadke and James S. Thorp, “Synchronized Phasor Measurements and Their Applications”, Springer, 1st Edition, 2008.3. Stanley H. Horowitz and Arun G. Phadke, “Power System Relaying”, Wiley-IEEE Press, 4th Edition, 2014.4. Gerhard Ziegler, “Numerical Differential Protection: Principles and Applications”, Siemens Publicis Corporate Publishing, 4th Edition, 2011.5. Alexander Apostolov, “Smart Grid Protection and Control”, CRC Press, 1st Edition, 2014. |
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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B-Tech. (Electrical Engineering)							Semester: VI		
Course: Electrical Machine Design							Code: EEPC612		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic Electrical Engineering, Electrical Machines.									
Course Objectives: The objectives of this course are									
1. To introduce the fundamental principles of electrical machine design and the key factors affecting the design of rotating machines and transformers. 2. To develop an understanding of magnetic, electric, and thermal loading, output equations, and main dimensions of DC machines, induction machines, and synchronous machines. 3. To impart knowledge of design procedures for transformers, DC machines, induction motors, and synchronous machines.									
Course Outcomes: After completion of this course, students will able to									
CO1	Explain the fundamental aspects of electrical machine design.								
CO2	Design the main dimensions and components of DC machines as per given specifications.								
CO3	Design core, windings, and cooling system of single-phase and three-phase transformers.								
CO4	Design stator and rotor of three-phase induction motors (squirrel cage and wound rotor) and single-phase induction motors.								
CO5	Design armature and field systems of synchronous machines.								
CO6	Apply optimization techniques in electrical machine design.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Fundamental Aspects of Electrical Machine Design Design of machines: design factors, limitations in design, modern trends in electrical machine design, types of magnetic, electric and insulating materials, modes of heat dissipation, cooling of rotating machines, methods of cooling. Computer Aided Design (CAD) of Electrical Machines : Limitations and assumptions in traditional designs, need of CAD, analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation								7
2	Design of DC Machines Output equation, selection of specific magnetic and electric loadings, separation of D and L, estimation of number of conductors, armature slots and conductor dimensions, choice of number of poles and calculation of length of air gap, design of field systems, interpoles and brushes.								7
3	Design of Transformers Output equation and main dimensions for three-phase transformers. – design of main dimensions— design of core - choice of flux density – determination of number of turns and length of mean term - resistance and leakage reactance – no load current calculation – cooling of transformers- Temperature rise calculation and design for								7

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	minimum cost/loss - calculation of number of tubes.	
4	Design of Induction Motor Output equation and main dimensions of 3-phase induction motor. - Stator and rotor design (slots, windings, air gap). - Design of squirrel cage and wound rotor. Design of single-phase induction motor.	7
5	Design of Synchronous Machines Output equation and main dimensions of alternators. - Armature winding design, field winding design. - Damper winding and short circuit ratio. - Design of turbo-alternator and salient pole machines. - Rotor design temperature rise and its effects.	7
6	Thermal Design, Ventilation & Modern Trends Heating and cooling of machines, temperature rise calculation. - Types of ventilation and cooling systems. - Energy efficient design, BIS standards. Introduction to optimization techniques and software tools (ANSYS, RMXprt, etc.).	7
TOTAL		42
Industrial Visit:		
Industrial visit to a manufacturing unit of transformer / Induction motor.		
Text Books:		
1. A. K. Sawhney, “A Course in Electrical Machines Design”, Dhan path Rai & Co. 2. M.G. Say, “Theory & Performance & Design of A.C. Machines”, ELBS and Pitman & Sons.		
Reference Books:		
1. 1. S. K. Sen, “Principles of Electrical Machine Design with computer programmes”, Oxford and IBH Publishing. 2. K. L. Narang, “A Text Book of Electrical Engineering Drawings”, Satya Prakashan. 3. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International. 4. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications.		
E-Resources:		
1. https://cusp.umn.edu/electric-machine-design-videos 2. https://nptel.ac.in/courses/108102146 3. https://nptel.ac.in/courses/108/105/108105017		

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Program: B-Tech. (Electrical Engineering)							Semester: VI		
Course: Electrical Machine Design Lab							Code: EEPC612P		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	25	25	-	50
Prerequisites:									
Basic Electrical Engineering, Electrical Machines.									
Course Objectives: The objectives of this course are									
1. To develop an understanding of the principles, design factors, and design procedures of DC machines, transformers, induction motors, and synchronous machines. 2. To develop practical skills in determining main dimensions, winding parameters, slots, cooling arrangements, and other design parameters of electrical machines. 3. To familiarize students with computer-based and optimization techniques for efficient, economical, and thermally suitable electrical machine design.									
Course Outcomes: After completion of this course, students will able to									
CO1	Apply electrical machine design principles and output equations to determine the main dimensions and design parameters of various electrical machines.								
CO2	Design and analyze transformers, induction motors, DC machines, and synchronous machines considering electrical, magnetic, mechanical, and thermal constraints.								
CO3	Utilize Python and optimization techniques to develop economical and efficient electrical machine designs considering factors such as cost, losses, weight, volume, and cooling.								
List of Experiments:									
(Any eight experiments from the following list)									
1. Outline Electrical Machine Design: Limitations, Design Factors, and Modern Trends. 2. Design of main dimensions (D&L) of DC machine using output equations for given output & speed. 3. Determination of Main Dimensions, Volts/Turn, Number of Turns and Conductor Area of a 3-Ø Transformer. 4. Design of a 3-Phase 25 MVA Core Type Transformer using Python. 5. Optimum Design of Transformer – Minimum Cost, Minimum Loss, Minimum Weight/Volume 6. Design of Transformer Tank with Round Cooling Tubes and Rectangular Tubes (ONAN cooling) 7. Design of Main dimensions and winding slots of a 3-Phase Induction Motor 8. Design of Stator Slots, Winding and Air-Gap Length of Three-Phase 50 KW Induction Motor 9. Design of Wound Rotor (Slip Ring) Induction Motor. 10. Design of main dimensions and field system for a salient pole synchronous generator. 11. Comparative Study of Modern Trends in Transformer/Induction Motor Design 12. Thermal Design and Cooling of Electrical Machines									
Text Books:									
1. A. K. Sawhney, “A Course in Electrical Machines Design”, Dhan path Rai & Co. 2. M.G. Say, “Theory & Performance & Design of A.C. Machines” , ELBS and Pitman & Sons.									
Reference Books:									
1. 1. S. K. Sen, “Principles of Electrical Machine Design with computer programmes”, Oxford and IBH Publishing.									



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| <ol style="list-style-type: none">2. K. L. Narang, “A Text Book of Electrical Engineering Drawings”, Satya Prakashan.3. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International.4. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications. |
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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B. Tech. (Electrical Engineering)							Semester: VI		
Course: Advance Control Systems							Code: EEPE602A		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Laplace Transform, Ordinary differential equations, operations on matrices, Control System Engineering									
Course Objectives:									
1. To design a PID controller to meet desired specifications. 2. To design a compensator to meet desired specifications. 3. To Introduce State space modeling 4. To Design of State feedback controller and observer 5. To Explore advanced control techniques 6. To Introduce nonlinear systems									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Design PID controller for a given plant to meet desired time domain specifications.								
CO2	Design compensator for a given plant to meet desired frequency domain specifications								
CO3	Model a physical system in state space representation								
CO4	Test controllability and observability properties of the system and to design state feedback controller and observer for the system								
CO5	Explain the basic concepts and principles of sliding mode control, adaptive control, and optimal control								
CO6	Analyze the stability of nonlinear control systems using common nonlinearities, describing function method								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Control design using PID Design specifications in time domain and frequency domain. Review effect of PID controller on performance, design of PID controller by Root Locus. Numericals								7
2	Compensator Design in Frequency Domain Approach to control system design, cascade compensation networks, Transfer function of lead and lag compensators, physical realization of compensators., phase-lead and phase-lag compensator designs using bode plot, Numericals								7
3	Introduction to State-Space Representation Concept of state, state-space representation of dynamical systems in physical variable form, phase variable forms and Jordon / diagonal canonical form, conversion of the transfer function to state-space model and vice versa, state equation and its solution, state transition matrix and its properties, computation of state transition matrix by Laplace transform and Caley Hamilton method.								7
4	State-Space Design (Controller and Observer) The concept of controllability and observability, Kalman's and Gilbert's tests for								7

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	controllability and observability, effect of pole-zero cancellation, duality property, controller design using pole-placement, using transformation matrix, direct substitution, and Ackermann's formula, State observers, design of a full order observer.	
5	Advanced control Strategies System uncertainties and disturbances: Effect of uncertainties and disturbances on system performance, effect of measurement noise and un-modeled dynamics. Concept of sliding mode control, equivalent control, chattering, sliding mode control based on reaching law, Introduction to adaptive control, adaptive schemes, and control problems Optimal control-linear quadratic regulator problem.	7
6	Introduction to Nonlinear Control Systems Introduction to nonlinear systems, common nonlinearities, describing function method, describing function of an ideal relay, stability analysis with describing function, introduction to Lyapunov stability analysis (basic concepts, definitions, and stability theorem)	7
Total		42
Text Books:		
1. Franklin G.F., Powell J.D., Emami-Naeini A., Feedback Control of Dynamic Systems, Pearson, Upper Saddle River, New Jersey, 5th edition, 2006. 2. Nagrath I.J, and Gopal M, Control Systems Engineering, 2017, 6th edition, New Age International Publishers. 3. Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010. 4. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson 5. Control Systems - A. Ananad Kumar, PHI.		
Reference Books:		
1. Norman S Nise, Control Systems Engineering, 2018, 7th edition, John Wiley and Sons, Inc. 2. Benjamin C. Ku, Farid Golnaraghi, Automatic Control Systems, 2017, 10th edition, McGraw-Hill Education 3. Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011. 4. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.		
E-Resources:		
1. https://nptel.ac.in/courses/107106081 2. https://nptel.ac.in/courses/108106164		

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Program: B. Tech. (Electrical Engineering)							Semester: VI		
Course: IoT for Smart Energy Systems							Code: EEPE602B		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic Electrical Engineering, Basic Electronics, Basic Programming Concepts (logic, variables, conditions).									
Course Objectives:									
1. To introduce the fundamental concepts, architecture, and Basic Electrical Engineering, Basic Electronics, Basic Programming Concepts (logic, variables, and conditions) enabling technologies of the Internet of Things (IoT) with emphasis on smart energy systems and smart grid applications. 2. To familiarize students with sensors, embedded IoT platforms, interfacing concepts, and embedded application development for smart energy monitoring and control. 3. To develop understanding of IoT connectivity technologies, cloud-based monitoring platforms, and remote supervisory applications used in smart energy systems. 4. To introduce practical IoT applications in intelligent energy infrastructure, industrial monitoring, and smart grid systems through case studies and real-world applications.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the fundamental concepts, architecture, communication models, and applications of IoT in smart energy systems and smart grid modernization.								
CO2	Identify and select suitable sensors, embedded IoT platforms, and interfacing methods for monitoring applications in electrical engineering.								
CO3	Develop basic embedded IoT applications for sensing, monitoring, and control using appropriate embedded development platforms.								
CO4	Compare IoT connectivity technologies and select suitable communication solutions for smart energy and smart grid applications.								
CO5	Explain the role of IoT cloud platforms, gateways, and remote supervisory systems for real-time monitoring and basic control applications.								
CO6	Analyse IoT applications in intelligent energy infrastructure, industrial monitoring, and smart grid systems through case studies and practical applications.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Fundamentals of IoT and Smart Energy Systems: Introduction to Internet of Things (IoT): Definition, evolution, need, characteristics, advantages, limitations, and applications of IoT; IoT in smart energy systems: Conventional electrical monitoring and control systems; limitations of conventional systems; need for automation, real-time monitoring, remote access, and data-driven decision-making in electrical engineering applications; Basic IoT concepts and architecture: Things, sensors, actuators, gateways, embedded devices, communication networks, cloud platforms, and user applications; layered IoT architecture; basic IoT communication models; Introduction to smart grid and IoT								8

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	applications: Concept, objectives, key features of smart grid; smart meters, Advanced Metering Infrastructure (AMI), Distributed Energy Resources (DER), demand-side management, and role of IoT in smart grid modernization.	
2	Sensors and Embedded Platforms for IoT Applications: Introduction to sensors used in IoT systems: Concept, classification, and characteristics of sensors, such as accuracy, sensitivity, resolution, range, and response time; Sensors for smart energy applications: Basic working principles and applications of temperature, proximity, infrared (IR), current, and voltage sensors for electrical engineering applications. Embedded platforms for IoT: Introduction to embedded systems; microcontroller vs microprocessor, Arduino UNO, Raspberry Pi, Node MCU, ESP8266, and ESP32 platforms; features and comparison; Basic interfacing concepts: Analog and digital signals, GPIO, ADC basics, and conceptual understanding of sensor interfacing with embedded platforms.	8
3	Embedded IoT Application Development for Smart Energy Monitoring: Embedded application development for IoT: Program structure, embedded programming concepts, Arduino IDE environment, variables, functions, conditional statements, program development using Arduino IDE; Digital interfacing applications: Programming and interfacing with LED, push button, relay, LCD, and serial communication using Arduino IDE for monitoring and control applications; Analog sensing applications: Interfacing with temperature sensors (LM35) using Arduino-based embedded platforms for monitoring applications; Control applications: Concept of PWM and basic DC motor interfacing and control applications.	8
4	IoT Connectivity Technologies for Smart Energy Applications: Introduction to IoT connectivity technologies: Need for connectivity in IoT systems; wired and wireless communication concepts; key selection parameters such as range, power consumption, data rate, latency, reliability, and application suitability; Short-range IoT communication technologies: Concepts, key features, and applications of IEEE 802.15.4, Zigbee, Bluetooth, Z-Wave, and Wi-Fi for IoT systems; Long-range IoT communication technologies: Concepts, key features, and applications of LoRa, and Narrowband IoT (NB-IoT); Selection of connectivity technologies for smart energy applications: Comparative suitability of different IoT connectivity technologies for smart metering, remote monitoring, industrial monitoring, and smart grid applications.	6
5	IoT Cloud Platforms and Remote Monitoring Applications: IoT cloud platforms for monitoring applications: Introduction to cloud-based IoT platforms for data acquisition, storage, visualization, dashboard creation, and alert generation using suitable IoT platforms; IoT gateway and supervisory monitoring concepts: Role of IoT gateway in smart energy systems; transmission of sensor data to cloud platforms; remote monitoring, dashboard-based supervision, and interpretation of monitored electrical parameters; Remote monitoring and basic supervisory applications: Concepts of event notification, abnormal condition monitoring, remote supervision, and basic remote switching applications in smart energy systems.	6
6	Intelligent Energy Infrastructure and IoT Case Studies: IoT applications in smart energy systems: Applications of IoT in smart energy meter monitoring, smart street lighting control, transformer monitoring, load monitoring	6

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	applications, and battery energy storage monitoring; IoT case studies in electrical engineering: Case studies of IoT applications in smart grid monitoring, and solar energy monitoring; Industrial IoT (IIoT) applications: Predictive maintenance concepts in industrial electrical systems using IoT sensors for monitoring motors, pumps, and electrical equipment.	
	TOTAL	42

Text Books:

1. Misra, S., Mukherjee, A., & Roy, A., *Introduction to IoT*, Cambridge University Press, 2021.
2. Mahajan, C. P., (*Arduino Programming for Everyone*), Kaushaltapeeth Prakashan.
3. Mahalle, P. N., & Railkar, P. N., *Identity Management for Internet of Things*, River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (e-book).

Reference Books:

1. Anuradha, J., & Tripathy, B. K., *Internet of Things (IoT): Technologies, Applications, Challenges and Solutions*, CRC Press, Taylor & Francis, 2018.
2. Alam, M., Shakil, K. A., & Khan, S., *Internet of Things (IoT): Concepts and Applications*, Springer, 2020.
3. Chaouchi, H., *The Internet of Things: Connecting Objects to the Web*, Wiley Publications, ISBN: 978-1-84821-140-7.
4. Hersent, O., Boswarthick, D., & Elloumi, O., *The Internet of Things: Key Applications and Protocols*, 2nd Edition, Wiley Publications, ISBN: 978-1-119-99435-0.
5. Kellmerit, D., & Obodovski, D., *The Silent Intelligence: The Internet of Things*, 1st Edition, Lightning Source Inc., 2014, ISBN-10: 0989973700, ISBN-13: 978-0989973700.
6. Margolis, M., *Arduino Cookbook*, 2nd Edition, O'Reilly Media, 2011.
7. Bradbury, A., & Everard, B., *Learning Python with Raspberry Pi*, John Wiley & Sons, 2014.
8. Bell, C., *Beginning Sensor Networks with Arduino and Raspberry Pi*, 1st Edition, Apress, 2014.

E Resources:

1. NOC: Introduction to Internet of Things, IIT Kharagpur, Prof. Sudip Misra
<https://nptel.ac.in/courses/106105166>.

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Program: B.Tech. (Electrical Engineering)							Semester: VI		
Course: High Voltage Engineering							Code: EEPE602C		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Electrical Engineering Materials and their properties									
Course Objectives:									
1. To explore types of over voltage in the power system. 2. To provide an overview of gaseous dielectrics breakdown mechanisms. 3. To provide an overview of liquid and solid dielectrics breakdown mechanisms. 4. To generate and measure DC, AC and impulse voltages and currents. 5. To measure high voltage and current quantity in an HV testing laboratory. 6. To introduce the testing procedure of HV power apparatus.									
Course Outcomes: At the end of the course, Student will be able to -									
CO1	Describe protection methods against over-voltages and the principle of insulation coordination in HV and EHV systems.								
CO2	Apply Paschen’s Law and analyze Corona discharge, time lag phenomena in gaseous dielectrics.								
CO3	Explain partial discharges, composite dielectrics and factors affecting breakdown in solid and liquid insulation.								
CO4	Illustrate the working of single and multistage Marx generators for impulse voltages and currents along with tripping and control circuits.								
CO5	Apply appropriate techniques for measurement of high DC, AC and impulse voltages.								
CO6	Demonstrate different tests on high voltage equipment and devices.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Over Voltages in Electrical Power Systems- Causes of over voltages and its effect on power system – Lightning, switching surges and temporary over voltages – Bewley lattice diagram-protection against over voltages; Principle of Insulation Coordination on High voltage and Extra high voltage power systems.								6
2	Breakdown in Gases- Ionization process in gas, Townsend’s Theory, current growth equation in presence of primary and secondary ionization processes, Townsend’s breakdown criterion, primary and secondary ionization coefficients, limitations of Townsend’s theory, Streamer mechanism of breakdown, Paschen’s Law and its limitations, Corona discharges for point plane electrode combination with positive and negative pulse application, time lag and factors on which time lag depends. (Numerical on Townsend’s theory and Paschen’s law).								7

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3	Breakdown in Liquid Dielectrics: Pure and commercial liquids, Different breakdown theories: Breakdown in Pure liquid and breakdown in commercial liquids: Suspended Particle theory, Cavitations and bubble theory, Thermal mechanism of breakdown and Stressed Oil volume theory Breakdown in Solid Dielectrics: Intrinsic breakdown: electronic breakdown, avalanche or streamer breakdown, electro-mechanical breakdown, thermal breakdown, treeing and tracking phenomenon, Chemical and electrochemical breakdown, Partial discharge (Internal discharge), Composite dielectric material, Properties of composite dielectrics, breakdown in composite dielectrics. (Numerical on theories of liquid and solid dielectric materials)	8
4	Generation of High Voltages and High Current- Generation of High DC voltages: Rectifiers, voltage multipliers and Vande Graff generator. Generation of High AC voltages: cascaded transformer, resonant transformer and tesla coil, Generation of High impulse voltages: single and multistage Marx circuits, Generation of switching voltages, Generation of impulse currents, Tripping and control of impulse generators.	7
5	Measurement of High Voltage and High Currents- Measurement of high DC, AC, and impulse voltages: Sphere gap, Potential dividers. Measurement of high currents: Resistive shunts, Magnetic potentiometers, Rogowski coils, High voltage dielectrics loss and capacitance measurement, Radio frequency and Partial discharge measurement.	7
6	High Voltage Testing of Electrical Power Apparatus- Overviews of International and Indian standards- laboratory test procedure: multi-level method, Up and Down method - HV Testing of Insulators, Bushings, Circuit Breakers, Power transformers, Surge Arresters, Power capacitors and Cables.	7
TOTAL		42

Industrial Visit:

Industrial visit to high voltage equipment manufacturing industry/EHV substation/High Voltage Testing Unit.

Text Books:

1. M.S. Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill Publishing Company Ltd, New Delhi, Fifth Edition, 2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd.

Reference Books:

1. E. Kuffel, W. S. Zaengl, J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication
2. Prof. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, "High Voltage Engineering", Khanna Publishers, New Delhi
3. Ravindra Arora, Wolf Gang Mosch, "High Voltage Insulation Engineering", New Age International
4. High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York and Basel.
5. Subir Ray, "An Introduction to High voltage Engineering" PHI Pvt. Ltd. New Delhi
6. IS 731-1971: Porcelain insulator for overhead power lines with nominal voltage > 1000 Volt
7. Bushings: IS2099-1986, specification for bushings for A.C. Voltages > 1000 Volts
8. Pollution test: IEC 60507-1991 on external and internal insulator
9. High voltage test techniques, general definitions and test requirements: IS 2071(part 1) 1993, IEC Pub 60-1(1989)



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E-references:
1. NPTEL courses on High Voltage Engineering, IIT Kanpur. www.onlinecourses.nptel.ac.in/noc18_ee41 2. High Voltage Engineering by Prof. Ravindra Arora IIT Kanpur https://nptel.ac.in/courses/108104048

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Program: B. Tech. (Electrical Engineering)							Semester: VI		
Course: Advanced Electrical Drives Systems							Code: EEPE603A		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic Electrical Engineering, Electrical Machines, Power Electronics.									
Course Objectives:									
1. To introduce the fundamentals and operating principles of electrical drive systems. 2. To develop an understanding of converter-fed DC motor drives and their control techniques. 3. To familiarize students with induction motor drive control methods including scalar and vector control. 4. To introduce the operation and control of BLDC motor drive systems for modern applications. 5. To familiarize students with the operating principles and control of PMSM and SRM drive systems. 6. To develop an understanding of the selection and application of electrical drive systems for industrial requirements.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Describe the fundamentals, dynamics, operating characteristics and stability of electrical drive systems.								
CO2	Explain the operating modes and control methods of converter-fed DC motor drive systems under motoring and braking conditions.								
CO3	Compare various control techniques employed in Induction Motor Drives								
CO4	Discuss the operation, electronic commutation and speed control methods of BLDC motor drives used in electric vehicle and automation systems.								
CO5	Explain the operating principles and control strategies of PMSM and switched reluctance motor drive systems.								
CO6	Select suitable electrical drive systems for industrial applications based on load characteristics, efficiency and operating requirements.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Fundamentals of Electrical Drive Systems: Introduction to electrical drive systems – Definition of Electrical Drives, classification and components of electrical drives, selection criteria of electrical drives, advantages of electrical drives over mechanical drives. Dynamics of electrical drives – Fundamental torque equation of electrical drive (derivation), speed-torque conventions and multi-quadrant operation of electrical drives. Equivalent drive parameters for loads with rotational motion and translational motion, components of load torque, nature and classification of load torque, Introduction to power electronic converters used in electrical drives – rectifiers, choppers and inverters.								7
2	DC Motor Drive Systems: Review of torque-speed and performance characteristics of DC motors for drive applications. Starting, braking, plugging, regenerative braking, and four-quadrant operation of DC drives. Single-phase and three-phase fully controlled rectifiers fed								7

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	separately excited DC motor drives under continuous and discontinuous conduction modes. Dual converter fed DC drives. PWM chopper controlled DC drives for motoring and braking operations. Closed loop speed control of DC drives using PI based current and speed feedback controllers.	
3	Control Techniques of Induction Motor Drives: Performance characteristics and analysis of induction motor drives. Speed control methods including stator voltage control, rotor resistance control, slip power recovery schemes, and frequency control methods. VSI, CSI and PWM inverter fed induction motor drives. Scalar control using constant V/f method and slip regulation techniques. Starting, braking, plugging and regenerative operation of induction motor drives. Introduction to vector control, field oriented control (FOC), basic concepts of direct torque control (DTC), and sensor less induction motor drives. Comparative study of scalar and vector control techniques of induction motor drives.	7
4	Brushless DC (BLDC) Motor Drives: Construction, principle of operation and performance characteristics of Brushless DC (BLDC) motors. Electronic commutation of BLDC motors using Hall sensors and introduction to sensor less commutation techniques. Three phase inverter fed BLDC drives and PWM based speed control techniques. Electronic Speed Controller (ESC) for BLDC drives. Torque-speed characteristics, starting, braking and regenerative operation of BLDC motor drives. Closed loop speed control using PI controllers. Applications of BLDC drives in electric vehicles, robotics, drones and industrial automation systems.	7
5	Special Motor Drive Systems: A. Permanent Magnet Synchronous Motor (PMSM) Drives: Construction, principle of operation and performance characteristics of Permanent Magnet Synchronous Motors (PMSM). Voltage source inverter fed PMSM drives and basic closed loop speed control techniques. Basic concepts of vector control and field oriented control (FOC) of PMSM drives. Flux weakening operation and introduction to sensorless operation of PMSM drives. Applications of PMSM drives in industrial automation and electric vehicle systems. B. Reluctance Motor Drives: Introduction to reluctance motor drives. Switched Reluctance Motor (SRM): construction, principle of operation and torque production mechanism. Converter circuits and control strategies of SRM drives. Performance characteristics and industrial applications of SRM drives.	7
6	Industrial Applications of Electrical Drives: A. Selection and Rating of Electrical Drives Motor duty cycles, thermal rating of motors, types of enclosures and cooling methods for electrical machines. Selection criteria of electrical drives based on load characteristics, environmental conditions, reliability and energy efficiency. B. Electrical Drives for Industrial and Modern Applications Selection and application of electrical drives for machine tools, rolling mills, electric traction, cranes, hoists, pumps, fans and conveyor systems. Energy efficient drives and recent trends in smart drive systems for industrial automation.	7
	TOTAL	42

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Text Books:

1. G. K. Dubey, *Fundamentals of Electric Drives*, 2nd Edition, Narosa Publishing House.
2. N. K. De and P. K. Sen, *Electric Drives*, Prentice Hall of India.
3. S. K. Pillai, *Analysis of Thyristor Power Conditioned Motors*, University Press.
4. G. K. Dubey, *Power Semiconductor Controlled Drives*, PHI Publication.
5. B. K. Bose, *Modern Power Electronics and AC Drives*, Pearson Education.

Reference Books:

1. R. Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, PHI India.
2. B. K. Bose, *Modern Power Electronics and AC Drives*, Pearson Education.
3. V. Subrahmanyam, *Electric Drives: Concepts and Applications*, Tata McGraw Hill.
4. M. D. Singh and K. B. Khanchandani, *Power Electronics*, Tata McGraw Hill.
5. Austin Hughes, *Electrical Motor and Drives: Fundamentals, Types and Applications*, Heinemann Newnes, London.
6. S. C. Tyagi, *MATLAB for Engineers*, Oxford University Press.
7. Malcolm Barnes, *Practical Variable Speed Drives and Power Electronics*, Elsevier Newnes Publications.

E Resources:

1. NPTEL Online Course on Fundamentals of Electric Drives, IIT Kanpur by Dr. S. P. Das - <https://nptel.ac.in/courses/108104140>
2. NPTEL Online Course on Advanced Electric Drives, IIT Kanpur by Dr. S. P. Das - <https://nptel.ac.in>
3. Allen Bradley PowerFlex 700 AC Drives User Manual - https://literature.rockwellautomation.com/idc/groups/literature/documents/um/20b-um001_-en-p.pdf
4. MATLAB/Simulink Documentation for Electrical Drive Systems and Motor Control Applications - <https://www.mathworks.com/help/mcb>
5. Texas Instruments Application Notes on BLDC and PMSM Motor Drives - <https://www.ti.com/document-viewer/lit/html/SLAAE96A>

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Program: B.Tech. (Electrical Engineering)							Semester: VI		
Course: Advanced Microcontroller							Code: EEPE603B		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Digital Electronics, 8051 Microcontroller Programming, Embedded C, Interrupts, Serial Communication, and Interfacing Techniques.									
Course Objectives:									
1. To develop an understanding of the architecture, memory organization, instruction set, and operating features of PIC18 advanced microcontrollers. 2. To develop programming skills using Assembly language and Embedded C for I/O ports, timers, interrupts, and serial communication. 3. To familiarize students with CCP modules, PWM, Capture/Compare modes, ADC, and DAC for embedded control applications. 4. To provide knowledge of interfacing LCDs, sensors, relays, opto-isolators, and motors with PIC18 microcontrollers. 5. To develop the ability to apply microcontrollers in measurement, motor control, waveform generation, and automation applications.									
Course Outcomes: At the end of the course, Student will be able to -									
CO1	Explain the architecture, memory organization, registers, instruction set, and operating features of PIC18 microcontrollers.								
CO2	Develop Assembly and Embedded C programs for I/O ports, timers, delays, and control operations using PIC18 microcontrollers								
CO3	Implement interrupt programming and serial communication for microcontroller-based applications.								
CO4	Apply CCP, Capture, Compare, PWM, ADC, and DAC techniques for waveform generation, signal measurement, and control.								
CO5	Interface LCDs, temperature sensors, relays, opto-isolators, and other peripherals with PIC18 microcontrollers.								
CO6	Design and implement PIC18-based motor control and automation applications using DC, stepper, and servo motors.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Introduction to Advanced Microcontrollers Need of advanced microcontrollers,Comparison of CISC and RISC, Comparison of 8-bit, 16-bit and 32-bit controllers, Introduction to PIC family, Register organization and memory map, Pipeline concept and operating modes, Overview of PIC18 controllers, Program counters, Stack pointer, Bank Select Register, Status register								7
2	Assembly language programming Addressing Modes for PIC 18 microcontroller, Branch instruction, CALL, RETURN, Bit addressable instruction. Assembly language programs I/O ports, SFR related to PORTs, I/O port programming.								7

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3	Port and Timer Programming Embedded C concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations. I/O port programming in C, Delay programming, PIC 18 Timer 0 Programming in C	7
4	Special Hardware features and Programming Timers required for CCP Applications, CCP module in PIC 18 microcontroller, Applications of CCP mode Generation of waveform using Compare mode of CCP module. Period measurement of a unknown signal using Capture mode in CCP module, Speed control of DC motor using PWM mode of CCP module	7
5	Interrupt programming Interrupt Programming, Programming of Timer interrupts, Programming of External interrupts, Serial port programming. Interfacing of PIC18F458 8 bit model LCD(16x2)	7
6	Application of Microcontroller PIC ADC, Programming of ADC using interrupts, Interfacing DAC with PIC18F458, Interfacing of Electromechanical Relays and Opto-isolators, temperature measurement using LM35 temperature sensor, DC motor speed control, Stepper motor speed control, Servo motor speed control	7
TOTAL		42

Text Books:

1. Andrew N. Sloss, Dominic Symes, Chris Wright, Morgan Kaufmann
2. ARM Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Pearson Education
3. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Joseph Yiu, Newnes (Elsevier)
4. Embedded Systems: Architecture, Programming and Design, Raj Kamal, McGraw Hill Education
5. ARM System Developer's Guide: Designing and Optimizing System Software, Andrew N. Sloss, Dominic Symes, Chris Wright, Morgan Kaufmann Publishers
6. Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, Jonathan W. Valvano, CreateSpace Publications

Reference Books:

1. Programming Embedded Systems in C and C++, Michael Barr, O'Reilly Media
2. Embedded Systems Design, Steve Heath, Newnes (Elsevier)
3. Embedded Microcomputer Systems: Real-Time Interfacing, Jonathan W. Valvano, Cengage Learning
4. Designing Embedded Systems with ARM Cortex-M Microcontrollers, Yifeng Zhu, E-Man Press LLC
5. The Insider's Guide to the STM32 ARM-Based Microcontroller, Trevor Martin

E-references:

1. Microcontrollers and Applications, by Dr. S.P. Das, IIT Kanpur – <https://www.nptel.ac.in/courses/117104072>
2. Microprocessors and Microcontrollers, by Prof. Santanu Chattopadhyay, IIT Kharagpur – <https://www.nptel.ac.in/courses/108105102>

Program: B.Tech. (Electrical Engineering)

Semester: VI

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Course: HVDC and FACTS Devices							Code: EEPE603C		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Power System, Power System Protection									
Course Objectives:									
1. To introduce the fundamental concepts, advantages, applications, and configurations of HVDC transmission systems in comparison with AC transmission. 2. To develop understanding of HVDC converter operation, control strategies, and system hierarchy for effective DC link control. 3. To introduce the concept of Flexible AC Transmission Systems (FACTS), power flow control constraints, and the need for transmission line compensation. 4. To study the principle of operation, characteristics, and applications of various shunt and series FACTS controllers.									
Course Outcomes: At the end of the course, Student will be able to -									
CO1	Analyse current source and voltage source converters for HVDC systems.								
CO2	Describe the control schemes for HVDC systems.								
CO3	Explain the need for FACTS devices.								
CO4	Classify reactive power compensators in power system.								
CO5	Interpret series and shunt connected FACTS devices for power system applications								
CO6	Explain the dynamic interconnection mechanisms of FACTS devices.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Introduction to HVDC System: Comparison of AC and DC transmission systems - Advantages and applications of HVDC transmission - Types of HVDC systems: Monopolar, Bipolar, Homopolar, Multi-terminal HVDC system components: Converters, Transformers, Filters, Reactive power sources, Smoothing reactors - Choice of converter configuration Modern trends in HVDC technology (CSC-HVDC and VSC-HVDC)								7
2	Converter & HVDC System Control:: Principal of DC link control –Converters control characteristics- system control hierarchy, firing angle control, current and excitation angle control, starting and stopping of DC link.								7
3	Harmonics, Filters and Reactive Power Control: Introduction, generation of Harmonics, AC and DC Filters. Reactive power requirements in steady state, sources of reactive power, static VAR systems.								7
4	Introduction to FACTS: Power flow in Power Systems – Voltage regulation and reactive power flow control in Power Systems - Power flow control -Constraints of maximum transmission line loading - Needs and emergence of FACTS - Types of FACTS								7

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	controllers-Advantages and disadvantages Transmission line compensation- Uncompensated line -shunt compensation - Series compensation -Phase angle control.	
5	Shunt and Series Facts Devices: Static shunt Compensator - Objectives of shunt compensations - Variable impedance type VAR Generators -TCR, TSR, TSC, FC-TCR (Principle of operation and schematic) and STATCOM (Principle of operation and schematic). Static Series compensator - Objectives of series compensations-Variable impedance type series compensators - GCSC. TCSC, TSSC (Principle of operation and schematic) Switching converter type Series Compensators-(SSSC) (Principle of operation and schematic)	7
6	UPFC AND IPFC: Unified Power Flow Controller: Circuit Arrangement, Operation of UPFC- Basic principle of P and Q control- independent real and reactive power flow control- Applications Introduction to interline power flow controller (IPFC) (Principle of operation and schematic) Thyristor controlled Voltage and Phase angle Regulators (Principle of operation and schematic)	7
TOTAL		42
Text Books:		
1. K. R. Padiyar– HVDC Power Transmission Systems 2. N. G. Hingorani & L. Gyugyi – Understanding FACTS		
Reference Books:		
1. S. Rao – EHV-AC, HVDC Transmission & Distribution Engineering 2. R. Mohan Mathur & Rajiv K. Varma - Thyristor-Based FACTS Controllers for Electrical Transmission Systems		
E-references:		
1. High Voltage DC Transmission, by Dr. S.N. Singh - https://nptel.ac.in/courses/108104013 2. Facts Devices, by Prof. Avik Bhattacharya, IIT Roorkee- https://nptel.ac.in/courses/108107114		

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DEPARTMENT OF ELECTRICAL ENGINEERING

Program: B.Tech. (Electrical Engineering)							Semester: VI		
Course: Electric & Hybrid Vehicle							Code: EEMD603		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
3	-	-	3	40	60	-	-	-	100
Prerequisites:									
Basics of Batteries, Electrical Motors, Power Electronics									
Course Objectives:									
1. To develop an understanding of the fundamentals, evolution, architecture, and performance parameters of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs). 2. To familiarize students with Li-ion battery technologies, charging methods, battery modeling, State of Charge (SoC) estimation, and thermal management. 3. To provide knowledge of EV/HEV propulsion systems, motors, drivetrain configurations, energy management strategies, and emerging EV technologies. 4. To develop an understanding of the application of power electronic converters and motor drives in EV/HEV systems, including unidirectional and bidirectional converters and DC–AC inverters. 5. To introduce Vehicle-to-Grid (V2G), Grid-to-Vehicle (G2V), smart-grid integration, demand response, and energy-management applications of electric vehicles.									
Course Outcomes: At the end of the course, Student will be able to -									
CO1	Identify the basic components of Electric and Hybrid Electric Vehicles.								
CO2	Explain lithium-ion batteries, charging methods, and battery management.								
CO3	Describe EV technologies and energy management systems.								
CO4	Analyze vehicle dynamics, propulsion systems, and electric motors.								
CO5	Explain the use of power electronic converters in EVs.								
CO6	Explain V2G, G2V, and smart grid applications in EVs.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1	Introduction: History, current scenario & Future of EV and Hybrid Vehicles, Current Major Issues, Advanced Electric and Hybrid drive vehicle technology, Comparison of EV, Hybrid EV and IC Engine vehicles. Components of Hybrid Electric Vehicle, Economic and environmental impacts of Electric and Hybrid vehicles: Comparative study of vehicles for economic and environmental aspects. In-wheel drives, EV and HEV Parameters: Weight, size, force, energy & performance parameters.								7
2	Li-Ion-Battery Charging and Modelling: Materials used for Li-ion battery, Nanostructured Electrode Materials for Li-Ion Batteries, Li-ion battery protection, TSCC/CV charging and CVCC/CC charging of Li-Ion battery, SoC Estimation methods (Kalman Filter, Neural Network, Fuzzy logic), Modeling of Lithium-ion batteries, Thermal Modeling of Li-ion battery.								7
3	Electric Vehicle Technologies:								7

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	Battery Swapping System, EV Fleet Management, Sensors for Electric Vehicles Electric bus, Electric trucks, Fuel cell vehicles, Introduction of EV Subsystems and Configurations, Energy management strategies and its general architecture.	
4	Dynamics of Electric and Hybrid Vehicles: General description of vehicle movement. Choice of electric and hybrid propulsion systems block diagram of EV and HEV propulsion system. Factors affecting vehicle motion – vehicle resistance, tires ground adhesion, rolling resistance, aerodynamic drag, equation of grading resistance, dynamic equation. Drive train configurations for EVs and HEVs, automobile power train, classification of vehicle power plants, need of gear box. Concept of EV/HEV motors, classification of EV/HEV motors, single motor and multi-motor configurations, fixed & variable geared transmission'	8
5	Use of Power Electronics in EV and EHV: EV and EHV configuration based on power electronics, Converter requirement for on board charger, battery pack, motor drive, auxiliary battery, commonly used DC to DC converter in EV and HVE: Isolated converter, Non Isolated converter, Unidirectional and Bidirectional converter. DC to AC converters: Three phase DC to AC converter, Voltage Control using sinusoidal PWM.	7
6	Grid Applications: Concept of Vehicle to Grid (V2G/G2V): Ancillary Services, peak saving, load-generation balance, Demand Response, Energy time shift, integration of EVs in smart grid, social dimensions of EVs.	6
TOTAL		42
Text Books:		
1. “Batteries for Electric Vehicles”, D.A.J Rand, R Woods & R M Dell, Research studies press Ltd, New York, John Willey & Sons 2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York, 2001. 3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003. 4. “Electrical Vehicle”, James Larminie and John Lowry, John Wiley & Sons, 2012.		
Reference Books:		
1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010. 2. “Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design”, Mehrdad Ehsani, Yimin Gao and Ali Emadi. CRC Press, 2009. 3. James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003. 4. “Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid”, Junwei Lu & Jahangir Hossain et al (eds), IET Digital Library. 5. “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011.		
E-references:		
1. https://www.theiet.org/resources/books/transport/vehicle2grid.cfm 2. https://www.sae.org/publications/books/content/pt-143.set/ 3. NPTEL Course :Electric Vehicles - https://www.nptel.ac.in/courses/108102121		

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Program: B.Tech. (Electrical Engineering)							Semester: VI		
Course: Electric & Hybrid Vehicle Lab							Code: EEMD603P		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	25	-	-	25
Prerequisites:									
Basics of Batteries, Electrical Motors, Power Electronics									
Course Objectives: The objectives of this course are									
1. To study the configuration, components, propulsion systems and operating characteristics of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs).									
2. To analyze and simulate EV battery, charging, vehicle dynamics, traction motor, power electronic converter and regenerative braking systems using suitable tools.									
3. To familiarize students with emerging Electric Mobility technologies such as battery swapping, energy management, V2G/G2V and smart-grid integration.									
Course Outcomes: After completion of this course, students will able to									
CO1	Identify and analyze the configurations, components and performance parameters of EV and HEV systems.								
CO2	Model, simulate and evaluate EV vehicle dynamics, Li-Ion battery, charging, SoC estimation, traction motor and power electronic systems.								
CO3	Analyze and demonstrate advanced EV technologies including regenerative braking, battery swapping, energy management and V2G/G2V operation.								
List of Experiments: To perform any eight experiments from the following list									
1. Study of Electric, Hybrid and IC Engine Vehicle Configurations									
2. Determination of Tractive Force and Power Requirement of an Electric Vehicle									
3. Simulation and Performance Analysis of an Electric Vehicle Drive Cycle									
4. Modelling and Simulation of a Lithium-Ion Battery									
5. Simulation of Constant Current–Constant Voltage (CC-CV) Charging of a Lithium-Ion Battery									
6. State of Charge (SoC) Estimation of a Lithium-Ion Battery									
7. Simulation of DC-DC Converter for Electric Vehicle Applications									
8. Simulation of Three-Phase Voltage Source Inverter Using Sinusoidal PWM for EV Motor Drive									
9. Simulation and Analysis of Regenerative Braking in an Electric Vehicle									
10. Study and Analysis of Traction Motor Characteristics for Electric Vehicle Applications									
11. Study and Simulation of Battery Swapping System for Electric Vehicles									
12. Simulation and Analysis of Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V) Operation									
Text Books:									
1. “Batteries for Electric Vehicles”, D.A.J Rand, R Woods & R M Dell, Research studies press Ltd, New York, John Willey & Sons									
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York, 2001.									
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.									
4. “Electrical Vehicle”, James Larminie and John Lowry, John Wiley & Sons, 2012.									
Reference Books:									
1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010.									
2. “Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design”,									



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Mehrdad Ehsani, Yimin Gao and Ali Emadi. CRC Press, 2009.

3. James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003.
4. “Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid”, Junwei Lu & Jahangir Hossain et al (eds), IET Digital Library.
“Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011.

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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Quality Management System – III							Code: EEVS606		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	25	-	-	25
Prerequisites:									
Quality Management System – I, Quality Management System – II.									
Course Objectives:									
1. To understand basic principles and terms related to statistical process control. 2. To understand Kaizen philosophy of continuous, incremental improvement & Six Sigma, data-driven methodology aimed at reducing defects and process variation. 3. To understand processes in Business process management and know significance of concept customer driven quality.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply control charts for process controls to perform statistical analysis.								
CO2	Apply kaizen and six sigma for industrial processes								
CO3	Gain knowledge in customer relationship management								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Statistical process Control: Specification and control limits, types of control charts, control charts for variables and attributes, Pareto diagram, process flow diagram, cause and effect diagram, check sheets and histogram, Experimental design.								08
2.	Six Sigma and Kaizen- Continuous Improvement: Key six sigma concepts, quality level, three sigma's', defects per million opportunities, implementation, DMAIC, DMADV Concept of Kaizen, lean, 5S, kaizen vs innovation, CWQC, Kaizen practice, QFD, QCC, Poka yoke, quality of work life Taguchi quality engineering, loss function, orthogonal arrays, signal to noise ratio Parameter and tolerance design								09
3.	Customer driven quality and business process management: Customers perception of quality, customer relationship management and its components, customer retention programs CRM modules, CRM in B2B and B2C context, e- CRM. BMP: introduction and BMP implementation framework.								09
TOTAL								26	
Text Books:									
1. Kanishka Bedi, "Quality Management", Oxford University Press. 2. Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education.									
Reference Books:									
1. Dale H. Besterfield, "Total Quality Management", Pearson Education. 2. Poornima M. Charantimath, "Total Quality Management", Pearson, 2nd Edition. 3. V. K. Khanna, "TQM: Planning, Design and Implementation", New Age International Publishers.									



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E-Resources:
1. 1. Dr. N. Venkateshwarlu, “Quality Engineering & Management”, NPTEL Course, https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_me09

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Program: B. Tech. (Electrical Engineering)							Semester: V		
Course: Internship – V							Code: EEIN605		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	-	-	02	-	-	25	-	-	25
Preamble:									
Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.									
Course Objectives:									
1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry. 2. Learn to implement the technical knowledge in real industrial situations.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.								
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.								
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.								
Internship Requirements									
1. Internship Duration: It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 3 to 5 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW). 2. Internship Opportunities: Students can explore various opportunities for internships at: f. Industries g. Research labs or organizations h. Collegiate clubs i. In-house research projects j. Online internships 3. Support and Assistance: Students can seek assistance for securing internships from: e. The Training and Placement cell, along with departmental coordinators f. Department or institute faculty members g. Personal contacts h. Directly connecting with industries or organizations 4. Request Letter: Once an industry, research organization, or collegiate club is identified, students must obtain a request letter from the concerned department or placement office. This									

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letter, in the standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.

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