PREVIOUS YEAR PAPER
ENGINEER VAULT
NOTES II SYLLABUS

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRAPATI SAMBHAJINAGAR.

NAAC- 'A ⁺' Grade

CIRCULAR NO.SU/Engg./College/NEP-2020/93/2026

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies and recommended by the Faculty of Science & Technology, *Academic Council at its meeting held on 02nd June 2026 has accepted* the following Syllabi of B. E. & B. Tech. under the Faculty of Science & Technology as per Norms of National Education Policy – 2020 as appended herewith.

Sr.No.	*Syllabi*
1.	*Third Year B. E./B. Tech. Civil Engineering*
2.	*Third Year B.E./B.Tech. Mechanical Engineering*
3.	*Third Year B. E./B. Tech. Information Technology*
4.	*Third Year B. E./B. Tech. Electronics & Telecommunication Engineering/Electronics Engineering /Electronics & Communication Engineering.*
5.	*Third Year B. E./B. Tech. Electrical and Electronics Engineering/ Electrical Engineering/ Electrical, Electronics and Power*
6.	*Third Year B. E./B. Tech. Computer Science and Engineering/ Computer Science/Computer Engineering*
7.	*Third Year B. E./B. Tech. Artificial Intelligence/ Artificial Intelligence and Machine Learning / Artificial Intelligence and Data Science*

This is effective from the Academic Year 2026-27 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Chhatrapati Sambhajinagar
- 431 004.
REF.NO.SU/AC I.No.06/2026/180-89
Date:- 12/06/2026

★★★★★

Deputy Registrar,
Syllabus Section

Copy forwarded and necessary action to :-

1] **The Principal of all Affiliated Colleges,** Dr. Babasaheb Ambedkar Marathwada University
2] The Director, University Network & Information Centre, UNIC, Dr.Babasaheb Ambedkar Marathwada University with a request to upload this Circular on University Website
3] The Director, Board of Examinations & Evaluation, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

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NOTES & SYLLABUS

Four Year UG Engineering/Technology Programme

Syllabus Structure of TY Electrical and Electronics Engineering/ Electrical Engineering / Electrical, Electronics and Power (EEE/EE/EEP)

(AS PER NEP-2020)

Effective from 2026-27

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FACULTY OF ENGINEERING AND TECHNOLOGY

Syllabus Structure of TY Electrical Engineering / Electrical and Electronics Engineering/ Electrical, Electronics and Power (EE/EEE/EEP) w.e.f.2026-27

(As Per NEP-2020)

Semester –V

Option 1 : Student can choose option 1 to get B.E./B.Tech with Multidisciplinary Minor (Following structure)

Sr. No.	Course Category	Course Code	Course Title	Contact Hours per week		Credits		Scheme of Examination		
				Theory	Practical	Theory	Practical	CIA	SEE	Total
1	Program Core Course (PCC)	PCCT-1	Electromagnetic Fields	3	----	3	----	40	60	100
		PCCT-2	Power Systems	3	----	3	----	40	60	100
		PCCP-2	Power Systems Lab		2		1	20	30	50
		PCCT-3	Control Systems	3	----	3	----	40	60	100
		PCCP-3	Control Systems Lab		2		1	20	30	50
		PCCT-4	Microprocessor & Interfacing	3	----	3	----	40	60	100
		PCCP-4	Microprocessor & Interfacing Lab		2		1	20	30	50
		PCCP-5	Electrical CAD lab		2		1	20	30	50
2	Programme Elective Courses (PEC)	PECT-1	Theory - 5	3	----	3	----	40	60	100
		PECP-1	Practical Based on PECT-1	---	2	---	1	20	30	50
3	Multidisciplinar y Minor (MDM)	MDMT-3	Theory –6 (Choose any one course from the other discipline : Minor Basket)	2	----	2	----	20	30	50
4	Open Elective (OE) to be chosen compulsorily from the faculty other than Major Discipline	OET-4	Theory -7 (Choose any one from the Basket. Respective BoS Group will prepare a Basket)	2	----	2	----	20	30	50
				19	**10**	**19**	**5**	**340**	**510**	**850**

Option 2 : Student can choose option 2 to get B.E./B.Tech Honours with Multidisciplinary Minor (above structure + following additional Honours degree course)

5	Honors Degree Course	PCCT-5	Theory -8 Electrical Machine Design	3	----	3	----	40	60	100

Please note that the course listed under Sr. No. 5 is optional and specifically designed for students pursuing a Bachelor's Degree Honors with Multidisciplinary Minor. Only those students who have secured a minimum of 7.5 CGPA (equivalent to 75% marks) in their previous year will be eligible to opt for this option

Option 3 : Student can choose option 3 to get B.E./B.Tech with Double Minor (Option 1 structure + following additional Double Minor course)

6	Double Minor Course	DMT-3	Theory -9 Electric Traction	3	----	3	----	40	60	100

Please note that the courses listed under Sr. No. 6 is optional and specifically designed for students pursuing a Bachelor's Degree with Double Minor. Only those students who have secured a minimum of 7.5 CGPA (equivalent to 75% marks) in their previous year will be eligible to opt for this option.

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FACULTY OF ENGINEERING AND TECHNOLOGY

Syllabus Structure of TY Electrical Engineering / Electrical and Electronics Engineering/ Electrical, Electronics and Power (EE/EEE/EEP) w.e.f.2026-27

(As Per NEP-2020)

Semester –VI

Option 1 : Student can choose option 1 to get B.E./B.Tech with Multidisciplinary Minor (Following structure)

Sr. No.	Course Category	Course Code	Course Title	Contact Hours per week		Credits		Scheme of Examination		
				Theory	Practical	Theory	Practical	CIA	SEE	Total
1	Program Core Course (PCC)	PCCT-1	Power System Protection	3	----	3	----	40	60	100
		PCCP-1	Power System Protection Lab	--	2	---	1	20	30	50
		PCCT-2	Power Electronics	3	----	3	----	40	60	100
		PCCP-2	Power Electronics Lab		2		1	20	30	50
		PCCT-3	Microcontroller & Applications	3	----	3	----	40	60	100
		PCCP-3	Microcontroller Applications Lab		2		1	20	30	50
2	Programme Elective Courses (PEC)	PECT-1	Theory - 4	3	----	3	----	40	60	100
		PECP-1	Practical Based on PECT-1	--	2	--	1	20	30	50
		PECT-2	Theory - 5	3	----	3	----	40	60	100
		PECP-2	Practical Based on PECT-2	--	2	--	1	20	30	50
3	Multidisciplinary Minor (MDM)	MDMT-4	Theory –6 (Choose any one course from the other discipline : Minor Basket)	2	----	2	----	20	30	50
4	Vocational and Skill Enhancement Courses (VSEC)	VSEC-3	Programme specific Skill Lab	--	4	---	2	20	30	50
5	Research Methodology	RMT	Theory -7 Course on Research Methodology	2	----	2	----	20	30	50
		RP	Research Project-1	--	4	--	2	20	30	50
				19	18	19	9	380	570	950

Option 2 : Student can choose option 2 to get B.E./B.Tech Honors with Multidisciplinary Minor (above structure + following additional Honors degree course)

6	Honors Degree Course	PCCT-4	Theory -8 Electrical Safety	3	----	3	----	40	60	100

Please note that the course listed under Sr. No. 6 is optional and specifically designed for students pursuing a Bachelor's Degree Honors with Multidisciplinary Minor. Only those students who have secured a minimum of 7.5 CGPA (equivalent to 75% marks) in their previous year will be eligible to opt for this option

Option 3 : Student can choose option 3 to get B.E./B.Tech with Double Minor (Option 1 structure + following additional Double Minor course)

7	Double Minor Course	DMT-4	Theory -9 Energy Conservation And Audit	3	----	3	----	40	60	100

Please note that the courses listed under Sr. No. 7 is optional and specifically designed for students pursuing a Bachelor's Degree with Double Minor. Only those students who have secured a minimum of 7.5 CGPA (equivalent to 75% marks) in their previous year will be eligible to opt for this option.

Exit Option: Students may choose to exit the program at the end of the third year and be awarded an B. Voc in the relevant discipline or subject, provided they have earned additional 8 credits through skill-based vocational courses, internships, or mini project undertaken during the summer vacation, after third year.

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Baskets of Program Elective Courses (PEC)

Semester / Domains	Energy & Power control	Electronics	EV Technology
V-PEC-1	Energy Conservation & Management	Digital Electronics	Fundamental of EV
VI-PEC-2	Conventional Energy sources	Analog Integrated Circuit	EV Infrastructure and Charging
VI-PEC-3	Non Conventional Energy Sources And Applications	Embedded Systems	Advance EV and Technology Application
VII-PEC-4	Power Quality	Illumination Engineering	Hands on EV Design

Basket of Open Electives Courses (OEC)

Semesters / Domains	Fin-Tech	Multimedia Forensic	SocialSciences
III-OE1	Introduction to Financial Market	Introduction to Digital Forensics	Indian Constitution
III-OE2	Risk Management and Compliances	Cyber Security and cyber law	Emotional Intelligence
IV- OE3	Data Analytics for Finance	Incident Response Management	Introduction to Sociology
V-OE4	Business Intelligence	Practical Case Studies and Investigations	Indian Economy

Basket of Multi-disciplinary Minor (MDM)

Semester	Mechanical	E&TC / ETX/ EC	EE / EEE/ EEP
Domain	**Industrial Automation**	**IOT**	**EV**
III MDMT-1	Robotics& Automation	IoT Fundamentals	Introduction to Electric Vehicles (EVs)
IV MDMT-2	Robotics Kinematics and Dynamics	IoT Hardware & Sensors	EV Technology and Components
V MDMT-3	Sensors and Actuators for Robotics	IoT Connectivity & Communication	EV Infrastructure and Charging
VI MDMT-4	Artificial Intelligence and Machine Learning in Robotics	IoT Data Processing & Analytics	EV Market and Industry Trends
VII MDMT-5	PLC and SCADA	Hands on Applications & Project Developments	Hands on EV Design

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SEM V

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Course Code: PCCT-1
Course: Electromagnetic Fields Semester–V

Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Prerequisites: Knowledge of Vector Calculus, Engineering Physics, and Engineering Mathematics-I & II.

Objectives

1. Provide the student with a comprehensive understanding of static and dynamic electric and magnetic fields.
2. To make the students capable of analyzing fields in different coordinate systems (Cartesian, Cylindrical, and Spherical).
3. To learn about the application of Maxwell equations to electromagnetic wave propagation.
4. To make the students learn how to represent and solve boundary-value problems in electromagnetics.
5. To introduce students to the practical application of electromagnetic fields in electrical machines, transmission lines, and high-voltage engineering.
6. To develop computational and analytical skills in students to solve complex boundary-value problems using mathematical principles like Poisson's and Laplace's equations.

Course Outcomes

CO1: Apply vector calculus and coordinate systems to solve problems in electromagnetics.
CO2: Analyze static electric fields, potential distributions, and calculate capacitance for various configurations.
CO3: Analyze static magnetic fields, magnetic forces, and evaluate inductance for different geometries.
CO4: Evaluate time-varying fields using Maxwell's equations and understand Poynting's theorem.
CO5: Formulate and solve electromagnetic wave propagation equations in various media.
CO6: Evaluate time-varying fields using Maxwell's equations, analyze electromagnetic wave propagation in different media, and calculate power flow using the Poynting vector.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	Part A Review of vector algebra and coordinate systems (Cartesian, Cylindrical, Spherical). Gradient, Divergence, Curl, and Stokes' theorem. Coulomb's Law, Electric Field Intensity (E), Gauss's Law and its applications. Part B Electric Potential, Relationship between E and V. Energy density in electrostatic fields. Conduction and convection currents. Continuity equation, Boundary conditions for perfect dielectric and conductor interfaces. Capacitance and Capacitors.	(15 hrs)
Unit-II	Part A Biot-Savart's Law, Ampere's Circuital Law and its applications. Magnetic Flux Density (B) and Magnetic Field Intensity (H). Vector Magnetic Potential. Part B Magnetic forces, Torque on a current loop. Magnetic boundary conditions. Inductor and Inductances (Self and Mutual inductance), Magnetic energy stored in a field.	(15 hrs)

Unit-III	Part A	(15hrs)
	Faraday's Law of Electromagnetic Induction, Displacement Current, Maxwell's Equations in point form and integral form for static and time-varying fields. Part B Wave propagation in free space, dielectrics, and good conductors. Poynting Vector and Poynting's Theorem. Skin depth and wave polarization.	

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Reference Books and Text Books:	
1.	*William H. Hayt Jr., John A. Buck, Engineering Electromagnetics, McGraw Hill Education.*
2.	*Matthew N. O. Sadiku, Principles of Electromagnetics, Oxford University Press.*
3.	*Joseph A. Edminister, Schaum's Outline of Electromagnetics, McGraw Hill.*
4.	*Ashutosh Pramanik, Electromagnetism: Theory and Applications, PHI Learning Pvt. Ltd.*
5.	*E.C. Jordan and K.G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall.*
6.	*William H. Hayt Jr., John A. Buck, Engineering Electromagnetics, McGraw Hill Education.*
7.	*Matthew N. O. Sadiku, Principles of Electromagnetics, Oxford University Press.*

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Course Code: PCCT-2
Course: Power Systems
Semester–V
Credits: 3 (Theory)

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of electrical circuits, electromagnetic fields, electrical machines, network analysis, power generation fundamentals, and Elements of Power Transmission and Distribution (EPTD).

Objectives

1. To understand various energy generation sources and synchronous machine modelling.
2. To study excitation systems and performance analysis of transmission lines.
3. To learn load flow analysis methods used in power system studies.
4. To understand power system transients and over-voltage protection techniques.
5. To study compensation techniques for voltage and reactive power control.
6. To understand economic load dispatch and basic concepts of power system deregulation.

Course Outcomes

CO1: Explain various energy generation sources and excitation systems used in power systems.
CO2: Analyze the modelling and performance characteristics of synchronous machines.
CO3: Evaluate the performance of transmission lines using different line models and ABCD constants.
CO4: Apply load flow analysis methods for power system studies and bus analysis.
CO5: Explain power system transients, over-voltage phenomena, and protection techniques.
CO6: Understand compensation techniques, economic load dispatch, and deregulated power system

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	**A) Energy Generation Sources** Overview of thermal power plants, hydro power plants, nuclear power plants, gas power plants. **B) Synchronous Machine Modelling** Schematic diagram and physical construction of synchronous machine, armature and field structure, MMF waveforms, direct and quadrature axes, basic stator and rotor equations, self and mutual inductances, dq0 and Park's transformation, swing equation. **C) Excitation System:** Excitation system requirements in terms of generator consideration, Power system consideration, Elements of excitation system, Types of excitation system,	(17 hrs)

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Unit-II	**A) Performance of Lines** Representation of lines, short transmission lines, medium length lines, nominal-T and nominal-π representations, long transmission lines, equivalent circuit representation of long transmission lines, A, B, C, D constants, voltage regulation and efficiency of transmission lines. **B) Load Flow Analysis** Formulation of power flow equations, bus admittance matrix, classification of buses, numerical methods for load flow analysis including Gauss-Seidel method, Newton-Raphson method, and Fast Decoupled load flow method, comparison of load flow methods, applications of load flow studies in power systems. **C) Power System Transients** Power system transients, over-voltage phenomena, switching surges, lightning surges, traveling waves on transmission lines, insulation coordination, protection against over-voltages.	(18 hrs)
Unit-III	**A) Compensation Techniques** Series compensation, shunt compensation, reactive power compensation, voltage control methods, power factor improvement techniques, static VAR compensation, FACTS devices, applications of compensation in transmission systems. **B) Economic Load Dispatch & Deregulation** Economic load dispatch, unit commitment, economic operation of power systems, generation scheduling, load forecasting concepts, basic concepts of power system deregulation, advantages and challenges of deregulated power systems, overview of electricity markets.	(10 hrs)

Reference Books and Text Books:

1. Power System Analysis – Hadi Saadat, McGraw Hill Education.
2. Modern Power System Analysis – D. P. Kothari and I. J. Nagrath, McGraw Hill Education.
3. Electrical Power Systems – C. L. Wadhwa, New Age International Publishers.
4. Power System Engineering – I. J. Nagrath and D. P. Kothari, Tata McGraw Hill.
5. Power System Stability and Control – Prabha Kundur, McGraw Hill Education.
6. Elements of Power System – V. K. Mehta and Rohit Mehta, S. Chand Publications.

Course Code: PCCP 2

Course: Power Systems Lab

Total Credits: 1

Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr

Maximum Marks: 50

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Prerequisite:

1. Basic knowledge of Electrical Power Systems and Electrical Machines.
2. Fundamentals of AC Circuits, Network Analysis, and MATLAB basics.

Learning Objectives of the Course:

1. To understand power generation systems, synchronous machine modelling, and excitation systems used in modern power systems.
2. To analyze transmission line performance and perform load flow studies using analytical and MATLAB techniques.
3. To study power system compensation methods, FACTS devices, and simulation tools for power system analysis.

Coare Outcomes (COs) : Student will be

Able to:

1. CO1: Explain different power generation sources, synchronous machine characteristics, and excitation systems used in power systems.
2. CO2: Analyze synchronous machine modelling, dq0 transformation, and transmission line performance using analytical and MATLAB/Simulink techniques.
3. CO3: Apply load flow analysis methods such as Gauss-Seidel and Newton-Raphson for power system studies.
4. CO4: Demonstrate reactive power compensation, FACTS devices, and modern simulation techniques for power system analysis.

Topics *I* actual contents of the syllabus	Contact Hours
List of the Experiments 1. Simulation of single area and multi area LFC using MATLAB/ Simulink. 2. Small-signal stability analysis of single machine-infinite bus system using classical machine model. 3. Simulation of IEEE excitation systems. 4. Belgian Case Study: Power Flow Controlling Devices as a Smart and Independent Grid Investment for Flexible Grid Operations 5. Case study of Real-Time Dynamic Security Assessment of Power Systems. 6. Modeling of AVR using MATLAB/ Simulink. 7. Verification of direct axis and quadrature axis characteristics of synchronous machine. 8. Study of excitation systems and voltage regulators used in power systems. 9. Simulation of synchronous machine model using MATLAB/Simulink. 10. MATLAB implementation of dq0 and Park's transformation. 11. Simulation of short, medium and long transmission line models in MATLAB.	**30Hrs**

Students should undertake at least 08 Experiments during thesemester from above List

Course Code: PCCT-3
Course: Control System
Semester–V
Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Practical : 2 hrs./Week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

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Prerequisites

Prerequisites: Knowledge of Differential Equations, Laplace Transforms, Basics of Network Theory/Circuit Analysis, and Matrix Algebra.

Objectives

1. To provide students with a comprehensive understanding of open-loop and closed-loop control systems.
2. To make the students capable of modeling physical systems mathematically using transfer functions and state-space representations.
3. To learn about time-domain and frequency-domain analysis techniques to evaluate system performance and stability.
4. To make the students learn how to design compensators and controllers (like PID) to meet specific design specifications.
5. To introduce students to the concepts of stability analysis using Routh-Hurwitz, Root Locus, Bode, and Nyquist criteria.
6. To develop computational and analytical skills in students to analyze multi-input, multi-output (MIMO) systems using modern state-space variables.

Course Outcomes

CO1: Apply mathematical modeling techniques to develop transfer functions for mechanical, electrical, and electromechanical systems.
CO2: Analyze transient and steady-state time responses of first and second-order control systems.
CO3: Evaluate the absolute and relative stability of linear time-invariant (LTI) systems using Root Locus and Routh-Hurwitz criteria.
CO4: Analyze system performance and stability in the frequency domain using Bode plots and the Nyquist stability criterion.
CO5: Design lag, lead, lag-lead compensators, and PID controllers to satisfy specified performance criteria. CO6: Formulate state-space models, evaluate state transitions, and analyze the controllability and observability of dynamic systems.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	Part A Introduction and Modeling of Control Systems: Open-loop and closed-loop systems, feedback characteristics. Mathematical modeling of physical systems: Electrical networks, mechanical systems (translational and rotational). Block diagram reduction techniques and Signal Flow Graphs (Mason's gain formula). Part B Time-Domain Analysis: Standard test signals. Time response of first and second-order systems to step, ramp, and impulse inputs. Time-domain specifications	(15 hrs)

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	(rise time, peak time, overshoot, settling time). Steady-state errors and error. Concept of stability and Routh-Hurwitz stability criterion.	
Unit-II	Part A Root Locus Technique: Concept of root locus, construction rules, and guidelines Determination of roots, stability margins, and system gain K adjustment from the root locus plot. Part B Frequency-Domain Analysis: Correlation between time and frequency response. Frequency domain specifications (resonant peak, resonant frequency, bandwidth). Stability analysis using Bode plots: Gain Margin (GM) and Phase Margin (PM). Polar plots and Nyquist Stability Criterion.	(15 hrs)
Unit-III	Part A Controllers and Compensators: Introduction to P, I, D, PI, PD, and PID controllers. Design concepts of root-locus and frequency-domain compensators: Lead, Lag, and Lag-Lead networks. Part B State-Space Analysis: Concept of state, state variables, and state models. State-space representation of continuous-time systems (diagonal, canonical forms). Solution of state equations, State Transition Matrix (STM). Concepts of Controllability and Observability.	(15 hrs)

Reference Books and Text Books:

1.	Benjamin C. Kuo, *Automatic Control Systems*, John Wiley & Sons.
2.	Katsuhiko Ogata, *Modern Control Engineering*, Pearson Education.
3.	I. J. Nagrath and M. Gopal, *Control Systems Engineering*, New Age International Publishers.
4.	Norman S. Nise, *Control Systems Engineering*, John Wiley & Sons.
5.	M. Gopal, *Control Systems: Principles and Design*, McGraw Hill Education.
6.	Richard C. Dorf and Robert H. Bishop, *Modern Control Systems*, Pearson Education.
7.	Benjamin C. Kuo, *Automatic Control Systems*, John Wiley & Sons.

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Course Code: PCCP 3 Course: Control System Lab

Total Credits: 1
Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr
Maximum Marks: 50

Prerequisite:

1. Linear Algebra and Differential Equations
2. Basic Electrical Engineering

Learning Objectives of the Course:

1. To provide practical experience in modeling, simulating, and analyzing linear control systems.
2. To understand the time-domain and frequency-domain characteristics of first and second-order systems.
3. To learn the design and implementation of compensators and PID controllers to meet stability and performance specifications.

Coor e Outcomes (COs) : Student will be able to:

CO1 Understand mathematical modeling of physical systems using software tools (like MATLAB/Simulika or Octave). CO2 Apply exact experimental and simulation setups for performance evaluation of feedback control systems. CO3 Analyze transient response, steady-state errors, and stability using root locus, Bode, and Nyquist plots. CO4 Interpret obtained results and simulation data to reach appropriate engineering conclusions.

Topics / actual contents of the syllabus	Contact Hours
List of the Experiments	30Hrs
1. To study the time response of a first-order and second-order system using MATLAB/ Simulink.	
2. To determine the mathematical model and transfer function of an armature-controlled DC motor.	
3. To study the effect of P, PI, and PID controllers on a second-order system.	
4. To determine the steady-state error and error constants for Type 0, 1, and 2 systems.	
5. To study the synchro transmitter-receiver pair and plot its characteristics.	
6. To plot and analyze the Root Locus of a given transfer function using simulation tools.	
7. To determine the stability of a system using Bode plots and find Gain Margin and Phase Margin.	
8. To perform stability analysis of a linear system using the Nyquist stability criterion.	
9. To design and study the performance of a Lead, Lag, and Lead-Lag compensator network.	
10. To study the performance and characteristics of an AC/DC servomotor position control system.	
11. To design a state-space model for a given system and verify its controllability and observability.	
12. To study the temperature control system using a virtual lab or physical trainer kit.	
13. To analyze the effect of non-linearities (dead-zone, saturation, backlash) on system performance.	
14. To perform speed control of a DC motor using a closed-loop feedback control system.	
15. To study the working and simulation of a digital control system.	

Students should undertake at least 12 experiments during the semester from above List

Course Code: PCCT-3

Course: Microprocessor and Interfacing

Semester–V

Credits: 3 (Theory);

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Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of electronic devices, digital electronics, and microprocessor fundamentals is required.

Objectives

1. To understand the architecture and operation of microprocessors.
2. To study interfacing techniques with peripheral devices.
3. To develop programming skills using assembly language.
4. To understand applications of microprocessors in control systems.
5. To apply microprocessor concepts in industrial and automation systems.

Course Outcomes

CO1:Explain the architecture and operation of microprocessors.
CO2:Develop and execute assembly language programs.
CO3:Interface memory and peripheral devices with microprocessors.
CO4:Apply microprocessor concepts in measurement and control systems.
CO5:Analyze microprocessor based industrial applications

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	Part A **Introduction to Microprocessor**,Microprocessor System which bus organization,Microprocessor Architecture and Operation ,Memory and Input/Output devices,Memory and Input/Output operation Part B **8085 Microprocessor Architecture**,Address,Data and control Buses,Pin Functions, Demultiplexing of Buses,Generation of control signals,instruction cycle,T-state Memory Interfacing	(15 hrs)
Unit-II	Part A **Assembly Language Programming** Basics,Classification of Instruction,Addressing modes,8085 Instruction and data formats,Writing ,Assembling and Executing a programs, Debugging the Program,Decision making looping ,Stack & Subroutine ,Developing counters and time delay routines,code converters,BCD Arithmetic ,16 bit data operations Part B **Interfacing Concepts** ,ports ,Interfacing of I/O Devices such as LED ,LCD Seven segment LED, Keyboards ,Stepper motor,relay ,Interrupts in 8085 ,Interfacing of Converters (A to D & D to A),programmable Interfacing Devices like 8279 keyboard / Display Controller ,8255 PPI ,8253/8254 Timer,8259 PIT,8257 DMA Controller ,Serial I/O Concept , SID and SOD 8251 USART,Interfacing of These chips with 8085 and its programming in different modes	(15 hrs)

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Unit-III	Part A Introduction to Advanced Processors, 16 bit Intel 8086 Microprocessor ,Architecture , Addressing Modes, Memory Organization, Instruction set & Assembly language programming (5 hrs) Part B **Real time application of microprocessor**,Smart energy meter concept, Automation using microprocessor,Microprocessor in Instrumentation	

Reference Books and Text Books:	
1.	*Ramesh S. Gaonkar – Microprocessor Architecture, Programming and Applications with 8085*
2.	*A.K. Ray & K.M. Bhurchandi – Advanced Microprocessors and Peripherals*
3.	*Douglas V. Hall – Microprocessors and Interfacing*
4.	*B. Ram – Fundamentals of Microprocessors and Microcontrollers*
5.	Aditya P. Mathur – Introduction to Microprocessors
6.	*N. Senthil Kumar, M. Saravanan & S. Jeevananthan – Microprocessors and Microcontrollers*

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Course Code: PCCP 3
Course: Microprocessor and Interfacing Lab

Total Credits: 1
Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr
Maximum Marks: 50

Prerequisite:
Basic knowledge of electronic devices, digital electronics, and microprocessor fundamentals is required.

Learning Objectives of the Course:

1. To understand the architecture and operation of microprocessors.
2. To study interfacing techniques with peripheral devices.
3. To develop programming skills using assembly language.
4. To understand applications of microprocessors in control systems.
5. To apply microprocessor concepts in industrial and automation systems.

Course Outcomes (COs) :

CO1 :Explain the architecture and operation of microprocessors. CO2:Develop and execute assembly language programs.
CO3:Interface memory and peripheral devices with microprocessors. CO4:Apply microprocessor concepts in measurement and control systems. CO5:Analyze microprocessor based industrial applications

Topics / actual contents of the syllabus	Contact Hours
List of the Experiments	30Hrs
1.Study of 8085 microprocessor architecture and pin diagram.	
2.Addition of two 8-bit numbers using 8085 assembly language program.	
3.Subtraction of two 8-bit numbers using 8085.	
4.Multiplication of two 8 bit numbers using 8085 program.	
5.Division of two 8 bit numbers using 8085 program.	
6.Addition of two 16 bit numbers using 8085 programs	
7.Multiplication of two 16 bit numbers using 8085 programs	
8.Interfacing of LED With 8085 Microprocessor	
9.Interfacing of Keyboard With 8085 Microprocessor	
10 Interfacing of DAC with 8085 and generation of waveform	
11.Interfacing of ADC with 8085 for analog signal measurement	
12.Interfacing of stepper motor with 8085 microprocessor	
13To Study of microprocessor based measurement based measurement system for voltage / frequency	
14..Interfacing of Seven segment Display With 8085 Microprocessor	
15.Division of two 16 bit numbers using 8085 programs	

Students should undertake at least 12 experiments during the semester from above List

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Course Code: PECT-1
Course: Energy Conservation & Management
Semester–V
Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours: 45 Max. Marks: 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of electrical engineering, energy systems, electrical machines, and thermal utilities.

Objectives

1. To understand energy scenario, energy consumption, and environmental aspects of energy utilization.
2. To study energy auditing, its types, methodology, instruments, and role of energy managers.
3. To understand Energy Conservation Act 2001, BEE schemes, designated consumers, and ECBC code.
4. To learn energy economics, payback period, NPV, IRR, life cycle costing, and ESCO concept.
5. To study energy monitoring, targeting, data analysis, and CUSUM techniques.
6. To understand energy conservation methods in electrical and thermal utilities.

Course Outcomes

After learning the course, the students should be able to:

1. Outline energy scenario, audit and management.
2. Apply energy conservation policy, regulations in industrial practices.
3. Evaluate energy economics.
4. Identify opportunities for rational use of energy.
5. Analyze electrical systems for energy conservation.
6. Analyze the thermal systems for energy efficiency.

Module No.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	**Part A Energy Scenario:** Energy Scenario: Introduction to energy & power scenario of world, National Energy consumption data and environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing. **Part B Energy Conservation Act 2001 and related policies:** Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, ECBC code for Building Construction.	(14 hrs)
Unit-II	**Part A Financial Management:** Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept. **Part B Energy Monitoring and Targeting:** Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM).	(15 hrs)

Unit-III	**Part A Energy Conservation in Electrical Utilities:** Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting. **Part B Energy Efficiency in Thermal Utilities and systems:** Thermal systems, Boilers, Furnaces, Heat exchangers and Thermic Fluid heaters-efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories. Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets.	(15 hrs)

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Reference Books and Text Books:	
1.	Witte L.C., Schmidt P.S. and Brown D.R., "Industrial Energy Management and Utilization", Hemisphere Publ., Washington, 1988..
2.	Callaghan P.W., "Design and Management for Energy Conservation", Pergamum Press, Oxford
3.	Murphy W.R. and McKay G., "Energy Management", Butterworth's, London, 1987
4.	Bureau of Energy Efficiency, "Energy Manager Training Manual", Reference book No:1 to 4.
5.	Dale R Patrick, Stephen W Fardo, "Energy Conservation Guidebook", 2nd Edition, CRC Press.
6.	Shobh Nath Singh, "Non-Conventional Energy Resources", Pearson Education India; First edition (2015).

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Course Code: PECT 1
Course: Energy Conversion & Management Lab

TotalCredits:1
Contact Hours Practical: 02Hrs./week. **Total Contact Hours:** 30hr.
MaximumMarks:50

Prerequisite:
Basic knowledge of Thermodynamics, I.C. engines, fuels and lubricants, P-V and T-S diagrams, along with measurement and laboratory safety skills.

Learning Objectives of the Course:

1. To study properties of fuels and lubricating oils.
2. To understand working of I.C. engines.
3. To perform engine performance tests.
4. To calculate IP, BP, FP, SFC and efficiencies.
5. To prepare heat balance sheet.
6. To understand energy conservation and electricity billing.

Course Outcomes(COs): Student will be able to:

CO1: Determine properties of fuels and lubricants.
CO2: Explain working and valve timing of I.C. engines.
CO3: Conduct performance tests on petrol and diesel engines.
CO4: Calculate engine performance parameters and efficiencies.
CO5: Prepare and analyze heat balance sheet.
CO6: Explain energy conservation and electricity billing concepts.

Topics/actualcontentsofthesyllabus	Contact Hours
List of the Experiments	30Hrs
1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus.	
2. Determination of Calorific value of solid, liquid and gaseous fuels	
3. Valve Timing diagram of 4-stroke IC Engine	
4. Calculation of work done and heat transfer from PV and TS diagram using Planimeter	
5. Performance Test on Four stroke Petrol Engine and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet.	
6. Performance Test on Four stroke Diesel Engine and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet.	
7. Performance Test on Four stroke Multi-cylinder Engine and calculations of IP, BP, Thermal efficiencies, and to draw heat balance sheet.	
8. Determination of Viscosity of lubricating oil using Torsion viscometers	
9. Performance Test on variable compression ratio I.C. Engine	
10. Performance Test on two stroke petrol Engine	
11. To study PLDs.	
12. Analysis of design & Development in Engines	
13. Study of Process Optimization in Engines	
14. To Study of Energy Conservation Act 2001.	
15. To Study of Electricity Billing System.	

Students should undertake at least 12 experiments during the semester from above List

Course Code: PECT-1
Course: Digital Electronics Semester–V

Credits: 3 (Theory);

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Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Knowledge of Number Systems, Basic Electrical and Electronics, Engineering Mathematics, and Basic Semiconductor Devices.

Objectives

1. To provide students with a comprehensive understanding of number systems, codes, and binary arithmetic.
2. To make students capable of analyzing and designing logic gates and logic families.
3. To learn Boolean algebra, De Morgan's theorem, and simplification of logic functions using Karnaugh Map.
4. To introduce students to the design of combinational circuits such as adders, sub tractors, comparators, multiplexers, demultiplexers, encoders, and decoders.
5. To make students understand sequential circuits such as flip-flops, counters, registers, and state machines.
6. To introduce students to semiconductor memories and programmable logic devices such as PLA and PAL.

Course Outcomes

CO1: Apply number systems, codes, binary arithmetic, logic gates, and logic families to solve digital electronics problems.

CO2: Simplify Boolean expressions and design combinational logic circuits such as adders, sub tractors, comparators, multiplexers, demultiplexers, decoders, ADC, and DAC.

CO3: Analyze sequential circuits, semiconductor memories, and programmable logic devices such as flip-flops, counters, registers, RAM, ROM, PLA, and PAL.

Module No.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	**Part A Number System and logic Family :** Analog and Digital circuit, Binary number system, Signed binary numbers, Binary arithmetic, Decimal, Hexa decimal number system, Arithmetic operations using 1's complement,2's complem ent, BCD code, Excess-3code, Logic gates and switching functions, Basic gates: AND, OR, NOT, EX-OR, EX-NOR, NAND, NOR. Introduction of family RTL, ECL, TTL, I2L, PMOS, NMOS, CMOS, **Part B : Combinational Logic Design :** Boolean Algebra Rules,De Morgan's theorem, Boolean algebra, Representation of logic functions using Simplification of Logic functions using Karnaugh Map, Don't care conditions, Design of combination blocks: Half-adder, Full-adder, Half-subtractor, 2 bit comparator,Full subtractor, Binary to Gray and Gray to Binary.	(15 hrs)

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Unit-II	**Part A Data Processing Circuits :** Multiplexers, Demultiplexers, multiplexers/Demultiplexers Trees, BCD-to-Seven-segme nt Decoders, Comparator, Analog to digital conversion and its classifications, Digital to analog conversion ADC0808 & DAC0808 parallel adder (IC7483). **Part B Sequential Logic Circuit :** Flip-Flops: Memory cell, R-S, J-K, Race around condition, Master-slave J-K, D, T, excit ation table, flip-flop Counter: Designing of asynchronous and synchronous counters, 4 bit up/down, MOD- N counter Registers: SISO, SIPO, PISO, PIFO Shift register.	(15 hrs)
Unit-III	**Part A Synchronous and Asynchronous Sequential Circuits :** Synchronous Sequential Circuits: General Model, Classification, Design, Use of Algo rithmic State MachineSequential Circuits. Asynchronous Sequential Circuits: Design of fundamental mode and pulse mode circuits State MachineCircuits, Design of Com binational and Sequential circuits. **Part B Semiconductor Memories and PLD :** Semiconductor Memory: Memory organization and operation, Expanding memory size, classification of RAM, ROM, EPROM, SRAM, DRAM, flash memory. Programmable Logic Devices : Introduction to Program Logic Arrays (PLA), Programmable Array Logic (PAL).	(15 hrs)

Reference Books and Text Books:

1.	R. P. Jain, "Modern Digital Electronic", 3rd Edition, TMH publication, 2003.
2.	Donald P Leach, Albert Paul Malvino & GoutamSaha, "Digital Principles and Applications" 7th Edition, TMH publication, 2011.
3.	Jaydeep Chakravorty,"Digital Electronics and Logic Design", Universal Press.
4.	Stephen Brown, ZvonkoVranesic,"Fundamentals of Digital Logic Design with VHDL", 2nd Edition, Tata McGraw Hill, 2005.
5.	Charles H. Roth, Fundamentals of Logic Design, Jr., 5th Edition, Cengage Learning, 2004.
6.	M. Morris Mano: Digital Logic and Computer Design, 10th Edition, Pearson Education, 2008.
7.	Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss "Digital Systems Principles and Applications", 10th Edition, Pearson Education, 2007.

Course Code: PECT 1 Course:
Digital Electronics Lab

TotalCredits:1
Contact Hours Practical: 02Hrs./week. **Total Contact Hours:** 30hr.
MaximumMarks:50

Prerequisite:

Basic knowledge of number systems, logic gates, Boolean algebra, and digital electronics.

LearningObjectivesoftheCourse:

1. To understand and verify the operation of logic gates, logic families, and combinational circuits.
2. To design and test digital circuits such as adders, subtractors, multiplexers, demultiplexers, encoders, and decoders.
3. To study and verify flip-flops, counters, digital converters, memories, PLDs, and state diagram implementation.

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CourseOutcomes(COs): Student will be able to:

CO1: Verify the operation of basic logic gates, logic families, and combinational circuits.
CO2: Design and test adders, subtractors, multiplexers, demultiplexers, encoders, and decoders.
CO3: Design and verify flip-flops, counters, digital converters, memories, PLDs, and state diagram circuits.

	Contact Hours
List of the Experiments	**30Hrs**
1. To study and verify Logic Gates.	
2. To study and verify Combinational circuits.	
3. To study and verify Flip flops.	
4. To study and verify digital converter.	
5. To study and verify Multiplexer and Demultiplexers.	
6. To study and design MOD 10 counter.	
7. To study and verify encoder and decoders.	
8. To study and verify Logic Families.	
9. To study semiconductor memories.	
10. To perform Half adder and Full adder.	
11. To study PLDs.	
12. To design & verify operation of Asynchronous counter.	
13. To perform Half Substractor and Full substractor.	
14. To design & verify the operation of synchronous UP/DOWN decade counter using JK flip.	
15. Conversion of state diagram to the state table and implement it using logical circuit.	

Students should undertake at least 12 experiments during the semester from above List

Course Code: Honors Degree
Course: Electrical Safety
Credits: 3 (Theory)

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours: 45 Max. Marks: 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of electrical engineering, electrical quantities, wiring, earthing, and protection devices.

Objectives

1. To understand the basic concepts, terms, and principles of electrical safety.
2. To study electrical hazards, shocks, burns, and their prevention methods.
3. To learn safety practices in residential, commercial, and agricultural installations.
4. To understand safety precautions during installation, testing, commissioning, operation, and maintenance.
5. To study electrical safety requirements in hazardous areas.
6. To understand safety management, IE Rules, first aid, firefighting, and Electricity Act 2003.

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Course Outcomes

After completion of this course, students will be able to:

CO1: Explain basic terms, objectives, scope, and principles of electrical safety.
CO2: Identify electrical hazards, types of shocks, effects, and prevention methods.
CO3: Apply safety precautions in residential, commercial, and agricultural installations.
CO4: Follow safe practices during installation, testing, commissioning, operation, and maintenance.
CO5: Classify hazardous areas and select suitable electrical equipment for hazardous locations.
CO6: Describe safety management principles, IE Rules, first aid, firefighting, and Electricity Act 2003.

Module No.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	**Part A Introduction to Electrical Safety, Shocks and Their Prevention:** Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops. **Part B Electrical Safety in Residential, Commercial and Agricultural Installation:** Wiring and fitting-Domestic appliances-water tap giving shock-shock from wet wall-fan firing shock-multi-storied building -Temporary installations - Agricultural pump installation-Do's and Don'ts for safety in the use of domestic appliances.	(15 hrs)

Unit-II	**Part A Electrical Safety during Installation, Testing and Commissioning, Operation and Maintenance:** Preliminary preparations -safe sequence-risk of plant and equipment -safety documentation -field quality and safety -personal protective equipment-safety clearance notice-safety precautions-safeguards for operators-safety. **Part B Electrical Safety in Hazardous Areas:** Hazardous zones -class 0,1 and 2-spark, flashovers and corona discharge and functional requirements - Specifications of electrical plants, equipment's for hazardous locations - Classification of equipment enclosure for various hazardous gases and vapours - classification of equipment/enclosure for hazardous locations.	(15 hrs)
Unit-III	**Part A Safety Management of Electrical Systems:** Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees. **Part B Review of IE Rules and Acts, their Significance:** Objective and scope – ground clearances and section clearances - standards on electrical safety safe limits of current, voltage-Rules regarding first aid and firefighting facility. The Electricity Act, 2003.	(15 hrs)

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Reference Books and Text Books:

1.	Rao, S. and Saluja, H.L.., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2.	Pradeep Chaturvedi, "Energy management policy, planning and utilization", Concept Publishing company, New Delhi, 1997
3.	Cooper. W.F, "Electrical safety Engineering", Newnes-Butterworth Company, 1978.
4.	John Codick, "Electrical safety hand book", McGraw Hill Inc., New Delhi, 2000.
5.	Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998
6.	Wadhwa, C.L., "Electric Power Systems", New Age International, 2004.

Course Code: PECT-1

Course: Introduction to Electric Vehicles

Semester-V

Credits: 3 (Theory);

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Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours: 45 Max. Marks: 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

1. Basics of Electrical and Electronics, Engineering Chemistry, Engineering Systems.

Objectives

1. To understand the basic technologies used in E-Vehicles.
2. To understand necessary advancements in E-Vehicles.

Course Outcomes

After completion of this course, students will be able to:

1. CO1 Understand the basics related to e-vehicle.
2. CO2 Classify the different hybrid vehicles.
3. CO3 Evaluate the different driving systems for e-vehicles.
4. CO4 Analyze EV benefits and challenges.

Module No.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	Introduction to EVs & Hybrid Vehicles: What is an Electric Vehicle (EV), definition and types (BEV, HEV, PHEV, FCEV); history; social and environmental importance; key milestones; conventional vehicles basics; benefits and challenges.	(15 hrs)
Unit -II	EV Components and Technology: Electric power train overview, motor, inverter, controller, drivetrain, battery technology, battery types (Li-ion, NiMH, solid-state), charging/discharging, BMS, charging infrastructure, Level 1/2/DC fast charging, public/home charging, smart charging, V2G, regenerative braking.	(15 hrs)
Unit -II	EV Ecosystem and Future Trends: Government policies and incentives, adoption strategies, subsidies, environmental/social impact, lifecycle emissions, urban mobility, autonomous EVs, renewable integration, emerging technologies (solid-state batteries, wireless charging), career opportunities.	(15 hrs)

Reference Books and Text Books:

1. Electric Vehicle Engineering – Nick Engle & Stephen Zoepf, McGraw Hill.
2. An Introduction to Electric Vehicles – Madhava Rao K & Dr. Murali M.

3.	Electric Vehicles: And the End of ICE Age – Anupam Singh.
4.	Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Mehrdad Ehsani et al., CRC Press.
5.	Electric Vehicle Technology Explained – James Larminie & John Lowry, Wiley.
6.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles (3rd Ed.) – Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz M. Ebrahimi.

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Course Code:PECP 1

Course: Introduction to Electric Vehicles

Contact Hours Practical: 02Hrs /week. **Total Contact Hours:** 30hr.
MaximumMarks:50

Prerequisite:

Basic knowledge of Electrical & Electronics Engineering, Engineering Chemistry, and Engineering Systems.

Learning Objectives of the Course:

1. Understand the fundamental concepts, types, and evolution of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs).
2. Explain the working principles of EV powertrain components, battery technologies, and charging infrastructure.
3. Analyze the performance, environmental impact, and energy efficiency of electric mobility systems.
4. Understand recent advancements, government policies, future trends, and career opportunities in the EV industry.

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Course Outcomes (COs): Student will be able to:

CO1 Describe the basic concepts, classifications, and operating principles of Electric Vehicles and Hybrid Electric Vehicles.

CO2 Explain the functions of EV powertrain components, battery management systems, charging methods, and regenerative braking.

CO3 Evaluate different EV technologies, battery types, charging infrastructure, and driving systems for suitable applications.

CO4 Analyze the environmental, economic, and technological benefits, challenges, and future trends of electric mobility.

Practical No.	List of Experiments	
1	Study of Electric Vehicle (EV) architecture and major components	30 hours
2	Comparative study of BEV, HEV, PHEV, and FCEV	
3	Study of EV powertrain and drivetrain configuration	
4	Identification and testing of EV motors (BLDC, PMSM, Induction Motor)	

5	Study and demonstration of EV inverter and motor controller
6	Battery pack assembly and cell voltage measurement
7	Performance analysis of Lithium-ion battery during charging and discharging
8	Study of Battery Management System (BMS) and its protection features
9	Measurement of State of Charge (SOC) and State of Health (SOH) of EV battery
10	Study of EV charging methods (AC Level-1, Level-2 and DC Fast Charging)
11	Simulation of regenerative braking using MATLAB/Simulink or EV simulation software
12	Study of Vehicle-to-Grid (V2G) and smart charging concepts
13	Performance analysis of EV under different driving cycles using simulation software
14	Case study on government EV policies, charging infrastructure, and incentives
15	Mini Project: Design and simulation of a basic Electric Vehicle powertrain

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Course Code: MDMT-3

Course: EV Infrastructure and Charging

Semester–V

Credits: 2 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 2 hrs./week Total Hours :30 Max. Marks : 50	Mid Semester Exam: 20 Marks End Semester Exam: 30 Marks

Prerequisites

Knowledge Electric Vehicles and Battery Technology, charging protocols and smart charging systems, Understanding of Power Systems and Electrical Machines, Electrical Safety and Protection Systems

Objectives

1. Understand the fundamentals of Electric Vehicle (EV) infrastructure and charging systems.
2. Learn different EV charging methods, standards, and charging equipment.
3. Analyze the design and operation of EV charging stations and grid integration.
4. Understand smart charging, energy management, and renewable energy integration.
5. Study government policies, business models, and future trends in EV infrastructure.

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Course Outcomes

CO1: Explain the basics of EV infrastructure and different types of electric vehicles.

CO2: Differentiate between various EV charging methods, charging levels, and standards. CO3: Design and analyze EV charging station layouts and associated electrical systems. CO4: Evaluate smart grid integration, V2G technology, and energy management techniques.

CO5: Understand EV policies, charging economics, and emerging technologies in EV charging infrastructure.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	Part A **Introduction to Electric Vehicle Infrastructure** Basics of Electric Vehicles (EVs) , Need for EV charging infrastructure , Types of EVs: BEV, HEV, PHEV, FCEV , EV ecosystem and market overview ,EV charging standards and regulations ,Challenges in EV infrastructure development Part B **EV Charging Systems** AC and DC charging ,Slow, fast and ultra-fast charging ,Conductive and wireless charging ,Battery swapping technology ,Charging levels (Level 1, Level 2, Level 3) ,EVSE (Electric Vehicle Supply Equipment)	(10 hrs)
Unit-II	Part A **Charging Connectors and Standards** Bharat AC & DC chargers ,CCS, CHAdeMO, GB/T, Type-2 connectors ,IEC 61851 and IEC 62196 standards ,Communication protocols ,OCPP (Open Charge Point Protocol) ,Smart charging systems Part B **Charging Station Design and Infrastructure** Site selection for charging stations ,Load calculation and sizing ,Single line diagram of charging station ,Grid integration ,Transformer and protection systems ,Safety requirements and earthing	(10 hrs)

Unit-III	Part A **Smart Grid and Energy Management** Smart grid concepts ,Vehicle-to-Grid (V2G) ,Renewable energy integration with EV charging ,Energy storage systems ,Demand response and load management ,Tariff structure and billing systems Part B **Policies, Business Models and Future Trends** Government policies and FAME scheme ,Public and private charging models ,Charging station economics ,Revenue models ,Future trends in EV infrastructure, Case studies of EV charging networks	(10 hrs)

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Reference Books and Text Books:	
1.	Electric Vehicle Technology Explained by James Larminie & John Lowry.
2.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao & Ali Emadi.
3.	Electric and Hybrid Vehicles by Tom Denton.
4.	Electric Vehicle Integration into Modern Power Networks by R. Garcia-Valle & J.A. Peças Lopes.
5.	Electric Vehicle Charging Infrastructure – Reference for charging standards and infrastructure concepts.
6.	Bureau of Indian Standards and International Electrotechnical Commission standards related to EV charging systems.

Course Code: PCCP-5
Course: Electrical CAD Lab

Contact Hours Practical: 02Hrs /week. **Total Contact Hours:** 30hr.
MaximumMarks:50

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Prerequisite:

1. Basic knowledge of Electrical Engineering fundamentals.
2. Familiarity with electrical symbols, circuits, and engineering drawing.
3. Basic computer skills and understanding of CAD software. **Learning Objectives of the Course:**

Learning Objectives of the Course

1. To develop the ability to create professional electrical drawings using CAD software.
2. To understand electrical symbols, wiring standards, and drafting practices.
3. To design and modify electrical schematics, layouts, and panel drawings.
4. To prepare industry-standard electrical documentation for installation and manufacturing.

Course Outcomes (COs): Student will be able to:

CO1 Draw and edit electrical circuit schematics using Electrical CAD software.
CO2 Develop electrical wiring diagrams, control circuits, and panel layouts following standards.
CO3 Prepare cable schedules, terminal plans, and bill of materials (BOM) using CAD tools.
CO4 Design completes electrical systems with proper documentation suitable for industrial applications.

Exp. No.	Experiment Title	Hours
1	Study of Electrical CAD software interface, drawing tools, layers, templates, and project settings.	30
2	Drawing of standard electrical symbols as per IEC/IS standards.	
3	Preparation of single-line diagram (SLD) of a residential electrical distribution system.	
4	Design of lighting layout and power outlet wiring for a residential building.	
5	Preparation of wiring diagram for staircase and corridor lighting circuits.	
6	Design of motor control circuit using Direct-On-Line (DOL) starter.	
7	Preparation of Forward-Reverse motor control circuit using CAD software.	
8	Design of Star-Delta starter control and power circuit.	
9	Preparation of electrical panel layout with component placement.	
10	Development of cable routing, cable schedule, and terminal numbering.	
11	Preparation of Bill of Materials (BOM) and component list for an electrical control panel.	
12	Design of earthing layout and lightning protection system for an industrial installation.	
13	Preparation of electrical layout for a commercial building including lighting and power distribution.	
14	Design of PLC input-output wiring diagram and control panel using Electrical CAD software.	
15	Mini Project: Design and documentation of a complete electrical installation (SLD, wiring diagram, panel layout, cable schedule, terminal plan, and BOM).	

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SEM-VI

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Course Code: PCCT-1
Course: Power System Protection
Semester–VI
Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Knowledge of Power System Analysis, symmetrical and unsymmetrical fault calculations, basics of electrical machines, switchgear components, and matrix algebra.

Objectives

1. To provide students with a comprehensive understanding of the principles, zones, and components of power system protection.
2. To make the students capable of modeling and analyzing the behavior of instrument transformers (CTs and PTs) under fault conditions.
3. To learn about the operation, construction, and characteristics of overcurrent, directional, distance, and differential relays.
4. To make the students learn how to design and configure protection schemes for specific power system components like alternators, transformers, and transmission lines.
5. To introduce students to the concepts of numerical, microprocessor-based, and digital relaying techniques.
6. To develop computational and analytical skills in students to evaluate wide-area protection, busbar protection, and system restoration strategies.

Course Outcomes

CO1: Apply mathematical and analytical techniques to calculate fault currents and determine appropriate protection zones for power system networks.
CO2: Analyze the performance, errors, and selection criteria of Current Transformers (CTs) and Potential Transformers (PTs) used in protection circuits.
CO3: Evaluate the operating characteristics and settings of overcurrent, directional, and distance relays for optimal system selectivity.
CO4: Analyze differential protection schemes and stability criteria for power transformers, alternators, and busbars.
CO5: Design coordinated relaying schemes (including primary and backup protection) to satisfy specified power system reliability criteria.
CO6: Formulate algorithms for digital/numerical relaying, evaluate signal processing techniques, and analyze wide-area monitoring protection setups.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours

Unit-I	Part A **Introduction to Protective Relaying & Instrument Transformers:** Principles of power system protection, zones of protection, primary and backup protection. Desirable qualities of protective relaying (speed, sensitivity, selectivity, reliability. Part B **Overcurrent and Earth Fault Protection:** Relay terminology (pickup, reset, plug setting multiplier PSM, time dial setting TDS). Electromagnetic and static relays. Overcurrent relay characteristics (definite time, inverse time, IDMT). Directional overcurrent relays. Earth fault protection.	(15 hrs)
Unit-II	Part A **Distance Protection:** Drawbacks of overcurrent protection on long transmission lines. Principles of distance relaying: Impedance relay, Reactance relay, and Mho relay. Characteristics on the R-X diagram. Three-zone protection of transmission lines. Part B **Differential Protection & Apparatus Protection:** Simple differential protection, percentage biased differential protection, and circulating current principles. **Transformer Protection:** Magnetizing inrush current, Buchholz relay, and percentage differential protection for star-delta transformers	(15 hrs)
Unit-III	Part A **Busbar Protection & Circuit Breakers:**Busbar protection schemes: Frame leakage, high impedance, and differential protection. Arc interruption theories (Slepian's and Energy balance theories). Circuit Breaker types and operation: SF6, Vacuum, Air Blast, and Oil circuit breakers. Concepts of Restriking Voltage, Recovery Voltage, RRRV, and current chopping. Part B **Numerical Relaying & Modern Trends:** Block diagram of a numerical relay. Sampling theorem, anti-aliasing filters, and Analog-to-Digital Conversion (ADC). Basic algorithms for digital relaying (Mann-Morrison and Fourier techniques).	(15 hrs)

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Reference Books and Text Books:

1. Badri Ram and D. N. Vishwakarma, *Power System Protection and Switchgear*, McGraw Hill Education.
2. Y. G. Paithankar and S. R. Bhide, *Fundamentals of Power System Protection*, PHI Learning.
3. B. Ram, *Power System Protection and Switchgear*, New Age International Publishers.
4. C. Christopoulos and A. Wright, *Electrical Power System Protection*, Springer.
5. Stanley H. Horowitz and Arun G. Phadke, *Power System Relaying*, John Wiley & Sons.
6. Sunil S. Rao, *Switchgear Protection and Power Systems*, Khanna Publishers.

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Course Code: PCCP 1 **Course:**

Power System Protection lab

SEM -VI

Total Credits: 1
Contact Hours Practical: 02 Hrs./week. **Total Contact Hours:** 30 hr
Maximum Marks: 50

Prerequisite:

1. Power System Analysis (Fault Calculations)
2. Basic Electrical Engineering

Learning Objectives of the Course:

1. To provide practical, hands-on experience in testing, configuring, and analyzing protective relays and power system components.
2. To understand the operational characteristics, timing boundaries, and directional features of overcurrent and distance relays.
3. To learn the design, implementation, and simulation of differential and numerical protection schemes to ensure power system stability and reliability.

Coor e Outcomes (COs) :
Student will be able to:

CO1: Understand the fundamental operating principles and hardware/software modeling of various protective relays and instrument transformers.
CO2: Apply exact experimental setups and secondary injection simulation tools to evaluate the performance of protection schemes.
CO3: Analyze relay operating time, pickup characteristics, and stability boundaries under distinct fault zones and network topologies.
CO4: Interpret obtained experimental results and simulation data to reach appropriate engineering conclusions regarding system protection coordination.

Topics / actual contents of the syllabus	Contact Hours
List of the Experiments	**30Hrs**
1. To plot the Magnetization (Excitation) Characteristic of a given Current Transformer (CT) and determine its Knee Point Voltage ($K_VS).	
2. To study the effect of CT burden on ratio and phase angle errors of a protection-class current transformer.	
3. To determine the operating characteristics of an Electromagnetic Induction-type Inverse Definite Minimum Time (IDMT) Overcurrent Relay.	
4. To study and verify the directional features of a Directional Overcurrent Relay under varying phase angles.	
5. To perform time and current grading coordination for two overcurrent relays in a simulated radial distribution network.	
6. To analyze the operating characteristics of an Impedance/Mho distance relay on a transmission line simulator network.	
7. To study the effect of power swings and fault resistance on the zones of a distance protection scheme.	

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8. To perform percentage biased differential protection on a three-phase po its stability under external fault conditions. transformer and observe	
9. To observe the phenomenon of magnetizing inrush current in a transformer and study the working of	
harmonic restraint in differential relays.	
10. To study the protection of a three-phase Alternator against stator earth faults and unbalanced loading conditions.	
11. To simulate and evaluate a High-Impedance Busbar Differential Protection scheme using a hardware trai software environment.	
12. To study the arc-extinction phenomenon and measure the Restriking Voltage and RRRV across a model circuit breaker panel.	
13. To configure and test a Multi-Function Numerical Relay for overvoltage, undervoltage, and overcurrent protections using secondary injection test kits.	
14. To develop and run a MATLAB/Simulink (or PSCAD) simulation for calculating symmetrical and unsymmetrical fault currents on a 3-bus or 5-bus system.	
15. To simulate a digital filtering algorithm (e.g., Discrete Fourier Transform) for extracting fundamental fa components from a corrupted voltage/current waveform.	
Students should undertake at least 12 experiments during the semester from above List	

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Course Code: PCCT-2 Course:
Power Electronics Semester–VI
Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Knowledge of: Electrical Circuits and Network Theory ,Electronic Devices and Circuits ,Signals and Systems ,Basic Electrical Machines ,Engineering Mathematics

Objectives

1. Understand the construction, characteristics, switching behavior, and applications of modern power semiconductor devices.
2. Analyze the operation and performance of various power electronic converters including AC-DC, DC-DC, DC-AC, and AC-AC converters.
3. Study PWM techniques, inverter configurations, resonant converters, and switched mode power supplies used in industrial applications.
4. Develop the ability to interpret converter waveforms, control strategies, and performance parameters for different types of loads.
5. Introduce modern power electronic applications in motor drives, renewable energy systems, UPS, and industrial power supplies.

Course Outcomes

CO1: After completion of the course, students will be able to:
CO2: Understand characteristics and applications of power semiconductor devices.
CO3: Analyze operation of controlled rectifiers and chopper circuits.
CO4: Design and evaluate inverter and PWM converter systems.
CO5: Explain resonant converters and modern power supply techniques.
CO6:Analyze AC-AC converters and industrial power electronic applications.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	Part A **Power Semiconductor Devices and Characteristics** Structure, characteristics, switching behavior, triggering requirements, ratings, protection, and applications of: , CR ,TRIAC ,DIAC ,GTO ,Power BJT ,Power MOSFET ,IGBT ,MCT ,Comparison of power semiconductor devices and selection criteria for industrial applications Part B **DC Converters (Controlled Rectifiers)** Single-phase and three-phase controlled rectifiers ,Half-wave semi-converter, and full-converter circuits ,Quadrant operation and converter modes ,Performance parameters ,Input-output waveforms for R, RL, and RLE loads ,Dual converters and circulating/non-circulating current modes ,PWM rectifiers and twelve-pulse converters	(15 hrs)

Unit-II	Part A **DC-DC Converters (Choppers)** Step-up and step-down chopper configurations ,Buck, Boost, and Buck-Boost converters ,CLC and TRC techniques ,PWM and FM control techniques ,Continuous and discontinuous conduction modes ,Practical transistorized chopper circuits ,Performance analysis and applications Part B **DC-AC Converters and Inverters**	(15 hrs)
	Single-phase and three-phase bridge inverters ,PWM techniques: Single PWM, Multiple PWM, and Sinusoidal PWM ,Voltage Source Inverter (VSI) and Current Source Inverter (CSI) ,Multilevel inverters: diode-clamped, flying capacitor, and cascaded H-bridge ,Principle of operation, performance parameters, and applications ,Comparison of inverter topologies	
Unit-III	Part A **Resonant and PWM Converters** Series and parallel resonant converters ,ZCS and ZVS resonant converters ,Class-E resonant inverter (basic concept) ,PWM converters and switched mode power supplies (SMPS) ,Switched mode rectifiers ,UPS and industrial applications Part B **AC-AC Converters and Power Supplies** AC voltage controllers: single-phase and three-phase ,Cycloconverters ,Matrix converters (introductory concepts) ,Frequency conversion techniques ,Flyback, Forward, Push-Pull, Half-Bridge, and Full-Bridge DC power supplies ,Control circuits and applications	(15 hrs)

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Reference Books and Text Books:

1.	Power Electronics: Circuits, Devices and Applications -Muhammad H. Rashid, Pearson Education.
2.	Power Electronics: Converters, Applications and Design -Wiley India / John Wiley & Sons.
3.	Power Electronics - Tata McGraw-Hill (TMH).
4.	Modern Power Electronics and AC Drives - Prentice Hall / Pearson Education.
5.	Fundamentals of Power Electronics - Springer

Course Code: PCCT -2

Course: Power Electronics Lab

TotalCredits:1 **ContactHoursPractical:**02Hrs./week

TotalContactHours:30hr **MaximumMarks:**50

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Prerequisite:

Students should have basic understanding of: Electrical Circuit Analysis , ,Semiconductor Devices and Switching Circuits ,Fundamentals of Power Electronics Theory ,Safety precautions while handling electrical and electronic equipment.

Learning Objectives of the Course:

1. Provide hands-on experience with power electronic devices and converter circuits.
2. Understand triggering, switching, and control techniques used in power electronics.
3. Analyze input-output waveforms and performance characteristics of converters.
4. Develop practical skills in simulation, testing, and troubleshooting of power electronic systems.
5. Familiarize students with industrial applications of converters and inverters.

Coore Outcomes(COs):

CO1: Test and analyze characteristics of power semiconductor devices.
CO2: Implement and evaluate converter and inverter circuits.
CO3: Interpret converter waveforms and switching performance.
CO4: Use simulation tools for power electronic system analysis.
CO5: Develop practical understanding of industrial power electronic applications.

Topics / actual contents of the syllabus	Contact Hours
List of the Experiments	30Hrs
1. Study of characteristics of SCR, TRIAC, MOSFET / IGBT.	
2. SCR triggering circuits using R, RC, and UJT triggering methods.	
3. Study of protection circuits for power semiconductor devices.	
4. Single-phase half-wave controlled rectifier with R and RL loads.	
5. Single-phase fully controlled bridge rectifier.	
6. Study of three-phase controlled rectifier using simulation software.	
7. Study of step-down (Buck) converter.	
8. Study of step-up (Boost) converter.	
9. PWM control of DC chopper circuits.	
10. Single-phase bridge inverter using MOSFET/IGBT.	
11. PWM inverter and waveform analysis.	
12. Simulation of three-phase inverter circuits.	
13. AC voltage controller using TRIAC.	
14. Study of Fly back and Forward converters.	
15. Demonstration of UPS and SMPS circuits.	

Students should undertake at least 12 Experiments during the Semester from above List

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Course Code: PCCT-3
Course: Microcontroller and Application
Semester–VI
Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of digital electronics, programming concepts, and electronic circuits.

Objectives

1. To understand the architecture and operation of microprocessors and microcontrollers.
2. To study the architecture, memory organization, and instruction set of 8051 microcontroller.
3. To develop assembly language programs using 8051 instruction set.
4. To understand timer, counter, serial communication, and interrupt programming in 8051.
5. To learn interfacing techniques of external devices such as ADC, DAC, sensors, motors, and displays with 8051 microcontroller.

Course Outcomes

CO1:Explain the architecture and working of 8086 microprocessor and 8051 microcontroller.
CO2:Develop assembly language programs using different instruction sets of 8051.
CO3:Implement timer, counter, and serial communication programming in 8051.
CO4:Apply interrupt handling techniques in microcontroller-based systems.
CO5:Interface external devices like ADC, DAC, sensors, motors, and displays with 8051 microcontroller applications.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	Introduction to Microcontrollers, Architecture of 8051, Comparison of Microprocessor and Microcontroller,Block dig of Microcontroller,Function of Each Block,Pin Details of 8051,ROM,RAM Memory Organization,Special Function Register ,Program Counter,Psw Register,Stack,I/O Ports,Timer,Interrupt, serial port and Clock Overview of 8051 family	(15 hrs)
Unit-II	Part A Instruction Set of 8051 ,Classification of 8051 Instruction - Data Transfer Instruction,Arithmetic Instruction,Logical Instruction ,Branching Instruction ,Assembly Language Programming Part B I/O Bit Address for I/O and Ram- I/O Programming - I/O bit manipulation Programming 8051 Timers: Timer 0 and Timer 1 Register (TH0,TLO,TH1,TL1) Different Modes of Timer: Mode 0 Programming, Mode 1 programming, Mode 2 Programming, Mode 3 Programming. Different modes of Counter: Mode 0 programming, Mode 1 Programming, Mode 2 Programming, Mode 3 Programming (Simple program)	(15 hrs)
Unit-III	Part A Interfacing external memory 8051, 8051 interfacing with 8255, Programming of relays,sensor,Interfacing ADC Interfacing DAC - Keyboard Interfacing,LCD Interfacing Stepper motor Interfacing	(15 hrs)

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	Part B Introduction to Auduino, specifications, Interfacing and applications	

	Reference Books and Text Books:
1.	*The 8051 Microcontroller and Embedded Systems Best book for 8051 programming and interfacing*
2.	*R. S. Gaonkar Microprocessor Architecture, Programming and Applications with 8085 Useful for microprocessor fundamentals*
3.	*Douglas V. Hall Microprocessors and Interfacing*
4.	*Kenneth J. Ayala The 8051 Microcontroller*
5.	*A. K. Ray & K. M. Bhurchandi Advanced Microprocessors and Peripherals*
6.	*Muhammad Ali Mazidi PIC Microcontroller and Embedded Systems*

Course Code: PCCP 3
Course: Microcontroller & Application Lab

Total Credits: 1
Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr
Maximum Marks: 50

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Prerequisite:
Basic knowledge of digital electronics, programming concepts, and electronic circuits.

Learning Objectives of the Course:
1.To understand the architecture and working of 8051 microcontroller.
2.To develop assembly language programming skills for 8051.
3.To study interfacing techniques of memory and peripheral devices.
4.To understand timer, counter, serial communication and interrupt concepts.
5.To apply microcontroller concepts in embedded system applications.
6.To develop practical knowledge of motor interfacing and control systems

Course Outcome:
CO1:Explain the architecture and operation of 8051 microcontroller. CO2:Develop and execute assembly language programs using 8051. CO3:Interface memory, ADC, DAC, LCD and other peripheral devices with 8051. CO4:Apply timer, counter, UART and interrupt programming techniques.
CO5:Design embedded applications using 8051 microcontroller. CO6:Analyze motor interfacing and real time control applications using 8051.

Topics / actual contents of the syllabus	Contact Hours
List of the Experiments	**30Hrs**
1.Study of 8051 Microcontroller architecture and pin diagram.	
2.Addition of two 8-bit numbers using 8051 assembly language program.	
3.Subtraction of two 8-bit numbers using 8051	
4.Multiplication of two numbers using 8051 program.	
5.Division of two numbers using 8051 program.	
6.Addition of two 16 bit number using 8051 program	
7.Use of Timer to genre-at delay	
8.Interfacing of stepper motor with 8051 microcontroller	
9.Interface ADC 08051 /0809 & Write a program to generate Sine wave	
11.Interface LCD Display & Write a Program to display message	
12. To study interfacing of memory with 8051 microcontroller	
13. To study LED Blinking using Arduino	
14.To study Stepper motor interfacing using Arduino	
15.To study Buzzer Alarm using IR Sensorusing Arduino	

Students should undertake at least 12 experiments during the semester from above List

Course Code: PECT-2
Course: Conventional Energy Sources
Semester–VI
Credits: 3 (Theory);

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Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks: 100	CIA: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Prerequisites: Basic Electrical Engineering, Thermodynamics, Power Generation Fundamentals, Electrical Machines, Energy Conversion Principles

Objectives

1. To understand conventional energy resources and power generation methods.
2. To study thermal, hydro and nuclear power plants and their operation.
3. To understand energy conversion, transmission and environmental impacts of conventional energy systems.
4. To analyze economic and operational aspects of conventional power generation systems.

Course Outcomes

CO1 Understand conventional energy resources and power generation methods CO2 Explain operation of thermal, hydro and nuclear power plants

CO3 Analyze economic and environmental aspects of power generation

CO4 Understand modern trends in energy systems and power management

Module No.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	**Part A: Energy Resources and Power Generation** Introduction to Energy Sources, Classification of Energy Sources, Conventional and Non-Conventional Energy Sources, Energy Scenario in India, Principles of Power Generation, Load Curve and Load Duration Curve, Base Load and Peak Load Plants **Part B: Thermal Power Plant** Layout of Thermal Power Plant, Coal Handling System, Boiler and Turbine Basics, Condenser and Cooling Tower, Ash Handling System, Advantages and Limitations of Thermal Power Plant, Environmental Impact of Thermal Power Plants	(15 hrs)

Unit-II	**Part A: Hydro Power Plant** Introduction to Hydro Power Plant, Classification of Hydro Power Plants, Layout and Components of Hydro Power Plant, Hydraulic Turbines, Pumped Storage Plants, Advantages and Disadvantages of Hydro Power Plants **Part B: Nuclear Power Plant**	(15 hrs)
	Introduction to Nuclear Energy, Nuclear Fission and Fusion, Layout of Nuclear Power Plant, Nuclear Reactors, Safety Measures in Nuclear Power Plants, Advantages and Limitations of Nuclear Power Plants, Environmental Impact of Nuclear Energy	
Unit-III	**Part A: Environmental Impact and Pollution Control** Environmental Effects of Conventional Energy Systems, Air Pollution, Thermal Pollution, Pollution Control Methods, Emission Standards, Carbon Emission Reduction Techniques **Part B: Modern Trends in Energy Systems** Smart Energy Management, Energy Storage Systems, Distributed Energy Systems, Hybrid Energy Systems, Introduction to Renewable Energy Integration, Future Trends in Energy Systems	(15 hrs)

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Reference Books and Text Books:	
1	*Power Plant Technology, M. M. El-Wakil, McGraw Hill.*
2	*Modern Power Station Practice, British Electricity International, Pergamon Press.*
3	*Electrical Power Generation, Ashfaq Hussain, CBS Publishers.*
4	*Energy Technology, S. Rao and B. B. Parulekar, Khanna Publishers.*
5	*Power Plant Engineering, P. K. Nag, McGraw Hill Education.*
6	*A Course in Power Plant Engineering, Arora and Domkundwar, Dhanpat Rai Publications.*
7	*Power Generation, Operation and Control, Allen J. Wood and Bruce F. Wollenberg, Wiley India*

Course Code: PECP-2

Course: CONVENTIONAL ENERGY SOURCES

Semester–VI

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Total Credits: 1
Contact Hours Practical: 02 Hrs./week **Total Contact Hours:** 30hr
Maximum Marks: 50

Prerequisite:

Prerequisites: Basic Electrical Engineering, Thermodynamics, Power Generation Fundamentals, Electrical Machines, Energy Conversion Principles

Learning Objectives of the Course:

3. Understand the concepts and importance of conventional energy resources and energy systems.
4. Analyze industrial energy utilization, energy conservation and energy management techniques.
5. Explain operation and performance of industrial boilers, furnaces, drives and cogeneration systems.
6. Identify environmental impacts of conventional energy systems and pollution control methods.

Course Outcomes (COs):

CO1 Understand conventional energy resources and industrial energy systems.
CO2 Explain energy management, energy conservation and energy audit techniques.
CO3 Analyze operation and performance of boilers, furnaces, industrial drives and cogeneration systems.
CO4 Describe environmental impacts, pollution control methods and modern trends in energy systems.
CO5 Understand hybrid energy systems, energy storage systems and future energy technologies.

Topics / actual contents of the syllabus	Contact Hours
List of the Experiments	
1. Study of Layout of Thermal Power Plant.	
2. Study of Boiler and Turbine Components.	
3. Study of Coal and Ash Handling Systems.	
4. Study of Cooling Tower and Condenser Systems.	
5. Study of Layout and Components of Hydro Power Plant.	
6. Study of Hydraulic Turbines used in Hydro Power Plants.	
7. Study of Nuclear Power Plant Components and Reactor Types.	
8. Study of Load Curve and Load Duration Curve.	
9. Study of Tariff and Electricity Billing Methods.	**30Hrs**
10. Study of Economic Operation of Power Plants.	
11. Study of Energy Conservation Techniques in Power Systems.	
12. Study of Environmental Pollution and Control Methods in Power	
13. Study of Smart Grid and Distributed Generation Systems.	
14. Study of Hybrid Energy Systems and Energy Storage Systems.	

15. Study of Renewable Energy Integration in Conventional Power S
Students should undertake at least 12 experiments during the semester from above List

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Course Code: PCCT-1

Course: Analog and Integrated Circuits

Semester–VI

Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of analog electronics, semiconductor devices, and electronic circuit fundamentals.

Objectives

1. To understand the fundamentals and characteristics of operational amplifiers.
2. To study linear and non-linear applications of Op-Amp circuits.
3. To analyze waveform generators, oscillators, and active filters.
4. To understand the working and applications of PLL and voltage regulators.
5. To develop the ability to design and analyze analog electronic circuits

Course Outcomes

CO1: Understand Op-Amp characteristics, parameters, and technologies.

CO2: Design and analyze linear and non-linear Op-Amp applications.

CO3: Analyze waveform generators, oscillators, and active filter circuits.

CO4: Explain the operation and applications of PLL systems and related ICS

CO5: Understand and design voltage regulator circuits using linear and switching regulators.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours

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Unit-I	Part A Operational Amplifier Introduction, Block Diagram of OP-Amp (IC-741),Specification,packing, Characteristics, AC and DC parameters and their measurements. Ideal and practical op-amp characteristics comparison, concept of virtual & short ground, Op-amp technologies comparison. Part B OP-Amp Linear and Non Linear Applications Inverting and Non Inverting amplifiers, Voltage follower, Summing amplifier, Differential amplifier, Instrumentation amplifier (using 3 Op-Amps) and its application,Voltage to current & Current to voltage converters.	(15 hrs)
Unit-II	Part A Wave Generator, Square Wave, Triangular wave, Peak detector, Zero crossing detector. Function generator using IC 8038. Multivibrators using timer IC-555 Part B Active Filter Design: Introduction, comparison between active and passive network design, transfer function, first order low pass active filter,Standard second order low pass and high pass butter worth filters, KRC Filters, Multiple feedback filter performances consideration , switched capacitor filter.	(15 hrs)
Unit-III	Part A Phase Lock loop: Basic phase lock loop principle, transient response of PLL, Liner model of PLL, Major Blocks PLL, Analog and digital phase detector, VCO, Application of PLL, Monolithic PLL,IC LM 565 and CD4046 CMOS PLL Part B Voltage Regulators: Introduction, Basics of voltage regulator, Linear Voltage regulator using OP-amp, Single polarity liner voltage regulator, IC Voltageregulator-IC 723	(15 hrs)

	Reference Books and Text Books:
	Design with Operational Amplifiers and Analog Integrated Circuits – McGowan Hill Education
	Op-Amps and Linear Integrated Circuits – Cengage Learning.
	Microelectronic Circuits – Oxford University Press
	Pulse, Digital and Switching Waveform s – McGowan Hill Education.
	Linear Integrated Circuits – New Age International Publications.
	Operational Amplifiers and Linear Integrated Circuits – PHI Learning.
	Electronic Devices and Circuit Theory – Pearson Education.

Course Code: PECT-I
Course: Analog And Integrated Circuits

Total Credits: 1
Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr
Maximum Marks: 50

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Prerequisite:
Basic knowledge of operational amplifiers, electronic components, analog circuits, and measuring instruments.

Learning Objectives of the Course:

1. To understand the fundamentals and characteristics of operational amplifiers and linear integrated circuits.
2. To design and analyze Op-Amp based linear and non-linear applications.
3. To study waveform generators, oscillators, and active filter circuits.
4. To understand the operation and applications of PLL and timer ICs
5. To Develop practical skills in designing testing, and troubleshooting analog electronic circuits.

Course Outcome:

CO1: Understand the characteristics and parameters of Op-Amp and linear ICs. **CO2:**

Design and analyze Op-Amp based linear and non-linear circuits. **CO3:** Develop and

test waveform generator and active filter circuits.

CO4: Explain the operation and applications of PLL and timer ICs.

CO5: Design and analyze linear and switching voltage regulator circuits.

Topics / actual contents of the syllabus	Contat Hours
List of the Experiments	30Hrs
1.Study of IC 741 Operational Amplifier characteristics.	
2.OP-amp parameters measurements	
3.Design of Integrator and Differentiator circuits.	
4. V to I & I to V Converter using op-Amp	
5. To study Instrumentation amplifier using 3 op-amp	
6.Op-amp application: Comparator / Sch mitt trigger	
7.Design of Triangular / Saw-Tooth Wave Generator circuits.	
8. Study of IC 555 Timer in A stable and Mono-stable mode	
9. Study of Peak detector / Zero crossing detector	
11. Design of First Order Active Low Pass Filter	
13. Design of Second Order Butter worth High Pass Filter	
13.Study of Linear Voltage Regulator using IC 723.	
14.. To study the operation of IC -565 as PLL	
15.Design of Voltage Follower / Summing Amplifier using Op-Amp.	

Students should undertake at least 12 experiments during the semester from above List

Course Code: PECT-2

Course: Non Conventional Energy Sources And Applications

Semester–VI

Credits: 3 (Theory);

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Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of Engineering Physics, Engineering Chemistry, Electrical Circuits, Thermodynamics, Electrical Machines, and fundamentals of conventional power generation systems.

Objectives

1. To understand the concepts of conventional and non-conventional energy sources.
2. To study the principles and applications of solar energy systems and photovoltaic technology.
3. To understand the operation and performance characteristics of wind energy conversion systems.
4. To study biomass energy conversion techniques and biogas generation systems.
5. To understand the principles and applications of emerging energy technologies such as fuel cells, MHD, geothermal, hydrogen, and OTEC systems.
6. To analyze the applications and integration of renewable energy systems for sustainable power generation.

Course Outcomes

CO1: Explain the concepts of conventional and non-conventional energy sources and their applications.

CO2: Analyze the operation and performance characteristics of solar energy systems and photovoltaic technologies.

CO3: Understand the principles and working of wind energy conversion systems.

CO4: Evaluate biomass energy conversion techniques and biogas generation systems.

CO5: Explain the operation and applications of emerging energy technologies such as fuel cells, MHD, geothermal, hydrogen, and OTEC systems.

CO6: Analyze renewable energy integration and applications for sustainable power generation systems.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours

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Unit-I	**A) Energy Sources & Availability** Conventional and non-conventional energy sources, renewable and non-renewable energy sources, prospects and perspectives of development of non-conventional energy sources in India, introduction to solar energy, wind energy, biomass energy, OTEC geothermal energy, hydrogen energy, fuel cells, MHD generation, thermionic convertor thermo-electric power, case study of any one non-conventional energy system. **B) Solar Energy (08 Hrs.)** Solar radiation, measurement and prediction of solar radiation, flat plate collectors of liquid and air type, theory of flat plate collectors, advanced collectors, optical design of concentrators, selective coatings, solar water heating, solar dryers, solar stills, solar cooling and refrigeration, thermal storage,	(15 hrs)
	conversion of heat into mechanical energy, active and passive heating of buildings, solar cells, PV cell characteristics, MPPT system, rooftop PV installation case study.	
Unit-II	**A) Wind Energy** Wind energy potential measurement, general theories of wind machines, laws and concepts of aerodynamics, aerofoil design, wind mill and wind electric generator description and performance of horizontal-axis wind machines, description and performance of vertical-axis wind machines, electricity generation using wind machines, wind energy case studies. **B) Biomass Energy** Introduction to biomass, biofuels and their heat content, biomass conversion technologies, aerobic and anaerobic digesters, factors affecting biogas generation biogas plants and their types, utilization of biogas, gasifiers, direct thermal applications of gasifiers, advantages and problems in development of gasifiers, use of gasifiers in I.C. engines.	(15 hrs)
Unit-III	**A) Other Energy Sources** Geothermal energy, geothermal sources and systems, fuel cells, principles and classification of fuel cells, conversion efficiency and polarization, MHD power generation, open and closed cycle MHD systems, thermonuclear fusion energy, OTEC hydrogen energy, thermionic generation, tidal wave energy. **B) Applications & Case Studies** Applications of renewable energy systems, distributed generation concepts, hybrid renewable energy systems, rooftop solar applications, renewable energy integration, industrial and domestic applications of renewable energy systems, practical case studies of renewable energy installations.	(15 hrs)

Reference Books and Text Books:

1. *Rai G. D., Non-Conventional Sources of Energy, Khanna Publishers, 4th Edition, 2007.*
2. *B. H. Khan, Non-Conventional Energy Resources, Tata McGraw Hill, 2nd Edition.*
3. *D. Mukherjee, S. Chakrabarti, Fundamentals of Renewable Energy Systems, New Age International Publishers, 2005.*
4. *S. P. Sukhatme, J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill Education.*
5. *John Twidell, Tony Weir, Renewable Energy Resources, Taylor & Francis Publications.*
6. *G. N. Tiwari, Renewable Energy Resources: Basic Principles and Applications, Narosa Publishing House. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press.*

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Course Code: PECT-2

Course: Non Conventional Energy Sources And Applications Lab

Total Credits: 1
Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr
Maximum Marks: 50

Prerequisite:

1. Basic knowledge of Electrical Engineering and Energy Conversion Systems.
2. Fundamentals of Thermodynamics, Electrical Circuits, and Power Generation concepts.

Learning Objectives of the Course:

1. To understand conventional and non-conventional energy sources and their applications.
2. To study solar, wind, biomass, and other renewable energy conversion systems.
3. To analyze renewable energy technologies, hybrid systems, and their practical applications in modern power systems.

Coare Outcomes (COs) : Student will be

Able to:

1. CO1: Explain conventional and non-conventional energy sources and their significance in modern energy systems.
2. CO2: Analyze the working principles and performance of solar energy systems and photovoltaic technologies.
3. CO3: Describe wind energy and biomass energy conversion systems and their practical applications.
4. CO4: Explain other renewable energy systems, hybrid energy systems, and applications of renewable energy technologies.

Topics *I* actual contents of the syllabus	Contact Hours

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List of the Experiments 1. Simulation of single area and multi area LFC using MATLAB/ Study of conventional and non-conventional energy sources. 2. Study of solar radiation measurement instruments and solar radiation data analysis. 3. Performance analysis of flat plate solar collector. 4. Study of solar water heating system and solar dryer. 5. Study of solar photovoltaic cell characteristics and MPPT system. 6. Case study of rooftop solar PV installation. 7. Study of wind energy conversion systems and aerofoil models. 8. Performance analysis of horizontal-axis and vertical-axis wind turbines. 9. Measurement and analysis of wind energy potential data. 10. Study of biomass conversion technologies and biofuels. 11. Study of biogas plant construction and operation. 12. Study of biomass gasifier and its applications in I.C. engines. 13. Study of fuel cells, hydrogen energy systems, and geothermal energy systems. 14. Study of MHD power generation, OTEC, thermionic and tidal energy systems. 15. Case study and presentation on hybrid renewable energy systems and distributed generation	**30Hrs**
Students should undertake at least 12 Experiments during the semester from above List	

Course Code: PECT-2
Course: Embedded Systems
Semester–VI

Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

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Prerequisites

Basic knowledge of Digital Electronics, Microprocessors and Microcontrollers, Computer Organization, Programming in C language, and fundamentals of Communication Systems.

Objectives

1. To understand the fundamentals and design concepts of Embedded Systems.
2. To study ARM architecture and on-chip peripherals of embedded controllers.
3. To learn interfacing techniques and embedded C programming.
4. To understand embedded communication protocols such as SPI, I2C, CAN and GSM.
5. To study the concepts and implementation of Real Time Operating Systems (RTOS).

Course Outcomes

CO1: Understand the fundamentals, design concepts and applications of Embedded Systems.
CO2: Analyze ARM architecture and on-chip peripherals of embedded controllers.
CO3: Develop embedded C programs and implement interfacing techniques for various devices.
CO4: Apply embedded communication protocols such as SPI, I2C, CAN and GSM in real time applications.
CO5: Understand and implement RTOS concepts including task scheduling, synchronization and inter-task communication.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	**a) Embedded System Fundamentals:** Introduction to Embedded System, History, Design challenges, optimizing design metrics, time to market, applications of embedded systems and recent trends in embedded systems. **b) Embedded Design Concepts:** Embedded design concepts and definitions, memory management, hardware and software design and testing, communication protocols like SPI, I2C, CAN etc.	(15 hrs)
Unit-II	**a) ARM Architecture:** Introduction to ARM core architecture, ARM extension family, instruction set, Thumb instruction set, Pipeline, memory management, Bus architecture. **b) On-Chip Peripherals:** Study of on-chip peripherals like I/O ports, timers, interrupts, on-chip ADC,	(15 hrs)

	DAC, RTC modules, WDT, PLL, PWM, USB, I2C, SPI, CAN etc. Use 2148 / 2368 / 2378 as reference micro-controllers.	
Unit-III	**a) Interfacing and Embedded Programming:** Basic embedded C programs for on-chip peripherals studied in system architecture need of interfacing, interfacing techniques, interfacing of different displays including Graphic LCD, interfacing of input devices including touch screen etc., embedded communication using SPI, I2C, GSM modem for AT command study etc. **b) RTOS Fundamentals and µC/OS-II RTOS:** Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues events, memory management, RTOS services in contrast with traditional OS Introduction to µC/OS-II RTOS, study of kernel structure of µC/OS-II synchronization in µC/OS-II, inter-task communication in µC/OS-II, memory management in µC/OS-II, porting of RTOS.	(6 hrs)

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Reference Books and Text Books:

1. *Rajkamal – Embedded Systems, TMH.*
2. *David Simon – Embedded Systems Software Primer, Pearson.*
3. *Steve Furber – ARM System-on-Chip Architecture, Pearson.*
4. *Jean J. Labrosse – MicroC/OS-II, Indian Low Price Edition.*
5. *Dr. K. V. K. K. Prasad – Embedded / Real Time System, Dreamtech.*
6. *Iyer, Gupta – Embedded Real Systems Programming, TMH.*
7. *Steve Heath – Embedded System Design, Neuwans.*
8. *Andrew Sloss – ARM System Developers Guide.*

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Course Code: PECT-2

Course: Embedded Systems

Total Credits: 1
Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr
Maximum Marks: 50

Prerequisite:

1. Basic knowledge of Microprocessors, Microcontrollers, and Digital Electronics.
2. Fundamentals of C Programming, Computer Organization, and Electronic Circuits.

Learning Objectives of the Course:

1. To understand embedded system fundamentals, ARM architecture, and embedded design concepts.
2. To study on-chip peripherals, interfacing techniques, and embedded C programming using ARM controllers.
3. To learn RTOS concepts, µC/OS-II architecture, task management, and inter-task communication techniques.

Coare Outcomes (COs) : Student will be

Able to:

1. CO1: Explain embedded system fundamentals, ARM architecture, and on-chip peripherals of ARM controllers.
2. CO2: Develop embedded C programs and interface various peripherals and communication protocols using ARM microcontrollers.
3. CO3: Apply RTOS concepts and µC/OS-II services for task scheduling, synchronization, memory management, and embedded system applications.

Topics *I* actual contents of the syllabus	Contact Hours
List of the Experiments 1. Study of ARM7 LPC2148/LPC2368/LPC2378 development board and IDE tools. 2. Write an embedded C program for LED interfacing and blinking operation. 3. Interfacing of push buttons and switches with ARM microcontroller. 4. Study and implementation of timer and counter programming using ARM controller. 5. Program for interrupt handling using external and timer interrupts. 6. Interfacing and programming of ADC module using LPC2148/LPC2368/LPC2378. 7. Interfacing and programming of DAC module for waveform generation. 8. Interfacing RTC module and display of real-time clock data. 9. PWM generation and motor speed control using ARM controller. 10. Serial communication using UART and GSM modem AT commands. 11. SPI communication interfacing between ARM controller and peripheral device. 12. I2C communication interfacing with EEPROM or sensor module. 13. Interfacing of Graphic LCD and touch screen with ARM controller. 14. Study and implementation of CAN communication protocol. 15. Study and implementation of RTOS concepts using µC/OS-II including task scheduling, semaphores, mailbox, message queues, and inter-task communication.	**30Hrs**

Students should undertake at least 12 Experiments during the semester from above List

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Course Code: DMT(3)
Course: Electrical Traction
Semester–VI
Credits: 3 (Theory);

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Basic knowledge of Electrical Machines, Power Electronics, Power Systems, Electrical Circuits, and fundamentals of Electrical Engineering.

Objectives

1. To understand the fundamentals and importance of Electric Traction systems.
2. To study various traction systems, track electrification and power supply arrangements.
3. To analyze characteristics and control of traction motors used in railway applications.
4. To understand train movement, tractive effort and braking methods in electric traction.
5. To study modern traction equipment and applications in railway transportation.

Course Outcomes

CO1: Understand the fundamentals and applications of Embedded Systems and Electric Traction systems.
CO2: Analyze ARM architecture, traction systems and power supply arrangements used in practical applications.
CO3: Develop embedded C programs and understand interfacing techniques for various devices and systems.
CO4: Apply embedded communication protocols and traction motor control methods in real-time applications.
CO5: Understand RTOS concepts, train movement analysis and different braking methods used in engineering systems.
CO6: Apply the concepts of Embedded Systems and Electric Traction for efficient, safe and economical industrial and transportation applications.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours
Unit-I	**a) Electric Traction System:** Electrical transmission system employing D.C. generator D.C. series motor, electrical transmission system employing 3 phase alternator supplying D.C. traction motors electrical transmission employing 3 phase alternator supplying induction motors, choice of traction system-battery drive, hybrid drive, flywheel drive, tramways, trolley bus. **b) Track Electrification and Power Supply:** D.C. System, single phase low frequency A.C. system, single phase high frequency A.C. system, 3 phase A.C. system and composite system, current collection system current collectors for overhead systems, overhead construction for tramways, trolley buses and railways, sag and tension calculation for trolley wire, traction substations location of substations, feeding and distributing system, substation equipments, block diagram of AC electric locomotive, signaling interference in telecommunication circuits.	(15 hrs)

Unit-II	**a) Traction Motors:** Characteristics of traction motors, straight D.C. series motor, suitability of series motor for traction duty, constructional details of D.C. traction motors, series motor using undulating D.C., suitability of shunt motor for traction duty. **b) Special Traction Motors:** Single phase series motors, repulsion motor, compensated repulsion motor, induction motor with variable frequency using SCR, linear induction motor.	(15 hrs)
Unit-III	**a) Traction Control:** Duty cycle, methods of traction motor control, series-parallel and other types of controllers, use of interlocks, run back prevented, multiple unit control, master controllers, reversers, dead man's handle, use of Metaldyne and Megavolt. **b) Train Movement and Braking:** Speed time curve, its analysis and construction, schedule speed and factors affecting it, train resistance and its components, tractive effort calculations, average acceleration and speed, energy output and consumption, mechanical versus electric braking, rheostatic braking, regenerative braking, method and energy saved in the process, magnetic track brakes.	(15 hrs)

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Reference Books and Text Books:

1. *H. Partab – Modern Electric Traction, Dhanpat Rai & Sons.*
2. *Upadhayay J. & Mahindra S. N. – Electric Traction, Allied Publishers Ltd.*
3. *Rao P. S. – Principle of 25 KV Overhead Equipments, R. (Nasik) Printpack Pvt. Ltd.*
4. *Edward P. Burch – Electric Traction for Railway Trains, McGraw Hill Book Co. Inc.*
5. *C. L. Wadhwa – Generation, Distribution and Utilization of Electrical Energy, New Age International Publishers.*
6. *J. B. Gupta – Electrical Power.*

Course Code: PEC-2

Course: EV Infrastructure and Charging

Semester–VI

Credits: 3 (Theory);

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Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Total Hours :45 Max. Marks : 100	Mid Semester Exam: 40 Marks End Semester Exam: 60 Marks

Prerequisites

Knowledge Electric Vehicles and Battery Technology, charging protocols and smart charging systems, Understanding of Power Systems and Electrical Machines, Electrical Safety and Protection Systems

Objectives

1. Understand the fundamentals of Electric Vehicle (EV) infrastructure and charging systems.
2. Learn different EV charging methods, standards, and charging equipment.
3. Analyze the design and operation of EV charging stations and grid integration.
4. Understand smart charging, energy management, and renewable energy integration.
5. Study government policies, business models, and future trends in EV infrastructure.

Course Outcomes

CO1: Explain the basics of EV infrastructure and different types of electric vehicles.

CO2: Differentiate between various EV charging methods, charging levels, and standards. CO3: Design and analyze EV charging station layouts and associated electrical systems. CO4: Evaluate smart grid integration, V2G technology, and energy management techniques.

CO5: Understand EV policies, charging economics, and emerging technologies in EV charging infrastructure.

ModuleNo.	Topics / actual contents of the syllabus	Contact Hours

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Unit-I	Part A **Introduction to Electric Vehicle Infrastructure** Basics of Electric Vehicles (EVs) , Need for EV charging infrastructure , Types of EVs: BEV, HEV, PHEV, FCEV , EV ecosystem and market overview ,EV charging standards and regulations ,Challenges in EV infrastructure development Part B **EV Charging Systems** AC and DC charging ,Slow, fast and ultra-fast charging ,Conductive and wireless charging ,Battery swapping technology ,Charging levels (Level 1, Level 2, Level 3) ,EVSE (Electric Vehicle Supply Equipment)	(15 hrs)
Unit-II	Part A **Charging Connectors and Standards** Bharat AC & DC chargers ,CCS, CHAdeMO, GB/T, Type-2 connectors ,IEC 61851 and IEC 62196 standards ,Communication protocols ,OCPP (Open Charge Point Protocol) ,Smart charging systems Part B **Charging Station Design and Infrastructure** Site selection for charging stations ,Load calculation and sizing ,Single line diagram of charging station ,Grid integration ,Transformer and protection systems ,Safety requirements and earthing	(15 hrs)
Unit-III	Part A **Smart Grid and Energy Management** Smart grid concepts ,Vehicle-to-Grid (V2G) ,Renewable energy integration with EV charging ,Energy storage systems ,Demand response and load management ,Tariff structure and billing systems Part B **Policies, Business Models and Future Trends** Government policies and FAME scheme ,Public and private charging models ,Charging station economics ,Revenue models ,Future trends in EV infrastructure, Case studies of EV charging networks	(15 hrs)

Reference Books and Text Books:	
1.	Electric Vehicle Technology Explained by James Larminie & John Lowry.
2.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao & Ali Emadi.
3.	Electric and Hybrid Vehicles by Tom Denton.
4.	Electric Vehicle Integration into Modern Power Networks by R. Garcia-Valle & J.A. Peças Lopes.
5.	Electric Vehicle Charging Infrastructure – Reference for charging standards and infrastructure concepts.

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Course Code: PCCP -1
Course: EV Infrastructure and Charging Lab

SEM -VI

Total Credits: 1
Contact Hours Practical: 02 Hrs./week, **Total Contact Hours:** 30 hr
Maximum Marks: 50

Prerequisite:

1. Basic knowledge of Electrical Engineering fundamentals (Voltage, Current, Power, AC/DC circuits).
2. Understanding of Electrical Machines, Power Electronics, and basic Electrical Safety practices.

Learning Objectives of the Course:

1. Understand the architecture, components, and standards of Electric Vehicle (EV) charging infrastructure.
2. Perform testing, installation, operation, and performance analysis of EV charging systems and associated equipment.
3. Develop practical skills in charging station design, battery charging, safety procedures, and smart charging technologies.

Course Outcomes (COs) :
Student will be able to:

1. **CO1:** Identify and explain the components, standards, and operating principles of EV charging infrastructure.
2. **CO2:** Perform installation, testing, and maintenance of AC and DC EV charging equipment following safety standards.
3. **CO3:** Analyse charging performance, battery parameters, power quality, and energy consumption of EV charging systems.
4. **CO4:** Design and evaluate smart EV charging solutions integrating renewable energy and energy management systems.

Topics / actual contents of the syllabus	Contact Hours
List of the Experiments	30Hrs
1. Study of Electric Vehicle charging infrastructure and charging standards (Bharat AC-001, DC-001, CCS, CHAdeMO, Type-2)	
2. Identification and testing of components used in EV charging stations	
3. Study of EV charging station layout, wiring, earthing, and protection system	
4. Installation and commissioning of a Level-1 and Level-2 EV charger	
5. Measurement of charging voltage, current, power, and charging efficiency	
6. Performance analysis of AC EV charging using different charging modes	
7. Performance testing of DC Fast Charging system	
8. Battery charging characteristics of Lithium-ion battery using EV charger	

9. Measurement and analysis of power quality parameters during EV charging
10. Study of communication protocols used in EV charging (OCPP/CAN)
11. Design and simulation of a solar-powered EV charging station
12. Energy management and load scheduling in smart EV charging systems
13. Fault diagnosis, troubleshooting, and maintenance of EV charging equipment
14. Mini Project: Design, testing, and performance evaluation of a smart EV charging station with renewable energy integration
15. Measurement and analysis of power quality parameters during EV charging
Students should undertake at least 12 experiments during the semester from above List

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Course Code: MDMT-4
Course : EV Market and Industry Trends

Total Credits: 2
Contact Hours Theory: 02Hrs./week, Total Contact Hours: 30Hrs.
Maximum Marks : 50

Prerequisite :

1. Basics of Electric Vehicles and EV technology.
2. Basic knowledge of EV charging infrastructure.
3. Fundamentals of economics, energy and transportation systems.

Leaning Objectives of the Course :

1. To understand the structure and development of the global and Indian EV market.
2. To study major EV manufacturers, market segments and industry ecosystem.
3. To understand government policies, incentives and business models related to EVs.
4. To analyze emerging technologies, market opportunities and future trends in the EV industry.

Course Outcomes(COs) :

After completion of the course, students will be able to:

CO1: Explain the structure, growth and major segments of the EV market.
CO2: Analyze the EV industry ecosystem, supply chain and business models.
CO3: Interpret government policies, incentives and their influence on EV adoption.
CO4: Evaluate emerging market opportunities, challenges and future trends in the EV industry.

Unit No.	Topics/actual content of the syllabus	Contact Hours
I	**EV Market Overview and Industry Ecosystem:** Introduction to global and Indian EV markets, evolution of the EV industry, EV market segmentation—electric two-wheelers, three-wheelers, passenger cars, buses and commercial vehicles, factors influencing EV adoption, consumer preferences and market demand, major global and Indian EV manufacturers, EV startups and new	**10 Hrs**

	market entrants. **EV Industry Ecosystem:** Vehicle manufacturers (OEMs), battery manufacturers, component suppliers, charging service providers, energy utilities, fleet operators, dealerships and service networks, role of startups and technology companies.	
II	**EV Supply Chain, Policies and Business Models:** EV supply chain structure, battery raw materials and critical minerals, battery cell and pack manufacturing, localization of EV components, semiconductor and power electronics supply chain, battery recycling and circular economy, supply-chain challenges. **Policies and Business Models:** Government policies for EV adoption, Indian EV policy framework, FAME scheme and transition toward current EV support programmers, state EV policies, incentives and subsidies, taxation and registration benefits, public and private charging business models, battery swapping models, EV fleet and mobility-as-a-service models, charging station economics and revenue opportunities.	10 Hrs
III	**Industry Trends and Future Market Opportunities:** Electrification of public and commercial transport, growth of electric two- and three-wheelers, connected and software-defined EVs, smart and ultra-fast charging, battery swapping, Vehicle-to-Grid (V2G), renewable-energy-based charging, solid-state and alternative battery technologies, AI and IoT applications in the EV industry, autonomous EVs, battery recycling and second-life applications. **Future Market and Career Opportunities:** EV market challenges, charging infrastructure gaps, battery cost and availability, consumer awareness, future EV market outlook, investment and entrepreneurship opportunities, EV startups, employment and skill requirements, case studies of EV manufacturers and charging networks.	10 Hrs

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Reference Books:

1. Iqbal Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press.
2. James Larminie and John Lowry, *Electric Vehicle Technology Explained*, Wiley.
3. Mehrdad Ehsani et al., *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, CRC Press.
4. Ali Emadi, *Advanced Electric Drive Vehicles*, CRC Press.
5. C. C. Chan and K. T. Chau, *Modern Electric Vehicle Technology*, Oxford University Press.

Course Code: PECT-3
Course : Advance EV and Technology Application

Total Credits: 3
Contact Hours Theory: 03 Hrs./week, Total Contact Hours: 45Hrs.
Maximum Marks : 100

Prerequisite :

1. Basics of Electrical and Electronics Engineering.
2. Fundamentals of Electric Vehicles.
3. Basic knowledge of electrical machines, batteries and power electronics.

Leaning Objectives of the Course :

1. To understand advanced technologies used in electric vehicles.
2. To study advanced battery, motor drive, power converter and energy management technologies.
3. To understand smart charging, connected EVs and intelligent vehicle technologies.
4. To explore emerging technologies and applications of electric vehicles.

Course Outcomes(COs) :

CO1: Explain advanced EV powertrain and energy storage technologies.
CO2: Analyze power electronic converters, motor drives and energy management systems used in EVs.
CO3: Apply smart charging, V2G and renewable energy integration concepts to EV applications.
CO4: Evaluate connected, autonomous and emerging technologies for future electric vehicles.

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Unit No.	Topics/actual content of the syllabus	Contact Hours
I	**Advanced EV Powertrain and Energy Storage:** Advanced EV architectures, BEV, HEV and PHEV powertrain configurations, series, parallel and series-parallel hybrid systems, electric drivetrain components, traction motor requirements, BLDC, PMSM and induction motors, motor selection for EV applications, regenerative braking and energy recovery. **Advanced Battery Technology:** Li-ion batteries, solid-state batteries, battery pack configuration, SOC, SOH, DOD and C-rate, Battery Management System (BMS), cell balancing, battery thermal management, battery safety, degradation, second-life batteries and recycling.	15 Hrs
II	**Advanced Power Electronics and Charging Technology:** Role of power electronics in EVs, DC-DC converters, traction inverters, onboard and off-board chargers, bidirectional converters, SiC and GaN semiconductor devices, fast and ultra-fast charging, wireless charging and battery swapping. **Smart Charging and Energy Management:** Smart charging systems, Energy Management System (EMS), energy optimization, Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), Vehicle-to-Load (V2L), demand response, load management, renewable energy integration, solar EV charging and energy storage integration.	15 Hrs
III	**Connected and Intelligent EV Technology:** Connected electric vehicles, IoT applications in EVs, telematics, remote vehicle monitoring, sensors, introduction to ADAS, autonomous driving levels, GPS and navigation, Vehicle-to-Everything (V2X) communication and cyber security. **Emerging Technologies and Applications:** AI and Machine Learning applications in EVs, predictive maintenance, digital twin technology, intelligent battery monitoring, advanced thermal management, fuel-cell electric vehicles, hydrogen technology, electric two/three-wheelers, electric buses and commercial vehicles, EV applications in smart cities and future trends in EV technology.	15 Hrs

Reference Books:

1. Iqbal Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press.
2. James Larminie and John Lowry, *Electric Vehicle Technology Explained*, Wiley.
3. Mehrdad Ehsani et al., *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, CRC Press.
4. Ali Emadi, *Advanced Electric Drive Vehicles*, CRC Press.
5. C. C. Chan and K. T. Chau, *Modern Electric Vehicle Technology*, Oxford University Press.

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Course Code: PECP-4

Course : Advance EV and Technology Application Lab

Total Credits: 1

Contact Hours Theory: 02Hrs./week, Total Contact Hours: 30Hrs.

Maximum Marks : 50

Prerequisite :

Basic knowledge of Electrical Engineering, Electric Vehicles, batteries, motors, and power electronics.

Leaning Objectives of the Course :

1. To study advanced EV technologies.
2. To understand EV batteries, motors and charging systems.
3. To study smart and connected EV applications.

Course Outcomes (COs) :

Student will be able to:

CO1: Analyze EV powertrain and battery systems.

CO2: Demonstrate EV motor drives and charging systems.

CO3: Apply smart charging and energy management concepts.

CO4: Explain connected and emerging EV technologies.

	Topics/actual contents of the syllabus	Contact Hours
	List of the Experiments	30Hrs
1	To study and compare advanced EV architectures of BEV, HEV and PHEV.	
2	To study and compare advanced EV architectures of BEV, HEV and PHEV.	
3	To study and compare BLDC, PMSM and induction motors used for EV traction applications.	
4	To study regenerative braking system and energy recovery in an electric vehicle.	
5	To study Li-ion battery pack configuration and determine SOC, SOH, DOD and C-rate.	
6	To study the Battery Management System (BMS) and cell balancing techniques used in EV battery packs.	
7	To study battery thermal management, safety, degradation and second-life applications of EV batteries.	
8	To study DC-DC converters and traction inverters used in electric vehicles.	
9	To study onboard and off-board EV battery charging systems and their operation.	
10	To study fast charging, ultra-fast charging, wireless charging and battery swapping technologies.	
11	To study smart charging and Energy Management System (EMS) for electric vehicles.	
12	To study Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H) and Vehicle-to-Load (V2L) technologies.	
13	To study the integration of solar PV and energy storage systems with EV charging.	
14	To study IoT-based connected EV monitoring, telematics, ADAS and V2X communication systems.	
15	To study emerging EV technologies including AI/ML, digital twin, predictive maintenance, fuel-cell EVs and hydrogen technology.	

Students should undertake at least 12 Experiments during the Semester from above List