



Assam Skill University

Department of Electrical Engineering

Structure of 3 Years Diploma in Electrical Engineering and Electric Vehicle Technology

Sl. No.	Course	Course Title and Course Code
1	PCC-01	Engineering Mechanics (PCCDE301)
2	PCC-02	Electrical & Electronics Measurement (PCCDE302)
3	PEC-01	1. Electric Vehicles (PECDE301) 2. Vehicle Dynamics and Control (PECDE302) 3. EV Technology and Policy (PECDE303)
4	PCC-03	Electric Motors and Transformers (PCCDE303)
5	PCC-04	Building Electrification (PCCDE304)
6	PCC-05	Electrical Power Transmission and Distribution (PCCDE305)
7	INT-01	Internship (INTDE301)

Sl. No.	Course	Course Title and Course Code
1	PCC-06	Induction Synchronous and Special Electric Machines (PCCDE406)
2	PCC-07	Energy Storage (PCCDE407)
3	PEC-02	1. Hybrid Electric Vehicle (PECDE401) 2. Electric Traction (PECDE402) 3. EV Powertrains (PECDE403) 4. EV Testing and Maintenance (PECDE404) 5. Automotive Engines (PECDE405)
4	PEC-03	1. Power Generation (Conventional and Non-conventional) (PECDE406) 2. Switchgear and Protection (PECDE407)
5	PCC-08	Fundamental of Power Electronics (PCCDE408)
6	HSM-02	Entrepreneurship and Start-ups (HSMD402)
7	PR-01	Mini Project (PRDE401)

Detailed Syllabus

Semester-III

Course Code	PCCDE301(PCC-01)		
Course Title	Engineering Mechanics		
Number of Credits	4 (L:2, T:0, P:2)		
Objectives	<i>To develop the ability to identify, classify, select, and use appropriate electrical measuring instruments and range multipliers for accurate measurement of electrical quantities such as current, voltage, resistance, inductance, and capacitance.</i>		
Course Outcomes (COs)	<p>After completion of the course, the students will able to</p> <p>CO1: Analyse equilibrium conditions of engineering systems by both analytically and graphically by constructing appropriate free body diagrams.</p> <p>CO2: Apply the law of polygon of forces to determine the magnitude and direction of unknown forces in concurrent force systems.</p> <p>CO3: Apply the laws of dry friction to analyse engineering problems involving blocks, wedges, sphere and ladders.</p> <p>CO4: Calculate the centroid or centre of gravity of simple and composite plane laminae and solids, determine the moment of inertia of simple and composite plane laminae by applying relevant methods, laws, principles, and theorems.</p> <p>CO5: Determine the support reactions of simply supported beams subjected to vertical point loads, inclined point loads, uniformly distributed loads, and uniformly varying loads using analytical and graphical methods.</p> <p>CO6: Apply the principle of virtual work to determine equilibrium conditions in mechanical systems.</p> <p>CO7: Solve engineering mechanics problems involving connected bodies, elevators, and moving systems using D'Alembert's principle.</p>		
Course Content		Lecture hours	Practical hours
Module I:	<p>Theory:</p> <p>Force vector representation, System of a force, Principle of Transmissibility, Resolution and compounding of forces, Resultant of coplanar non-concurrent forces and parallel forces (analytical and graphical method), Bow's notation, Space diagram, Vector diagram, Funicular polygon or string polygon, Moment of force, graphical representation of moment, Varignon's theorem-law of moments, Principle of moments, Simple lever, Couple, Properties of couple.</p>	5	

Module II:	Equilibrium, Free body diagram, equilibrant, Relation between resultant and equilibrant, Algebraic conditions of equilibrium (force law of equilibrium and moment law of equilibrium), Principles of force equilibrium- Two force, three force and four force principle, Equilibrium of coplanar concurrent and non-concurrent force system- analytical and graphical method of analysing equilibrium, Lami's theorem and its application for various engineering problems.	4	
Module III:	Centroid and Centre of Gravity, Centroid of geometrical plane figure (square, triangular, rectangular, circle, semicircle lamina and composite figure composed of not more than three geometrical figure, Centre of gravity of simple solids (cube, cuboid, cone, cylinder, sphere, hemisphere) and composite solids composed of not more than two simple solids, Moment of Inertia, Derivation of general formula for determination of moment of inertia for area and mass, Section modulus, Radius of gyration, Theorem of Parallel and perpendicular axes, Moment of inertia of simple geometrical figure (square, rectangle, circle, triangle) and composite sections.	5	
Module IV:	Types of beams (Simple, Cantilever, Propped cantilever, Fixed or Encastre, Continuous and Overhanging beam), Statically determinate and indeterminate beams- definitions only, Supports (Simple, Hinged, Roller and Fixed support), Loads acting on beam (vertical and inclined point load, uniformly distributed load, uniformly varying load), Beam reactions for simply supported beam with or without overhang- engineering problems subjected to point load and combination of point load and uniformly distributed load, Beam reactions graphically for simply supported beam with vertical point load- simple numerical problems on analytical and graphical methods, Plane truss and Space truss (definition only), Assumptions in plane truss analysis, Relationship between number of joints and members in simple truss, External and	8	

	internal redundancy, Method of joints analysis, Method of sections analysis, Graphical methods of truss analysis- simple numerical problems by method of joints and section only.		
Module V:	Definition of friction, Static and dynamic friction, Coulomb's Laws of friction, Types of friction, limiting friction, Coefficient of friction, Angle of friction, Angle of repose, Cone of friction, Equilibrium of bodies on level surface subjected to a force parallel and inclined to the plane, Equilibrium of bodies on an inclined plane subjected to a force parallel to the plane only, Simple engineering problems on ladder friction and wedge friction.	4	
Module VI:	Concept of relative and resultant velocity, equation of motion for system of particles, D' Alembert's Principle, Translation and Rotation of Rigid Bodies, Rotational motion, torque, angular momentum and their relation, Moment of inertia and its expression, radius of gyration, Relation between torque and angular acceleration, kinetic energy of rotating body, Acceleration of a body rolling down an inclined plane. Motion of connecting bodies, Concept of momentum and impulse, Impulse and Momentum Relations for a Particle, Impact of two bodies, types of impact, coefficient of restitution, plane central collision, collision of a small body with a massive body, Conservation of momentum and energy, Principle of work and energy, virtual work and principles of potential energy.	6	
Module VII:	Machine, Simple machine and compound machine, Basic concepts and definition, Relation between Mechanical Advantage (M.A), Velocity Ratio (V.R) and efficiency, Maximum mechanical advantage and efficiency, Compound efficiency, Simple numerical problems on the concepts and topics on lifting machine, Velocity ratio of Simple wheel and axle, differential wheel and axle , worm and worm wheel, Simple screw jack, Single purchase and double purchase	3	

	crab winch, Weston's differential pulley block, First system of pulleys- simple numerical problems.		
Practical			
	<p>Course Outcomes:</p> <p>After completion of the students will be able to:</p> <p>CO1: Verify Lami's theorem, polygon law of forces with the aid of Gravesand's apparatus and Universal Force Table.</p> <p>CO2: Compare actual, analytical and graphical values of support reactions at the two ends of a simply supported beam on a Beam apparatus.</p> <p>CO3: Calculate co-efficient of friction between two contact surfaces on a rough horizontal plane.</p> <p>CO4: Determine the centroids of given set of plane objects</p> <p>CO5: Calculate mechanical advantage, velocity ratio and efficiency of simple screw jack.</p>		
	<p>Ex-01: To verify triangle law of forces, parallelogram law of forces and polygon law of forces with the help of Gravesand's apparatus.</p> <p>Ex-02: To verify the reactions at the support of a simply supported beam.</p> <p>Ex-03: To find co-efficient of friction and angle of repose between two surfaces.</p> <p>Ex-04: To find the mechanical advantage, velocity ratio and efficiency of a simple screw jack.</p> <p>Ex-05: Find the Centre of Gravity of a given section both experimentally and theoretically.</p>		60
	Total	30	60
<p>Text Books</p> <p>1) A Text Book of Applied Mechanics, R.K. Rajput, Laxmi Publications (P) Ltd., New Delhi.</p> <p>2) A Textbook of Engineering Mechanics, Dr. D.S. Kumar, S.K. Kataria & Sons.</p> <p>Reference Books</p> <p>1) Engineering Mechanics, S.P. Timoshenko, D.H. Young and J.V. Rao, Tata McGraw Hill, New Delhi.</p>			

Course Code	PCCDE302(PCC-02)		
Course Title	Electrical & Electronics Measurement		
Number of Credits	4 (L:2, T:0, P:2)		
Objectives	<i>To develop the ability to identify, classify, select, and use appropriate electrical measuring instruments and range multipliers for accurate measurement of electrical quantities such as current, voltage, resistance, inductance, and capacitance.</i>		
Course Outcomes (COs)	<p>After successful completion of the course, the student will be able to:</p> <p>CO1: Explain systems of units, standards, dimensional analysis, and the basic concepts and characteristics of electrical measuring instruments.</p> <p>CO2: Classify electrical measuring instruments and analyze their operating principles, static and dynamic characteristics, and torque mechanisms.</p> <p>CO3: Select, operate, and calibrate ammeters, voltmeters, and other analog measuring instruments including PMMC, MI, electro-dynamometer, and electrostatic types.</p> <p>CO4: Measure low, medium, and high resistances using bridges, Megger, and potentiometers, and apply standardization and calibration techniques.</p> <p>CO5: Analyze and perform measurements of inductance, capacitance, and frequency using A.C. bridges and evaluate the performance of CTs and PTs including ratio and phase angle errors.</p> <p>CO6: Conduct electrical measurement experiments, interpret results, and prepare technical reports with proper accuracy and safety practices.</p>		
Course Content		Lecture hours	Practical hours
Module I: Fundamentals of Measurements and Standards	<p>Theory: Fundamental units, absolute and derived units: CGS, MKS and SI systems of units; dimensional analysis; standards and classification of standards.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of different systems of units and conversion of units ● Verification of dimensional equations of physical quantities ● Identification and study of various electrical standards and measuring instruments ● Practice on least count and measurement accuracy determination 	4	8
Module II: Methods of	Theory: Method of measurement; role of instruments;	6	

Measurement and Instrument Characteristics	<p>selection and types of instruments; static and dynamic characteristics of instruments; classification of instruments: absolute instruments, secondary instruments, indicating instruments, integrating instruments.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of static characteristics of instruments (accuracy, precision, sensitivity, error) ● Study of dynamic characteristics of instruments ● Calculation of absolute, relative, and percentage errors in measurements. ● Calibration of indicating instruments ● Comparative study of analog and digital instruments based on performance characteristics. 		12
Module III: Measuring Instruments and Their Construction	<p>Theory: Constructional idea and different types of torques: deflecting torque, controlling torque, damping torque, measuring instruments: PMMC instruments, Moving Iron (MI) instruments, induction type instruments, energy meter, electrodynamicometer type instruments, electrostatic instruments; construction and working principle of different types of ammeters and voltmeters; extension of range.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of Galvanometer and Determination of Sensitivity and Galvanometer Constants ● Study and testing of PMMC and MI ammeter and voltmeter ● Study of electrodynamicometer wattmeter ● Extension of voltmeter and ammeter range ● To test and calibrate a single-phase energy meter by comparing its recorded reading with the actual power consumed under varying load conditions 	7	12
Module IV: Resistance Measurement and Potentiometers	<p>Theory: Measurement of low, medium and high resistance using, modified Kelvin's double bridge, wheatstone bridge, megger;</p>	5	

	<p>construction and working principle of megger, D.C. and A.C. potentiometers: basic circuits, applications, standardization, advantages.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Measurement of medium resistance using Wheatstone bridge • Measurement of low resistance using Kelvin's double bridge • Measurement of insulation resistance using Megger • Measurement of unknown voltage using potentiometer • Study of A.C. potentiometer 		10
Module V: A.C. Bridges and Instrument Transformers	<p>Theory: Fundamentals of A.C. bridges; measurement of inductance and capacitance using Maxwell's bridge, Owen's bridge, De-Sauty's bridge, Wien bridge, Current Transformer (CT) and Potential Transformer (PT): ratio error, phase angle error</p> <p>Practical:</p> <ul style="list-style-type: none"> • Measurement of inductance using Maxwell's bridge • Measurement of inductance using Hay's bridge • Measurement of capacitance using Schering bridge • Measurement of frequency using Wien bridge • Measurement of Power in a single-phase circuit by using CTs and PTs. • Determination of inductance using Anderson Bridge 	6	14
Module VI: Electronic Instruments	<p>Theory Basic concept of analog electronic voltmeter; functional block diagram of digital voltmeter and multimeter; basic working principle of analog CRO using functional block diagram.</p> <p>Practical</p> <ul style="list-style-type: none"> • Measurement of voltage, current, frequency and phase by CRO. 	2	4
Total		30	60
Text Books:			
1. A Course in Electrical Measurement and Measuring Instruments — A. K. Sawhney, Dhanpat Rai Publications, New Delhi			

2. Electrical Measurement and Instrumentation — J. B. Gupta, S. K. Kataria & Sons, New Delhi

Reference Books:

1. Electrical Measurement and Measuring Instruments — M. L. Anand & S. K. Sahdev, S. K. Kataria & Sons / Unique International Publications
2. Modern Electronic Instrumentation and Measurement Techniques — Albert D. Helfrick & William D. Cooper, Prentice Hall India

Course Code	PECDE301(PEC01)		
Course Title	Electric Vehicle		
Number of Credits	3 (L:1, T:0, P:2)		
Objectives	<i>Introduce the fundamentals, working principles of Electric Vehicles (EVs). Develop understanding of EV batteries, motors, charging systems, and controllers. Provide hands-on practical exposure to EV components, diagnostics, and maintenance. Build skill competency for entry-level EV service technician roles.</i>		
Course Outcomes (COs)	<p>After completing this course, the student will be able to:</p> <p>CO1: Explain the concept, classification, and advantages of electric vehicles.</p> <p>CO2: Identify and understand EV components such as battery, motor, controller, and charger.</p> <p>CO3: Demonstrate battery testing, charging, and maintenance procedures.</p> <p>CO4: Perform basic diagnostics and troubleshooting of EV systems.</p> <p>CO5: Apply safety practices and practical skills in EV workshop operations.</p>		
Course Content		Lecture hours	Practical hours
Module 1: Introduction to Electric Vehicles	<p>Theory: History and evolution of electric vehicles; need for EVs in modern transportation; types of EVs: BEV, HEV, PHEV, FCEV; comparison between ICE vehicles and EVs; advantages, limitations, and future outlook of EVs.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Familiarization with the main parts of the Electric Vehicle Motor Kit Trainer. ● The Operation of the Electric Vehicle Motor Kit Trainer. 	3	8
Module 2: EV Architecture and Major Components	<p>Theory: Block diagram of EV system and detailed explanation of various components; electric traction motor (DC, BLDC, PMSM, Induction Motor); motor controller and inverter; DC-</p>	4	

	<p>DC converter and introduction to regenerative braking.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Assembling the Electric Vehicle Motor Kit Trainer ● Charging System of Electric Vehicle Motor Kit Trainer ● System Measurement of Electric Vehicle Motor Kit Trainer ● Familiarization of Laboratory Power Electronics Workbench for Electric Vehicle ● Inverter for a Three-Phase BLDC Electric Motor. ● DC-DC Converter (Step-Down/ Buck Converter) ● Boost Converter (Step-Up Converter) 		28
<p>Module 3: EV Batteries and Charging Systems</p>	<p>Theory: Introduction to battery pack and Battery Management System (BMS); types of batteries: Lead Acid, NiMH, Lithium-ion; battery specifications and ratings; charging methods: CC, CV charging method, slow, fast, smart charging; charging stations and connectors; battery safety and thermal issues.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of various charging process and charging connectors. ● Constant current charging method of Li-ion battery ● Constant voltage charging method, ● Demonstration of regenerative Braking power flow in EV system simulator. ● Preparing the checklist of EV battery safety. 	4	16
<p>Module 4: EV Maintenance and Safety (3 Hours)</p>	<p>Theory: Preventive maintenance of EVs; common faults and troubleshooting; personal protective equipment (PPE); electrical safety precautions; fire hazards and battery disposal.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Troubleshooting and Test Point Measurement: Power Delivery Module 	2	6

	<p>(PDM) Troubleshooting, EV Battery Troubleshooting.</p> <ul style="list-style-type: none"> • Troubleshooting and Test Point Measurement: Auxiliary Battery Troubleshooting, Motor/Generator Troubleshooting, Vehicle Control Module (VCM) Troubleshooting, Motor/Generator Inverter Troubleshooting, Charging System Troubleshooting. • Troubleshooting and Test Point Measurement: Air Conditioning Control Unit Troubleshooting, Battery Temperature Sensor Troubleshooting, Pedal Position Sensor Circuit Troubleshooting. • Preparing the checklist for EV service maintenance. 		
Module 5: EV Policies and Emerging Trends	<p>Theory: Government policies and subsidies (FAME India); environmental impact and sustainability; smart mobility concepts; future trends: V2G, autonomous EVs; solid-state batteries.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Case studies on EV policy guidelines, and battery standardization. 	2	2
Total		15	60
<p>Textbooks</p> <p>1. Electric and Hybrid Vehicles: Design Fundamentals — Iqbal Husain — CRC Press</p> <p>Reference Books</p> <p>1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles — Mehrdad Ehsani, Yimin Gao, Sebastian Gay, Ali Emadi — CRC Press</p> <p>2. Electric Vehicle Technology Explained — James Larminie, John Lowry — Wiley Publications</p>			

Course Code	PECDE302(PEC01)
Course Title	Vehicle Dynamics and Control
Number of Credits	3 (L:1, T:0, P:2)
Objectives	<i>Understand the fundamental principles of vehicle motion and road interaction. Analyze forces affecting vehicle performance including traction, braking, and cornering. Study steering geometry, suspension behaviors, and ride comfort. Understand braking systems including ABS and regenerative braking. Develop practical skills in vehicle testing,</i>

	<i>diagnostics, and simulation tools. Apply control concepts to EV traction, stability, and safety systems.</i>		
Course Outcomes (COs)	<p>At the end of the course, the student will be able to:</p> <p>CO1: Explain basic vehicle dynamics concepts and road load forces.</p> <p>CO2: Analyze acceleration, braking, and traction characteristics.</p> <p>CO3: Understand steering, suspension, and ride control systems.</p> <p>CO4: Demonstrate practical skills in vehicle dynamics testing and diagnostics.</p> <p>CO5: Apply modern vehicle control concepts such as ABS, TCS, ESC, and regenerative braking.</p>		
Course Content		Lecture hours	Practical hours
Module 1: Introduction to Vehicle Dynamics	<p>Theory: Basics of vehicle motion; vehicle architecture: conventional, hybrid, electric vehicle layouts; vehicle coordinate system; forces acting on a vehicle: rolling resistance, aerodynamic drag, gradient resistance, weight distribution and center of gravity.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of vehicle chassis layout and major subsystems. Identification of vehicle dynamic parameters. ● Measurement of rolling resistance and aerodynamic drag. ● Acceleration test under varying loads. 	3	12
Module 2: Longitudinal Dynamics	<p>Theory: Traction force and power requirement; acceleration performance; gradeability; tyre-road friction; braking dynamics; braking distance calculation.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Braking distance measurement ● Tire pressure vs traction experiment ● ABS demonstration model study 	3	12
Module 3: Lateral Dynamics and Steering System	<p>Theory: Cornering forces; slip angle and tire characteristics; understeer; oversteer; neutral steer; steering geometry: Ackermann steering principle, Steering systems: Manual, Power steering, Electronic Power Steering (EPS).</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Steering geometry inspection 	4	4
Module 4:	Theory:		

Suspension and Ride Dynamics	Suspension objectives; types of suspension systems; ride comfort and vehicle stability; shock absorbers and springs; wheel alignment: camber, caster, toe. Practical: <ul style="list-style-type: none"> • Suspension system component study 	2	4
Module 5: Vehicle Control Systems	Theory: Anti-lock Braking System (ABS); Traction Control System (TCS); Electronic Stability Control (ESC); regenerative braking in EVs; introduction to ADAS and autonomous control basics. Practical: <ul style="list-style-type: none"> • Simulation of vehicle dynamics • Basic PID speed control experiment • CAN-based vehicle parameter monitoring • Mini project on EV dynamics or control system (In any of the following or other relevant topics) <ul style="list-style-type: none"> ○ EV regenerative braking model ○ Steering angle sensor integration ○ ABS prototype demonstration ○ Vehicle speed control using PID ○ Battery load effect on EV acceleration 	3	28
Total		15	60
Textbook 1. Vehicle Dynamics — Reza N. Jazar — Springer Publications			
Reference Books 1. Fundamentals of Vehicle Dynamics — Thomas D. Gillespie — SAE International 2. Vehicle Dynamics and Control — Rajesh Rajamani — Springer Publications			

Course Code	PECDE303(PEC01)
Course Title	EV Technology and Policy
Number of Credits	3 (L:1, T:0, P:2)
Objectives	<i>Develop students' understanding of electric vehicle technologies, architecture, charging infrastructure, EV regulations, government policies, and future mobility trends while building practical skills in EV systems, battery operation, maintenance, sustainability, and entrepreneurship opportunities in the EV sector.</i>
Course Outcomes (COs)	After successful completion, students will be able to: CO1: Understand EV fundamentals, types, and components. CO2: Explain battery technologies, charging methods, and infrastructure.

	<p>CO3: Analyze EV policies, subsidies, and environmental impacts.</p> <p>CO4: Perform basic EV servicing, safety checks, and system testing.</p> <p>CO5: Develop awareness of EV business opportunities and public transport electrification.</p>		
Course Content		Lecture hours	Practical hours
Module 1: Introduction to Electric Vehicles	<p>Theory: History and evolution of electric vehicles; need for EVs in modern transportation; types of EVs: BEV, HEV, PHEV, FCEV; comparison between ICE vehicles and EVs; advantages, limitations, and future outlook of EVs.</p> <p>Practical:</p> <ul style="list-style-type: none"> Familiarization with the main parts of the Electric Vehicle Motor Kit Trainer. 	3	4
Module 2: EV Architecture and Components	<p>Theory: Block diagram of EV system and detailed explanation of various components; introduction to battery pack and Battery Management System (BMS); Electric traction motor (DC, BLDC, PMSM, Induction Motor); Motor controller and inverter; DC-DC converter and introduction to regenerative braking.</p> <p>Practical:</p> <ul style="list-style-type: none"> The Operation of the Electric Vehicle Motor Kit Trainer Assembling the Electric Vehicle Motor Kit Trainer Charging System of Electric Vehicle Motor Kit Trainer System Measurement of Electric Vehicle Motor Kit Trainer Familiarization of Laboratory Power Electronics Workbench for Electric Vehicle 	4	20
Module 3: Battery Technology and Energy Storage	<p>Theory: Lithium-ion; lead acid; solid state batteries; battery specifications: voltage, Ah, kWh; battery life cycle and thermal issues; battery swapping concept; recycling and disposal.</p> <p>Practical:</p> <ul style="list-style-type: none"> Study of Battery Charging and Discharging Techniques with Essential Safety Precautions 	4	18

	<ul style="list-style-type: none"> • Experimental Investigation of Constant Voltage Charging Method for EV Batteries • Experimental Investigation of Constant Current Charging Method for EV Batteries 		
Module 4: EV Policy and Government Regulations	<p>Theory: FAME I & FAME II policies; State EV policies; subsidies and incentives; road tax exemptions; EV safety standards; role of NITI Aayog and Ministry of Heavy Industries; international policies and standards.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Field Survey and Technical Study of Electric Vehicle Charging Infrastructure, User Adoption, and Operational Challenges in Local Regions 	2	8
Module 5: Sustainability, Economics and Future Scope	<p>Theory: Carbon footprint and environmental benefits; EV economics: running cost vs fuel cost; public charging infrastructure challenges; smart grid integration; entrepreneurship in EV sector; future of autonomous and connected EVs.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Field Survey and Policy Analysis of Government EV Incentives, Public Awareness, and Implementation of Electric Mobility Programs 	2	10
Total		15	60
<p>Textbook</p> <p>1. Electric Vehicles and the Future of Energy — Mahesh Kumar — Wiley Publications.</p> <p>Reference Books</p> <p>1. Electric Vehicle Technology Explained — James Larminie, John Lowry — Wiley Publications.</p> <p>2. Electric and Hybrid Vehicles — Tom Denton — Routledge Publications.</p>			

Course Code	PCCDE303(PCC-03)
Course Title	Electric Motors and Transformers
Number of Credits	4 (L:2, T:0, P:2)
Objectives	<p><i>To understand the construction and working principles of D.C. machines and transformers. To study the characteristics, operation and applications of D.C. generators, D.C. motors and transformers.</i></p> <p><i>To analyze the performance, losses, efficiency and testing methods of</i></p>

	<i>electrical machines. To understand speed control, starting methods and operation of D.C. motors. To develop problem-solving skills related to electrical machines and transformers. To understand three-phase transformer, its connections, cooling, autotransformer, CT, PT</i>		
Course Outcomes (COs)	<p>CO1: Understand the construction, working principle, characteristics, performance analysis, losses, efficiency and applications of D.C. generators, and solve related numerical problems.</p> <p>CO2: Analyse the operation, characteristics, speed control methods, starting techniques, testing and applications of different types of D.C. motors.</p> <p>CO3: Understand the construction, working principle, equivalent circuit, testing, efficiency, and regulation, performance characteristics of single-phase and three phase transformers.</p> <p>CO4: Study of the construction, principle and testing of Induction Machines.</p> <p>CO5: Perform and analyse laboratory experiments on AC/DC machines and transformers using standard electrical measuring instruments.</p>		
Course Content		Lecture hours	Practical hours
Module I: DC Generator	<p>Theory: Principle of operation and construction of D.C. Generator; E.M.F. Equation of D.C. generator; types of D.C. generators; characteristics and performance of D.C. generator; armature reaction; commutation; losses; efficiency and applications.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Identification of different terminals of a dc machine by multi-meter and to measure insulation resistance by megger. ● Dimensional and material study of various parts of a dc machine. ● Open circuit characteristic of a DC shunt generator. ● Load test on DC shunt generator. ● Load characteristics of DC series and shunt generator. ● Hopkinson's test on DC shunt machines. For predetermination of efficiency. 	8	16
Module II: DC Motor	<p>Theory: Principle of operation and construction of D.C. Motor; back E.M.F.; types and voltage equation; torque equation, losses and</p>	8	

	<p>efficiency, characteristics and speed control of D.C. motors; motor starters; testing of D.C. machines; applications of D.C. motors</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of three-point starter, connect and run a dc shunt motor and measure the no load current ● Study of four-point starter, connect and run a dc compound motor and measure no load current ● DC shunt motor load characteristic ● Speed control of D.C. shunt motor by (a) Flux control (b) by armature control method ● Brake test on dc shunt motor ● Retardation test on dc shunt motor 		16
<p>Module III: Single Phase and Three Phase Transformer</p>	<p>Theory: Working principle of transformer; construction and types of transformers; E.M.F. equation and no-load operation; transformer on load and voltage drop; losses in transformer; open circuit and short circuit tests; efficiency; regulation and equivalent circuit; all-day efficiency and transformer rating; construction of three-phase transformer and accessories; connections of three-Phase transformers; power and distribution transformers; cooling of transformers; parallel operation of transformers; autotransformer.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Identification of terminals of a single-phase transformer by performing polarity test ● Determination of transformation ratio in single phase transformer ● Open circuit and short-circuit test on single phase transformer ● Determine voltage regulation of transformer by direct loading ● Sumpner's test on two identical single-phase transformers. ● Scott connection of single-phase transformer ● To study the various connections of 	9	18

	<p>three phase transformer</p> <ul style="list-style-type: none"> • Study of CT and PT, its connections 		
Module IV: Induction Machines	<p>Theory: Working principal construction of 3-phase induction motor; types of rotors slip speed; frequency of rotor current; relationship between torque and rotor power factor; starting torque; maximum starting torque; effect of change of supply voltage; torque-slip characteristics; no-load test and blocked rotor test; starting of induction motor; different types of starters, its construction; speed control of induction motor.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Study of starter of 3-phase induction motor (Auto transformer/star-delta starter) • Study of resistance starter and starting of slip ring I.M. • Determination of Efficiency by No-load test and blocked rotor test on an induction motor. • Slip –torque characteristic of 3-phase induction motor. • Measurement of slip of a 3-phase induction motor 	5	10
Total		30	60
<p>Text Books:</p> <ol style="list-style-type: none"> 1. VK Mehta, Rohit Mehta: Principles of Electrical Machines, S. CHAND & COMPANY LTD. 2. J B Gupta: Electrical Machines 3. P.S. Bimbhra Electrical Machines <p>Reference Books:</p> <ol style="list-style-type: none"> 1. D.P Kothari, I.J Nagrath: Electrical Machines 2. B.L Theraja and A.K Theraja: Electrical Technology-II 3. Ashfaq Hussain: Electrical Machines 			

Course Code	PCCDE304
Course Title	Building Electrification
Number of Credits	3 (L:1, T:0, P:2)
Objectives	<i>To develop practical expertise in selecting wiring components, installing protection systems and interpreting electrical blueprints. It emphasizes hands-on troubleshooting, earthing techniques and building maintenance safety.</i>
Course Outcomes	CO1: Understand electrical wiring systems and protection devices

(COs)	<p>used in residential installations.</p> <p>CO2: Apply domestic wiring methods and building electrification principles to design safe wiring layouts.</p> <p>CO3: Analyze illumination concepts and select appropriate lighting systems for residential applications.</p> <p>CO4: Evaluate smart home automation systems and their applications in modern residential environments.</p> <p>CO5: Perform laboratory/practical experiments to construct, test, and troubleshoot domestic wiring circuits, evaluate indoor lighting using a lux meter, analyze electrical circuit parameters, and document findings in compliance with national electrical codes.</p>		
Course Contents		Lecture hours	Practical hours
<p>Module-I: Electrical wiring and system protection</p>	<p>Theory: Classification of electrical accessories, conductors, wires and cables; BIS standard wire sizes; wire measurement tools and jointing methods; electrical protection devices such as fuses, MCB, RCCB/ELCB and MCCB, including their types, construction, ratings and applications; earthing; methods of reducing earth resistance and earthing methods; classification of cables like VIR, PVC and XLPE; selection of suitable cable size and type and various cable laying methods.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Design and demonstrate an electrical installation board for identifying and studying electrical accessories, cables, protective devices, and tools used in electrification. ● Study of Conductors, Wires and BIS Standard Wire Sizes ● Practice of common wire jointing methods. ● Study on Fuse characteristics. ● Testing Operation of MCB and RCCB. ● Measurement of earth resistance using earth tester. ● Study of Earthing Methods ● Insulation resistance and continuity testing of cables. 	4	20

	<ul style="list-style-type: none"> • Study of Cable layout and laying methods 		
Module-II: Domestic Wiring and Building Electrification	<p>Theory: Wiring systems and classification; standards and selection of wiring methods; electrical circuit design and applications for room, house and building.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Identify and demonstrate PVC casing-capping wiring and conduit wiring (surface & concealed) with components and layout. • Two- way control of a lamp (staircase wiring circuit). • Go-Down (Warehouse) wiring circuit. • Bedroom lighting circuit (with master switch control) • Corridor/ Tunnel lighting circuit using intermediate switches. • Prepare wiring installation on a board from the commencement of supply showing energy meter, MCB, control of one lamp, one fan and one socket from one switch board in PVC surface conduit wiring system. • Calculate total load of a house, select conductor size, and choose suitable main switch and protective devices as per standards. • Design a wiring diagram of a residential building. 	4	20
Module-III: Illumination in Residential Installation	<p>Theory: Concept of luminous flux; luminous intensity; Lumen; Illumination or illuminance; Lux; Space-height ratio; utilization factor; depreciation factor; luminous efficacy; laws of Illumination-Inverse Square Law, Cosine Law (related numerical); factors affecting the illumination; different types of lighting arrangements; luminous flux of different types of light sources; lux level required for different places as per SP 72: 2010; lighting design of a room for estimation of lamps.</p> <p>Practical:</p>	4	

	<ul style="list-style-type: none"> • Measurement of Lux levels and calculation of room illumination efficiency. • Comparative analysis of luminous efficiency of different residential lighting sources. • To design lighting system for a room using lumen method. • To design complete lighting system for a house. • To design lighting system for office/building spaces. 		12
Module-IV: Introduction to Smart Home Automation	<p>Theory: Introduction to smart building architecture; technologies required to build smart building; building automation systems (BAS): Heating, Ventilating and Air conditioning system (HVAC system); sensors; actuators; applications in smart buildings; potential benefits of smart building; drawbacks of incorporating technology in buildings.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Physical Addressing and Basic Lighting Control via KNX Bus. • Dimming control configuration for mood lighting. • Motorized curtain control with safety interlocking logic. • Integration of conventional switches & scene creation. 	3	8
Total		15	60
<p>Text Books:</p> <ol style="list-style-type: none"> 1. Basic Electrical Engineering by V. K. Mehta & Rohit Mehta 2. Lab Course in Electrical Engineering by S G Tarnekar, P K Kharbandha 3. Singh, Surjit, Electrical Estimating and Costing, Dhanpat Rai and Co. New Delhi, ISBN: 1234567150995 <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Gupta, J B: A Course in Electrical Installation Estimating and Costing, S K Kataria and Sons, New Delhi, ISBN:978-93-5014-279-0 2. Bureau of Indian Standard, IS: 732-1989, Code of practice for electrical wiring installation. 3. Smart building Digitization by O.V. Gnana Swathika, K. Karthikeyan, Sanjeevikumar Padmanaban, CRC Press 			

Course Code	PCCDE305(PCC-05)
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Course Title	Electrical Power Transmission and Distribution		
Number of Credits	3 (L:1, T:0, P:2)		
Objectives	<i>To develop knowledge and skills related to power generation, transmission, distribution, substations, control, and stability of power systems for safe operation and further study of power utilization systems.</i>		
Course Outcomes (COs)	<p>After successful completion of this course, the learner will be able to:</p> <p>CO1: Explain the structure and components of electrical power transmission systems and prepare single-line diagrams of power networks.</p> <p>CO2: Measure and evaluate transmission line parameters such as resistance, inductance, capacitance, voltage regulation, and efficiency using standard methods and simulation tools.</p> <p>CO3: Operate and analyze electrical distribution systems, distribution transformers, feeders, and underground/overhead distribution networks for effective power delivery.</p> <p>CO4: Apply modern power system technologies including HVDC, FACTS, SCADA, smart grids, renewable energy integration, and EV charging infrastructure in practical applications.</p> <p>CO5: Perform laboratory experiments, field studies, troubleshooting, and energy auditing activities related to transmission and distribution systems using appropriate tools/software.</p>		
Course Content		Lecture hours	Practical hours
Module I: Introduction to Electrical Power Transmission	<p>Theory: Structure of electrical power system; generation, transmission, and distribution overview; types of transmission systems: AC and DC, advantages, disadvantages; voltage levels in power systems; high transmission voltage – advantages, economic choice of transmission voltage; components of overhead transmission lines; sag and tension concept.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Preparation of single-line diagram of a power system. ● Demonstration of Effect of Transmission Voltage on Line Current and Losses 	4	16

	<ul style="list-style-type: none"> • Study of conductors, insulators, poles, cross-arms, and transmission towers. • Study of pin, suspension, strain, and shackle insulators and their applications. • Demonstration of line safety tools and PPE. • Field visit to nearby transmission line/substation. 		
Module II: Transmission Line Parameters and Performance	<p>Theory: Resistance, inductance, and capacitance of transmission lines; short, medium, and long transmission lines; voltage regulation and efficiency; Corona effect and skin effect; Ferranti effect; power factor improvement.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Study of Short Transmission Line performance • Study of Medium Transmission Line Performance • Determination of transmission line voltage regulation under different load conditions. • Demonstration of Ferranti effect using setup/simulation. • Measurement of power factor and Power factor improvement using capacitor bank in 1-phase and 3-phase circuit. • Simulation of transmission line performance and measurement of line current and voltage under load conditions. 	4	18
Module III: Electrical Distribution System	<p>Theory: Primary and secondary distribution systems; radial, ring main, and interconnected systems; overhead and underground distribution; feeders, distributors; and service mains; distribution transformers; voltage drop in distribution systems.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Construction and testing with measurement of voltage at different 	4	14

	<p>load points of a simple radial distribution network with load variation.</p> <ul style="list-style-type: none"> ● Construction and testing of a ring main system and observation of continuity during fault/open condition. ● Study and testing of distribution transformer. ● Measurement of voltage drop in a feeder. ● Load distribution analysis in laboratory setup. 		
Module IV: Modern Trends in Power Transmission and Distribution	<p>Theory: HVDC transmission; FACTS devices; smart grid technology; SCADA systems; renewable energy integration; energy conservation and auditing.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Demonstration of SCADA system operation. ● Study of smart meter and smart grid components. ● Energy audit of laboratory/classroom. ● Solar PV integration with distribution panel. ● Preparation of energy conservation report. 	3	14
Total		15	60
<p>Text Books:</p> <ol style="list-style-type: none"> 1. Electrical Power Systems by C. L. Wadhwa, published by New Age International Publishers 2. Modern Power System Analysis by D. P. Kothari and I. J. Nagrath, published by McGraw Hill Education India 3. HVDC Power Transmission Systems by K. R. Padiyar, published by New Age International Publishers <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Principles of Power Systems by V. K. Mehta and Rohit Mehta, published by S. Chand Publishing 2. Switchgear and Protection by Sunil S. Rao, published by Khanna Publishers; 3. Smart Grid: Fundamentals of Design and Analysis by James Momoh, published by Wiley India. 			

Semester-IV

Course Code	PCCDE406		
Course Title	Induction, Synchronous and Special Electrical Machines		
Number of Credits	3 (L:1, T:0, P:2)		
Objectives	<i>To analyse the construction, operation, speed control and parallel synchronization of polyphase induction and synchronous machines. Additionally, to study the characteristics and parallel applications of single phase, universal, stepper and special purpose electric machines</i>		
Course Outcomes (COs)	<p>CO1: Explain the construction, operating principles, and performance characteristics of AC machines.</p> <p>CO2: Analyze the operation, excitation, and performance characteristics of synchronous machines.</p> <p>CO3: Demonstrate the synchronization and load-sharing operation of synchronous machines connected in parallel.</p> <p>CO4: Explain the working principles, characteristics, and applications of single-phase induction motors and special purpose motors.</p> <p>CO5: Perform laboratory experiments to conduct hands-on practical experiments to determine the performance characteristics, speed control and efficiency of induction, synchronous and special electrical machines.</p>		
Course Contents		Lecture hours	Practical hours
Module-I: Principle operation of AC Machine	<p>Theory: Introduction to AC machines and electromagnetic induction; working principle of AC generator and AC motor; rotating magnetic field and synchronous speed; types of AC machines and induction motors; deep bar induction motor and double cage induction motor; advantages and applications of AC machines.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To determine efficiency and performance under load conditions on a 3- phase induction motor. • Speed control of a three- phase induction motor by variable voltage and frequency. • To reverse the direction of rotation of a three-phase induction motor. 	4	12

	<ul style="list-style-type: none"> • To study the construction and operation of a deep bar and double cage induction motor. • To study the load performance of deep bar and double cage induction motors. 		
Module-II: Synchronous Machine	<p>Theory: Alternator: E.M.F equation; armature reaction; leakage reactance; synchronous reactance and impedance; phasor diagram; load characteristics; voltage regulation. Synchronous motor: effects of excitation on armature current and power factor, V-curve and inverter V-curve, load angle, phasor diagram, losses and efficiency.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To Find Regulation of Alternator by Synchronous Impedance method. (OC & SC Test of Alternator) • To perform Load Test on Alternator • To perform ZPF Test on Alternator • To Find Voltage Regulation of Alternator at 0.8PF by Direct Loading. • Direct load test on alternator • To obtain open circuit characteristics (OCC) and short circuit characteristics (SCC) of alternator. • Determination of Synchronous Impedance and Voltage Regulation by EMF Method. • Determination of Voltage Regulation by MMF Method. • Determination of Voltage Regulation by Zero Power Factor (ZPF) Method. • To study the performance characteristics of a three-phase alternator under different load conditions • Study and starting of a Synchronous motor. 	4	

	<ul style="list-style-type: none"> • Determination of V-Curve and Inverted V-Curve of a Synchronous Motor. • Determination of losses and efficiency of synchronous motor. 		
Module-III: Parallel Operation of Synchronous Machines	Theory: Synchronizing alternators with infinite bus bars; synchronizing power torque; parallel operation and load sharing - effect of change of excitation and mechanical power input. Practical: <ul style="list-style-type: none"> • Synchronization of a 3-phase alternator with infinite bus bars using the dark lamp method. • Synchronization of an alternator using the bright and dark lamp method (Two bright, one dark) • Load sharing between two parallel alternators • Effect of change of excitation on a parallelly connected alternator. • Effect of prime mover input on load sharing. 	3	14
Module-IV: Single Phase Induction motor and Special Purpose Motors	Theory: Single phase induction motor: constructional features; double revolving field theory equivalent circuit; split-phase motors; principles of A.C. series motor-universal motor; stepper motor; brushless DC motor and AC motor; shaded pole motor (Qualitative Treatment Only). Practical: <ul style="list-style-type: none"> • Study of capacitor start single phase induction motor and calculate starting and running current. • Determination of Core Losses, Friction, and Windage Losses in a Single-Phase Induction Motor • Speed control and characteristics of an A.C. universal motor 	4	12

	<ul style="list-style-type: none"> • Performance, speed control and reversal of a brushless DC (BLDC) motor. • Study of special purpose motors: stepper motor and shaded pole motor. 		
	Total	15	60
Text Books:			
1. Special Electrical Machines by E.G. Janardanan, PHI Learning.			
2. Special Electrical Machines by Simmi P. Burman, Katson Publications.			
Reference Books:			
1. Generalized Theory of Electrical Machines by P.S. Bimbhra, Khanna Publications.			
2. VK Mehta, Rohit Mehta: Principles of Electrical Machines, S. CHAND & COMPANY LTD.			
3. J B Gupta: Electrical Machines.			
4. D.P Kothari, I.J Nagrath: Electrical Machines.			
5. B.L Theraja and A.K Theraja: Electrical Technology-II.			

Course Code	PCCDE407(PCC-07)		
Course Title	Energy Storage		
Number of Credits	4 (L:2, T:0, P:2)		
Objectives	<i>To provide knowledge of the fundamentals of energy storage systems, different storage technologies, their operating principles, characteristics, and applications and to develop an understanding of the role of energy storage in non-conventional energy systems and electric vehicles along with performance evaluation aspects of energy storage systems.</i>		
Course Outcomes (COs)	<p>CO1: Familiarize with energy storage systems and understand the fundamentals, need, and importance of energy storage systems.</p> <p>CO2: Describe the principles and applications of thermal and mechanical energy storage.</p> <p>CO3: Analyse the working and characteristics of electrochemical energy storage devices including batteries, capacitor, and supercapacitor.</p> <p>CO4: Understand hydrogen energy storage methods and operating principles of fuel cells.</p> <p>CO5: Evaluate the suitability of different energy storage technologies in non-conventional energy systems, electric vehicles and power systems.</p> <p>CO6: Demonstrate the experimental setups and models of different energy storage technologies.</p>		
	Course Contents	Lecture hours	Practical hours
Module I: Introduction to	Theory: Energy demand; need for energy storage;	3	

Energy Storage	<p>opportunity in energy storage; classification and types of energy storage; energy storage system terminologies.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● To familiarize with different type of energy storage system. ● To analyse the load of the different classrooms and energy consumption. ● To analyse the efficiency of energy storage devices. 		6
Module II: Thermal energy storage	<p>Theory: Sensible and latent heat; phase change materials; thermo-chemical storage, and underground storage.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● To study the thermal energy storage capacity in different materials. ● To study the sensible thermal storage using solar cooker. ● To study the thermal energy storage using paraffin wax as a phase change material. ● To study the cooling and heating characteristics of thermal energy storage materials. 	6	8
Module III: Mechanical energy storage	<p>Theory: Construction, working principle and applications of i) Flywheels; ii) compressed air; iii) pumped-hydro.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● To study the recovery and storage of mechanical energy during braking. ● To study the storage and release of energy using compressed air systems. ● To demonstrate the working principle of pumped hydro energy storage using water as a medium for storing and generating energy. 	6	6
Module IV: Electrochemical energy storage	<p>Theory: Batteries: primary and secondary batteries; types of batteries; battery performance parameters; battery management system. Capacitor and supercapacitor: difference between batteries and capacitors; working</p>	8	

	<p>principle, types and performance characteristics.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To familiarize with different type of batteries. • To study the series, parallel and combination of series-parallel connection of batteries to meet energy demand. • To study the static charging and discharging of a battery. • To study the dynamic charging and discharging of a battery. • To study the charging and discharging characteristics of a capacitor. • To study the charging and discharging characteristics of a supercapacitor. • To familiarize with safety precautions and testing of storage devices. 		24
<p>Module V: Emerging Technology and Applications of energy storage</p>	<p>Theory: Introduction to hydrogen storage and fuel cell; storage for renewable energy systems, electric vehicles: charging infrastructure and vehicle to grid (V2G) integration; electrical energy storage systems; hybrid storage systems.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To familiarize with the working principle of a fuel cell. • To study the performance of a fuel cell. • To study the charging characteristics of a battery using solar photovoltaic panel. • To analyse the PWM waveform for Battery Charging. • To study the BMS electrical characteristics. • To study the regenerative braking system in electric vehicle. • To study the energy storage in hybrid system. • To present a model demonstrating continuous power supply and load sharing between storage systems. 	7	16
	Total	30	60
Textbooks			

1. P. Jayarama Reddy, "Principles of Energy Storage Systems", BS Publications.
2. Robert A. Huggins, "Energy Storage", Springer Science (ISBN - 978 -1-4419-1023-3), 2010.

Reference Books

1. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.
2. P. Jayarama Reddy, "Principles of Energy Storage Systems", BS Publications/BSP Books (ISBN - 9789395038065).
3. O'Hayre R. P., Cha S.W., Colella W., and Prinz F. B., (2008); Fuel cell fundamentals, John Wiley.
4. Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press, 2011.

Course Code	PECDE401(PEC02)		
Course Title	Hybrid Electric Vehicle		
Number of Credits	4 (L:2, T:0, P:2)		
Objectives	<i>Understand the fundamentals, architecture, and working principles of Hybrid Electric Vehicles (HEVs), including hybrid powertrains, energy management, batteries, motors, controllers, and regenerative braking systems. Develop practical skills in testing, diagnostics, maintenance, simulation, safety standards, and environmental aspects of HEV technology.</i>		
Course Outcomes (COs)	<p>After completing this course, the student will be able to:</p> <p>CO1: Explain the fundamentals and classifications of Hybrid Electric Vehicles.</p> <p>CO2: Describe the components and operation of hybrid powertrains and charging systems</p> <p>CO3: Explain regenerative braking, energy recovery methods, energy management strategies, fuel economy techniques, and drive cycle analysis in HEVs.</p> <p>CO4: Perform testing, diagnostics, and maintenance of HEV systems safely.</p> <p>CO5: Demonstrate practical knowledge of hybrid vehicle operation and control systems.</p>		
Course Contents		Lecture hours	Practical hours
Module 1: Introduction to Hybrid Electric Vehicles	Theory: Introduction to Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs); need and advantages of HEVs; comparison between conventional vehicles, EVs, and HEVs; classification of HEVs: series hybrid, parallel hybrid, series-parallel hybrid, plug-in hybrid electric vehicle (PHEV); applications of HEVs; environmental impact and energy efficiency.	8	

	<p>Practical:</p> <ul style="list-style-type: none"> ● Identification of major components of Hybrid Electric Vehicles ● Study of different HEV architectures using charts/models/software ● Demonstration of series and parallel hybrid powertrain operation 		12
<p>Module 2: Hybrid Powertrain and Vehicle Architecture</p>	<p>Theory: Components of HEV system, Internal Combustion Engine (ICE) in HEV; electric motor and generator; power split devices; transmission systems used in HEVs; hybrid powertrain configurations; energy flow in different driving conditions; vehicle control strategies; charging methods and charging standards, electrical safety in HEVs.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Demonstration of Energy Flow, Transmission System, and Vehicle Control Strategies in HEV ● Measurement of voltage, current, and power in HEV battery systems ● Study and testing of Battery Management System (BMS) ● Charging and discharging characteristics of lithium-ion batteries ● Study of DC-DC converter and inverter used in HEVs 	8	24
<p>Module 3: Regenerative Braking and Energy Management</p>	<p>Theory: Concept of regenerative braking; working principle of regenerative braking system; energy recovery methods; hybrid vehicle energy management strategies; fuel economy improvement techniques; drive cycle analysis.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Demonstration of regenerative braking system ● Analysis of energy flow during acceleration and braking 	7	8
<p>Module 4: Fault</p>	<p>Theory:</p>		

Diagnosis, Troubleshooting and Maintenance	<p>HEV maintenance procedures; common faults and troubleshooting; diagnostic tools and onboard diagnostics (OBD); thermal management systems; safety precautions during servicing; future trends in hybrid mobility; government policies and standards for HEVs creation; spare parts management; calibration schedules; service economics; case studies, field service best practices and environmental/safety compliance for maintenance operations.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● To analyses the checklist of services and maintenance ● Fault diagnosis using OBD scanner ● Maintenance procedure for HEV electrical systems ● Thermal management study of battery pack ● Study of fittings, joints, and electrical connections in retrofitting and assembly of HEVs models. 	7	16
Total		30	60
<p>Textbooks</p> <ol style="list-style-type: none"> 1. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives — Chris Mi, M. Abul Masrur, David Wenzhong Gao — Wiley Publications <p>Reference Books</p> <ol style="list-style-type: none"> 1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles — Mehrdad Ehsani, Yimin Gao, Sebastian Gay, Ali Emadi — CRC Press 2. Electric and Hybrid Vehicles — Tom Denton — Routledge Publications 			

Course Code	PECDE402(PEC02)
Course Title	Electric Traction
Number of Credits	4 (L:2, T:0, P:2)
Objectives	<p><i>Understand the fundamentals and operating principles of electric traction systems, including traction motors, power supply systems, control methods, braking systems, and energy-efficient operation. Develop practical skills in testing, diagnostics, and maintenance of traction equipment while studying applications in railways, metro systems, and electric mobility.</i></p>

Course Outcomes (COs)	After completing this course, the student will be able to: CO1: Explain the fundamentals and characteristics of electric traction systems. CO2: Identify various traction motors and power supply systems used in traction. CO3: Analyze traction control and braking methods. CO4: Perform testing and maintenance of traction equipment safely. CO5: Demonstrate practical knowledge of electric traction systems and energy management.		
Course Contents		Lecture hours	Practical hours
Module 1: Fundamentals of Electric Traction	Theory: Introduction to electric traction; advantages and disadvantages of electric traction; comparison with diesel traction systems; requirements of an ideal traction system; types of traction systems: steam traction, diesel traction, electric traction; applications of electric traction: railways, metro rail, tramways, electric vehicles. Practical: <ul style="list-style-type: none"> ● Study of components used in electric traction systems ● Identification and testing of traction motors. 	6	8
Module 2: Traction Power Supply Systems	Theory: Traction power supply arrangements; DC traction system; AC traction system; composite systems; overhead equipment (OHE); third rail system; substations for traction supply. Practical: <ul style="list-style-type: none"> ● Demonstration of traction substation and power distribution system 	6	4
Module 3: Traction Motors and Drives	Theory: Characteristics of traction motors; DC series motor for traction; three-phase induction motor; permanent magnet synchronous motor (PMSM); BLDC motor in traction applications; motor control methods; starting and speed control of traction motors; electric drives used in traction systems.	6	

	<p>Practical:</p> <ul style="list-style-type: none"> • Speed control of DC series motor used in traction. • Speed-torque characteristics of induction motor for traction applications. 		8
<p>Module 4: Regenerative Braking and Energy Management</p>	<p>Theory: Concept of regenerative braking; working principle of regenerative braking system; energy recovery methods; hybrid vehicle energy management strategies; fuel economy improvement techniques, drive cycle analysis.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Demonstration of regenerative braking system. • Analysis of energy flow during acceleration and braking. 	6	8
<p>Module 5: Protection, Maintenance, and Recent Trends</p>	<p>Theory: Protection systems in electric traction; faults in traction motors and power systems; safety precautions in traction systems; maintenance procedures of traction equipment; introduction to high-speed rail systems; modern electric traction and smart transportation; future trends in electric mobility.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Study and testing of regenerative braking system • Measurement of traction motor current, voltage, and speed • Study of traction motor starter and controller circuits • Testing of protection devices used in traction systems • Fault diagnosis in electric traction systems • Study of battery-powered traction systems for EVs • Simulation of train/EV traction drive 	6	32

	<ul style="list-style-type: none"> • Study of energy consumption during acceleration and braking 		
	Total	30	60
Textbook 1. Electric Traction — H. Partab — Dhanpat Rai Publications			
Reference Books 2. Fundamentals of Electric Drives — G. K. Dubey — Narosa Publishing House 3. A Textbook of Electrical Technology: Volume III (Transmission, Distribution and Utilization) — B. L. Theraja, A. K. Theraja — S. Chand Publications			

Course Code	PECDE403(PEC02)		
Course Title	Electric Vehicle Powertrain		
Number of Credits	4 (L:2, T:0, P:2)		
Objectives	<i>Understand the components and architecture of EV powertrains, including electric motors, batteries, power electronic converters, motor controllers, and basic control strategies. Develop knowledge of selection criteria, performance characteristics, testing, measurements, fault diagnosis, safety practices, standards, and maintenance procedures for EV systems and powertrain assemblies.</i>		
Course Outcomes (COs)	After completing this course, the student will be able to: CO1: Identify EV powertrain components and architectures (ICE hybrid, BEV, PHEV). CO2: Explain working principles and characteristics of traction motors and batteries. CO3: Analyze basic power electronic converters and motor control methods for EV applications. CO4: Conduct tests and measurements on batteries, motors and controllers; interpret results. CO5: Apply safety, charging, regenerative braking and simple integration concepts.		
	Course Contents	Lecture hours	Practical hours
Module 1: Introduction to EVs and Powertrain Architectures	Theory: Global trends, types of electric vehicles: BEV, PHEV, HEV, FCEV; EV powertrain overview: traction motor, transmission/gearbox, battery pack, BMS, power electronics, chargers; comparison of ICE and electric powertrains, advantages, limitations; basic performance parameters: torque, speed, power, efficiency, range, energy consumption (Wh/km).	6	

	<p>Practical:</p> <ul style="list-style-type: none"> • Familiarization with EV lab safety rules, PPE, HV isolation, emergency procedures. • Study and identification of EV powertrain components on a cutaway module or small EV kit. 		8
<p>Module 2: Electric Machines for Traction</p>	<p>Theory: Review of DC and AC machine fundamentals relevant to traction; brushless DC (BLDC), permanent magnet synchronous motor (PMSM); induction motor—construction; torque-speed characteristics; efficiency maps; motor selection criteria for small EVs: power density, torque density, peak vs continuous ratings, cooling and thermal limits; gearboxes and final drive considerations; direct drive vs geared drive.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Measurement of motor no-load characteristics and mechanical run-up tests (BLDC/PMSM/Induction). • Torque-speed test on traction motor; plot torque-speed and efficiency curves. • Motor controller (inverter) basic operation: switching waveforms, controlled start/stop, open-loop speed control. 	6	12
<p>Module 3: Energy Storage Systems (Battery Technology)</p>	<p>Theory: Battery fundamentals: cell types (lead-acid, NiMH, Li-ion chemistries), cell configuration (series/parallel), pack architecture; Battery performance parameters: capacity (Ah), energy (Wh), C-rate, internal resistance, State of Charge (SOC), State of Health (SOH); Battery Management System (BMS): functions—monitoring, balancing, protection, communication; Thermal management, charging methods, fast charging basics, safety and handling.</p>	6	

	<p>Practical:</p> <ul style="list-style-type: none"> ● Battery testing: capacity test, internal resistance measurement, simple charge-discharge cycle and SOC estimation. ● Experiment on how to operate the Electric Vehicle System Simulator Trainer ● BMS demo and data logging: cell voltage monitoring, balancing operation. 		12
<p>Module 4: Power Electronics and Motor Drives</p>	<p>Theory: Power semiconductor devices used in EVs (IGBT, MOSFET basics); DC-DC converters; DC-AC inverters; on-board chargers; bidirectional converters; inverter topologies for motor drive; PWM techniques; modulation basics; regenerative braking principles and integration with BMS and motor controls.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Inverter for a Three-Phase BLDC Electric Motor. ● DC-DC Converter (Step-Down/Buck Converter) ● Boost Converter (Step-Up Converter) 	6	12
<p>Module 5: Vehicle Integration, Controls and Safety</p>	<p>Theory: Vehicle-level energy flow, drive cycles, load estimation and range calculation; Basic traction control, torque control strategies, speed/torque controllers (PI control concepts); Safety standards and practices: isolation, grounding, high-voltage PPE, emergency disconnect; Diagnostic methods, troubleshooting typical faults in motors, controllers, batteries; Environmental, economic and maintenance considerations.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Observation of Electric Motor, Drivetrain and Power Flow: Battery Charging, Acceleration, 	6	16

	<p>Deceleration and Regenerative Braking, Driving Flat, Driving Up Hill, Driving Down Hill</p> <ul style="list-style-type: none"> • Regenerative braking test on a small EV platform or motor dynamometer; measure recovered energy. • Fault simulation and basic troubleshooting: overvoltage, short, sensor failure—identify and rectify (using safe procedures / low-voltage simulators). • Final mini-project / assembly: assemble and demonstrate a simple battery + motor + controller demo vehicle or rolling chassis with performance measured and presented. 		
Total		30	60
<p>Textbook</p> <ol style="list-style-type: none"> 1. Electric and Hybrid Vehicles: Design Fundamentals — Iqbal Husain — CRC Press 2. Electric Vehicle Technology Explained — James Larminie, John Lowry — Wiley Publications <p>Reference Books</p> <ol style="list-style-type: none"> 1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles — Mehrdad Ehsani, Yimin Gao, Sebastian Gay, Ali Emadi — CRC Press E 			

Course Code	PECDE404(PEC02)
Course Title	EV Testing and Maintenance
Number of Credits	4 (L:2, T:0, P:2)
Objectives	<i>Introduce EV-specific testing methods, instrumentation, standards, and diagnostic procedures for batteries, motors, and controllers. Develop practical skills in routine and corrective maintenance of EV subsystems, high-voltage safety practices, emergency procedures, maintenance documentation, and preventive maintenance planning.</i>
Course Outcomes (COs)	<p>After completing this course, the student will be able to:</p> <p>CO1: Explain EV testing standards, measurements and safety practices.</p> <p>CO2: Perform electrical and performance tests on traction motors, controllers and battery systems.</p> <p>CO3: Diagnose common faults in EV subsystems and propose corrective actions.</p> <p>CO4: Prepare preventive maintenance schedules and document</p>

	<p>maintenance activities.</p> <p>CO5: Demonstrate safe isolation, servicing and recommissioning of EV systems.</p>		
Course Contents		Lecture hours	Practical hours
<p>Module 1: Introduction to EV Maintenance & Safety</p>	<p>Theory: Overview of maintenance types: preventive, predictive, corrective, condition-based; regulatory and safety standards (national/international) for EV servicing; high-voltage system basics, PPE, isolation procedures, emergency response; service documentation: maintenance logs, fault history, service manuals.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Prepare the checklist for EV service maintenance • Familiarization with EV lab safety rules, PPE, HV isolation, emergency procedures. • Study and identification of EV powertrain components on a cutaway module or small EV kit. 	4	8
<p>Module 2: Instrumentation and Measurement Techniques</p>	<p>Theory: Measurement instruments: multimeter, clamp meter, insulation tester (megger), oscilloscope, power analyzer, battery cycler, thermal camera; measurement of DC/AC voltage, current, power, harmonics, insulation resistance; sensor testing: temperature, current shunts, Hall sensors, speed encoders; data acquisition and basic signal conditioning for diagnostics.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Measurement of Electrical Parameters Using Modern Electrical Instruments: Digital Multimeter, Clamp Meter, Oscilloscope, Power Analyzer, Insulation Tester (Megger), AC/DC Power Supply, Resistive and inductive loads, Connecting wires and probes. 	6	8

	<ul style="list-style-type: none"> • Testing and Calibration of Sensors Used in Electric and Hybrid Vehicles. 		
Module 3: Battery Testing, Diagnostics and Maintenance	<p>Theory: Battery health metrics: capacity test, C-rate, internal resistance, open circuit voltage, SOC & SOH estimation methods; test procedures: charge/discharge cycling, capacity measurement, pulse test, impedance spectroscopy (overview); BMS diagnostics: cell voltage imbalance, balancing circuits, thermal behavior, communication faults (CAN/serial); thermal management system checks, connectors and wiring integrity, battery pack-level maintenance and safe disposal/recycling considerations.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Battery testing: capacity test, internal resistance measurement, simple charge-discharge cycle and SOC estimation. • Experiment on how to operate the Electric Vehicle System Simulator Trainer. • BMS demo and data logging: cell voltage monitoring, balancing operation. 	8	12
Module 4: Motor, Inverter and Drivetrain Testing	<p>Theory: Motor testing: no-load, locked-rotor, torque-speed characterization, insulation resistance, bearing checks, vibration and thermal inspection; inverter/controller testing: switching waveform verification, gate drive checks, DC bus checks, short-circuit and overcurrent protection testing (simulated/low-voltage trainers); regenerative braking system evaluation, gearbox and differential checks, mechanical alignment and lubrication.</p> <p>Practical:</p>	6	20

	<ul style="list-style-type: none"> • Measurement of motor no-load characteristics and mechanical run-up tests (BLDC/PMSM/Induction). • Torque-speed test on traction motor; plot torque-speed and efficiency curves. • Motor controller (inverter) basic operation: switching waveforms, controlled start/stop, open-loop speed control. • Inverter for a Three-Phase BLDC Electric Motor. • DC-DC Converter (Step-Down/Buck Converter) • Boost Converter (Step-Up Converter) 		
Module 5: Fault Diagnosis, Troubleshooting and Maintenance Planning	<p>Theory: Systematic troubleshooting methodology: symptom collection, fault isolation, root-cause analysis; common faults: battery degradation, cell/CAN faults, controller faults, motor winding/insulation failures, connector failures; preventive maintenance schedule creation, spare parts management, calibration schedules, service economics; case studies, field service best practices and environmental/safety compliance for maintenance operations.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Fault simulation and basic troubleshooting: overvoltage, short, sensor failure—identify and rectify (using safe procedures / low-voltage simulators). • CAN bus electric vehicle system trainer fault analysis • Final mini-project: To assemble and demonstrate a simple EV model, and evaluate the performance characteristics. 	6	12
	Total	30	60

Textbooks

1. Advanced Electric Drive Vehicles — Ali Emadi — CRC Press
2. Electric Vehicle Technology Explained — James Larminie, John Lowry — Wiley Publications

Reference Books

1. Electric and Hybrid Vehicles — Tom Denton — Routledge Publications

Course Code	PECDE405(PEC02)		
Course Title	Automotive Engines		
Number of Credits	4 (L:2, T:0, P:2)		
Objectives	<i>Understand the fundamentals, construction, and working principles of automotive engines, including SI and CI engines, fuel systems, lubrication, cooling, ignition, and emission control systems. Develop practical skills in engine testing, diagnostics, maintenance, modern engine technologies, and automotive safety practices.</i>		
Course Outcomes (COs)	<p>After completing this course, the student will be able to:</p> <p>CO1: Explain the fundamentals and classifications of automotive engines.</p> <p>CO2: Describe the working principle and components of SI and CI engines.</p> <p>CO3: Analyze fuel supply, cooling, lubrication, and ignition systems.</p> <p>CO4: Perform testing, servicing, and troubleshooting of automotive engines.</p> <p>CO5: Understand emission control systems and recent trends in automotive engine technology.</p>		
	Course Contents	Lecture hours	Practical hours
Module 1: Introduction to Automotive Engines	<p>Theory: Introduction to automotive engines; classification of engines: two-stroke and four-stroke engines, spark ignition (SI) and compression ignition (CI) engines, air-cooled and water-cooled engines; working principle of IC engines; engine terminology: bore, stroke, compression ratio, swept volume, TDC and BDC, engine performance parameters,</p> <p>Practical:</p> <ul style="list-style-type: none"> • Identification of major components of SI and CI engines 	6	12

	<ul style="list-style-type: none"> • Study of two-stroke and four-stroke engine operation • Valve timing diagram demonstration 		
Module 2: Engine Construction and Components	<p>Theory: Cylinder block and cylinder head; piston; piston rings, and connecting rod; crankshaft and camshaft; valves and valve timing diagram; flywheel and crankcase; intake and exhaust manifold; engine lubrication system; cooling system: air cooling, water cooling</p> <p>Practical:</p> <ul style="list-style-type: none"> • Dismantling and assembly of single-cylinder engine • Study and testing of lubrication system • Study of engine cooling systems 	6	14
Module 3: Fuel Supply and Ignition Systems	<p>Theory: Fuel supply system in SI engines; carburetor and fuel injection system; diesel fuel injection system; Electronic Fuel Injection (EFI); Ignition systems: battery ignition, magneto ignition, electronic ignition; fuel properties and combustion process.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Carburetor tuning and adjustment • Study of diesel fuel injection system • Testing of battery ignition and electronic ignition systems • Measurement of engine speed, fuel consumption, and power 	6	14
Module 4: Engine Performance, Emission, and Control	<p>Theory: Engine performance characteristics; brake power and indicated power; mechanical efficiency and thermal efficiency; engine emissions: CO, NO_x, HC, particulate matter; emission control techniques; catalytic converter; introduction to Engine Control Unit (ECU).</p> <p>Practical:</p>	6	8

	<ul style="list-style-type: none"> • Compression testing of IC engine • Observation and analysis of engine exhaust emissions 		
Module 5: Maintenance, Diagnostics, and Modern Trends	<p>Theory: Engine servicing and preventive maintenance; common engine faults and troubleshooting; compression testing; engine diagnostics using OBD; safety precautions during engine servicing; hybrid engine systems overview; alternative fuels: CNG, LPG, biofuels; future trends in automotive engines.</p> <p>Practical:</p> <ul style="list-style-type: none"> • Engine fault diagnosis using OBD scanner • Preventive maintenance and servicing of automotive engine • Mini project on automotive engine system or engine performance analysis 	6	12
Total		30	60
Suggested Reading			
Textbook			
<ol style="list-style-type: none"> 1. Internal Combustion Engines — V. Ganesan — McGraw Hill Education 2. Automobile Engineering — Kirpal Singh — Standard Publishers Distributors 			
Reference Books			
<ol style="list-style-type: none"> 1. A Course in Internal Combustion Engines — J. B. Heywood — McGraw Hill Education 			

Course Code	PECDE406(PEC-03)
Course Title	Power Generation (Conventional and Non-Conventional)
Number of Credits	3 (L:1, T:0, P:2)
Objectives	<i>To provide basic knowledge of conventional and non-conventional power generation resources and systems, their working principles, components, and operation, and to develop an understanding of the applicability of non-conventional energy technologies to eco-friendly power generation and sustainable development.</i>
Course Outcomes (COs)	<p>CO1: Understand with different energy resources and power generation systems</p> <p>CO2: Describe the working principles and operation of conventional power plants</p> <p>CO3: Explain and analyse the working and characteristics renewable energy systems related to solar, wind, biomass,</p>

	<p>small hydropower, geothermal, and ocean energy technologies.</p> <p>CO4: Evaluate the emerging renewable technologies and recent development in sustainable power generation systems.</p> <p>CO5: Illustrate the experimental setups and models of different conventional and non-conventional power generation systems.</p>		
Course Contents		Lecture hours	Practical hours
Module I: Introduction to power generation	<p>Theory: Energy demand in India and Global aspect; energy and its unit; energy resources and classification; comparison between conventional and non-conventional energy sources; need for renewable energy; opportunities in renewable energy; environmental impact of power generation.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To familiarize with different energy resources and their existing generation capacity in the Indian scenario. • Comparative analysis of renewable and non-renewable energy resources. 	1	4
Module II: Conventional Energy	<p>Theory: Thermal power plant: principle, working of steam power plant, components, advantages and disadvantages. Hydroelectric power plant: principle, classification, components, advantages and disadvantages. Nuclear power plant: nuclear fission and fusion, components, advantages and disadvantages. Diesel power plant: working, components, advantages and limitations.</p> <p>Practical: Visit the canteen/academic block/hostel/any other official building of your campus, make a list of all appliances used in campus, note down</p>	3	4

	the hours of usage and estimate daily and monthly electricity consumption.		
Module III: Solar Energy	<p>Theory: Solar radiation and measurement; fundamentals of solar energy; solar energy conversion principles. Solar photovoltaic: introduction to semiconductor physics; doping; p-n junction; solar cell; I-V characteristics; PV systems components; balance of solar PV system, design of PV system. Solar thermal energy: basics of heat transfer; types of solar thermal collectors; solar thermal energy storage.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● To measure the sunshine duration using sunshine recorder ● To study and compare the instantaneous solar irradiation (W/m^2) inside a classroom, under cloudy condition, and under clear sunny sky condition. ● To study the electrical characteristics of solar panel. ● To study the electrical characteristics of solar panel under varying orientations. ● To analyse the tracking system of a solar panel. ● To analyse different converters used in solar power system ● To measure the efficiency of MPPT charge controller ● To analyse the effect of shading on solar PV modules. ● To analyse the effect of dust on solar PV modules. ● To study the stand-alone solar power generation system. ● To study the operational working of Grid Tied using Solar Power Generation Training System. 	4	
Module IV: Wind Energy	<p>Theory: Wind resource analysis; wind speed statistics: mean wind speed, variance,</p>	3	

	<p>standard deviation; wind turbine aerodynamics; wind energy conversion systems.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To determine the power generation by a wind turbine. • To study the performance of wind turbine. • To study hybrid solar and wind power generation. 		8
<p>Module V: Biomass Energy, Small Hydropower Energy, Geothermal Energy and Ocean Energy</p>	<p>Theory: Biomass energy: basics of biomass energy; principles of biomass energy conversion; biomass energy systems. Small hydropower energy: fundamentals of hydropower; hydro resources; types of hydro turbine; small hydro systems. Introduction to Geothermal and Ocean energy.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To demonstrate conversion of Mechanical Energy into Electrical Energy using a hydropower system. • To study the performance of hydropower systems under various load conditions. • To determine the turbine efficiency in a small hydro setup. • Study the geothermal and ocean energy technology 	3	8
<p>Module VI: Emerging Technologies</p>	<p>Theory: Fuel cell; hydrogen as energy carrier; hybrid energy system.</p> <p>Practical:</p> <ul style="list-style-type: none"> • To study generation of hydrogen by using hydrogen generator. • To test the fuel cell at different load condition. • To study the IV characteristics of fuel cell. • To present a model demonstrating hybrid power generation system. 	1	8
Total		15	60
Textbooks			

1. B H Khan, "Non-conventional Energy Resources", Third Edition, Mc Graw Hill.
2. Chetan Singh Solanki, "Solar Photovoltaic- Fundamentals, Technologies and Applications", Third Edition, PHI Learning Private Limited, 2015.

Reference Books

1. Chetan Singh Solanki, "Solar Photovoltaic Technologies and Systems: A manual for Technicians, Trainers and Engineers", PHI Learning Private Limited, 2019.
2. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.
3. John Twidell, "Renewable Energy Resources", Fourth Edition, Routledge, Taylor & Francis Group.
4. Robert A. Huggins, "Energy Storage", Springer Science (ISBN - 978 -1-4419-1023-3), 2010.

Course Code	PECDE407(PEC-03)		
Course Title	Switchgear and Protection		
Number of Credits	3 (L:1, T:0, P:2)		
Objectives	<i>This course provides basic knowledge of switchgear and electrical protection systems used in power networks. Students will learn about protective devices, fault protection methods, testing, maintenance, and modern digital protection techniques.</i>		
Course Outcomes (COs)	<p>CO1: Identify various components of switchgear and control panel.</p> <p>CO2: Understand construction and working of components used in protective systems.</p> <p>CO3: Understand principles and procedural aspects of switchgear and protection.</p> <p>CO4: Understand sequence of operation of switchgear.</p> <p>CO5: Identify faults and perform basic troubleshooting and repair.</p> <p>CO6: Develop operational skills related to switchgear and protection systems.</p>		
	Course Content	Lecture hours	Practical hours
Module I: Fundamentals of Protection and Relays	<p>Theory:</p> <p>Elements of Protection</p> <p>Normal and abnormal conditions in power systems; functions of protective system; basic elements of protection and backup protection.</p> <p>Protective Relays</p> <p>Concept and purpose of protective relay; general principles of relay operation; basic relay terminology; time and current settings; electromagnetic and induction</p>	3	

	<p>type relays; introduction to static relays and comparison with electromagnetic relays.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● To study different types of equipment in switchgear & Protection lab ● Study of Overcurrent Relay ● Time-Current Characteristics of Overcurrent Relay ● To study the operation of Numerical Overvoltage and Undervoltage Relay. ● Plug Setting Multiplier (PSM) Calculation and Time Multiplier Setting (TMS) Effect ● Earth Fault Protection ● To plot the characteristics of Electromagnetic IDMT Relay. 		12
<p>Module II: Circuit Interrupting Devices</p>	<p>Theory: Circuit Interrupting Devices: Necessity of interrupting devices, Difference between switch, isolator and circuit breaker, Isolators: requirements and types,</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Identification and comparison of solid, resistance, reactance, and resonant earthing methods. ● Demonstration of Neutral Earthing in Electrical System ● Circuit Breaker Trip Operation ● Study of Interlocking System in Substations with demonstration of circuit breaker and isolator operation. 	2	12
<p>Module III: Arc Phenomenon and Circuit Breakers</p>	<p>Theory: Arc Formation Process: Arc phenomenon; principles of arc extinction; zero current interruption method; restriking voltage; recovery voltage; RRRV; current chopping and resistance switching.</p> <p>Circuit Breakers: Working principle of circuit breakers and type; air circuit breaker and air blast circuit breaker; SF6 and vacuum circuit breaker; merits and demerits of various circuit breakers.</p> <p>Practical:</p>	4	14

	<ul style="list-style-type: none"> ● Demonstration of Arc Formation and Arc Extinction ● Study of Recovery Voltage and Restriking Voltage Using Trainer/Simulation ● Demonstration of switching transient reduction using resistive switching circuit ● Study of Circuit Breaker Trip Operation ● Study of Air Circuit Breaker (ACB) ● Study of SF₆ Circuit Breaker and Vacuum Circuit Breaker 		
Module IV: Protection Schemes for Power System Equipment	<p>Theory:</p> <p>Abnormalities and faults in alternators and transformers, Overcurrent protection, Differential protection, Earth fault protection, Buchholz relay.</p> <p>Causes of faults in feeders and transmission lines, Distance protection, Pilot wire protection, Translay scheme.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Demonstration of Overcurrent Protection in Alternator/Transformer Setup ● Study of Merz-Price Protection Scheme Model ● Demonstration of negative sequence protection concept. ● Study of Field Failure Protection in Alternator ● Differential Protection of 3-Phase Transformer ● Study of Distance Protection Principle Using Relay Trainer ● Earth Fault Protection of Transmission Line/Feeder 	3	14
Module V: Over Voltage Protection and Digital Protection Systems	<p>Theory:</p> <p>Over Voltage Protection: Causes and effects of overvoltage, Methods of reducing overvoltage, Function of ground wire, Mechanism of lightning, Lightning arresters: rod gap, horn gap, thyrite</p>	3	

	arrester and surge absorber Digital Protection and Control: Introduction to digital protection Scheme. Practical: <ul style="list-style-type: none"> ● Preventive maintenance checklist preparation. ● Study of Digital Protection Panels and Relay Architecture ● Remote Monitoring of Electrical Parameters Using Digital Interface ● Fault Simulation and Real-Time Trip Monitoring via Ethernet System 		8
Total		15	60
Text Books: <ol style="list-style-type: none"> 1. Switchgear and Protection by Sunil S. Rao, Khanna Publishers. 2. Power System Protection and Switchgear by Badri Ram and D. N. Vishwakarma, McGraw Hill Education India. Reference Books: <ol style="list-style-type: none"> 1. A Textbook of Electrical Technology Volume III by B. L. Theraja and A. K. Theraja, S. Chand Publishing. 2. Electrical Power Systems by C. L. Wadhwa, New Age International Publishers. 3. Power System Engineering by I. J. Nagrath and D. P. Kothari, McGraw Hill Education India 4. Power System Protection and Switchgear by B. Ravindranath and M. Chander, New Age International Publishers 			

Course Code	PCCDE408
Course Title	Fundamental of Power Electronics
Number of Credits	4 (L:2, T:0, P:2)
Objectives	<i>Understand the characteristics and operation of semiconductor devices such as SCRs, MOSFETs, and IGBTs, along with rectifiers, choppers, inverters, and AC voltage controllers. Learn PWM and phase control techniques, converter performance analysis, and applications in motor drives, SMPS, UPS, and renewable energy systems while developing practical skills in testing, troubleshooting, and safe maintenance of power electronic hardware.</i>
Course Outcomes (COs)	CO1: Understand the construction, characteristics, triggering methods, commutation techniques, protection methods and applications of SCR, power semiconductor devices and related switching components used in power electronics circuits.. CO2: Analyze the operation and performance of phase-controlled rectifiers with different types of loads, evaluate output voltage

	<p>characteristics, and solve numerical problems related to controlled rectifier circuits.</p> <p>CO3: Analyze the principles, operations, and control strategies of DC-to-DC converter (chopper) circuits, and evaluate their applications in semiconductor drives and electric vehicles.</p> <p>CO4: Analyze the operation and waveforms of single-phase series, parallel, and bridge inverters (VSI, CSI, and PWM) and evaluate their quality using performance parameters.</p> <p>CO5: Analyze the operation, topologies, and control techniques of AC-to-AC converters and Switched-Mode Power Supplies (SMPS) while evaluating their performance and efficiency for power electronic applications.</p> <p>CO6: Perform and analyze power electronics laboratory experiments using rectifiers, choppers, inverters, and switching devices safely and effectively.</p>		
Course Content		Lecture hours	Practical hours
Module I: Power Semi- Conductor Devices	<p>Theory: Construction and forward/reverse characteristics of SCR, concept of latching current and holding current, applications of SCR, triggering methods and gate characteristics. Basic gate triggering circuits including R-C and UJT firing circuits, commutation methods of SCR, series and parallel operation of SCR, and protection against overvoltage, overcurrent, dv/dt and di/dt. Characteristics and applications of Bipolar Junction Transistor (BJT), enhancement type Power MOSFET, UJT, Gate Turn-Off Thyristor (GTO), Light Activated SCR (LASCR), DIAC and TRIAC.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of different triggering methods ● Study of SCRs ● Study of power BJT ● Study of MOSFET 	7	10
Module II: AC to DC Converters	<p>Theory: Operation of phase-controlled rectifiers with resistive and resistive-inductive loads, use of freewheeling diode, single-phase half-controlled and fully controlled bridge rectifiers, calculation</p>	7	

	<p>of average and RMS output voltage.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of Single-Phase Half Wave Controlled Rectifier with Lamp Load. ● Study of Single-Phase Full Wave Controlled Rectifier with Lamp Load ● Study of Single-Phase Full Wave Controlled Rectifier with Motor Load. ● Study of Single-Phase Full Wave Controlled Rectifier (Effect of Freewheeling Diode) with Motor Load ● Study of single-phase bridge controller rectifier with motor load 		20
<p>Module III: Choppers: DC to DC converter</p>	<p>Theory: Introduction to choppers, principle of operation, types of choppers, step-up and step-down choppers, single quadrant and multi-quadrant choppers, duty cycle control methods, chopper circuits using semiconductor devices, commutation techniques, advantages and applications of choppers in speed control of D.C. motors / electric vehicles and industrial drives.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of Boost Rectifier ● Study of Buck Converter ● Study of buck-boost converter ● Study of commutation circuits 	7	12
<p>Module IV: Inverter: DC to AC converter</p>	<p>Theory: Single phase series inverters, output voltage and current wave forms, principle of operation of bridge inverters, concept of voltage source, current source and pulse width modulated bridge inverters.</p> <p>Practical:</p> <ul style="list-style-type: none"> ● Study of gate pulse generating circuit for a multilevel inverter. ● Study of PWM Circuit ● Study of inverter 	5	8
<p>Module V:</p>	<p>Theory:</p>		

AC to AC Converters	AC voltage controllers and cyclo-converters, Switched-mode power supplies (SMPS), Uninterruptible Power Supply Practical: <ul style="list-style-type: none"> ● Study of Cycloconverter Firing Circuit ● Study of Single Phase Cycloconverter with Lamp Load ● Study of SMPS 	4	10
Total		30	60
Text Books:			
1. P.S Bimbhra, Power Electronics, Khanna Publisher, New Delhi latest edition			
2. P.C Sen, Power Electronics			
Reference Books:			
1. Rashid, Muhammad H., Power Electronics PHI Learning, New Delhi latest edition			
2. Singh, M. D. K. Khanchandani, B, Power Electronics, Tata Mc. Graw Hill, New Delhi			
3. Gupta, B. R., Singhal V., Power Electronics, S.K Kataria and sons			

Course Code	HSMD402		
Course Title	Entrepreneurship and Startups		
Number of Credits	2 (L:0, T:0, P:2)		
Objectives	<i>To provide fundamental knowledge of entrepreneurship, startup ecosystems, business planning, startup management, and financing mechanisms. The course aims to develop entrepreneurial motivation to pursue entrepreneurship as a viable career option.</i>		
Course Outcomes (COs)	<p>CO1: Introduce students to the fundamentals of entrepreneurship and startup ecosystems.</p> <p>CO2: Develop entrepreneurial thinking, creativity, and innovation skills.</p> <p>CO3: Familiarize students with startup formation, business models, and financing.</p> <p>CO4: Enable students to understand business planning and startup management.</p> <p>CO5: Encourage students to explore entrepreneurship as a career option.</p>		
Course Contents			Lecture hours (Practical)

Module I: Foundations of Entrepreneurship	Entrepreneur and Entrepreneurial Traits, Types of Entrepreneurs, Entrepreneurship and Economic Development, Entrepreneurship vs. Intrapreneurship, Entrepreneurial Competencies and Skills, Startup Culture and Entrepreneurship in India, Business Problem Identification and Problem Solution.	12
Module II: Creativity, Innovation and Opportunity Recognition	Creativity and Innovation: Concepts and Importance, Sources of Business Ideas, Opportunity Identification and Evaluation, Design Thinking Basics, Innovation and Entrepreneurship.	11
Module III: Startup Formation and Business Models	Startup Lifecycle, Lean Startup Concept, Business Model Canvas, Forms of Business Ownership, Basics of Intellectual Property Rights (IPR), Legal and Registration Requirements for Startups.	11
Module IV: Business Planning and Startup Finance	Business Plan: Meaning and Importance, Components of a Business Plan, Market and Feasibility Analysis, Financial Planning Basics, Sources of Startup Finance: Bootstrapping, Angel Investment, Venture Capital, Crowdfunding, Government Support and Startup India Initiative.	15
Module V: Managing and Scaling Startups	Startup Growth Strategies, Marketing for Startups, Challenges and Causes of Startup Failure, Ethics and Sustainability in Entrepreneurship.	11
Total		60
<p>Textbook:</p> <p>1. Entrepreneurship Development and Business Ethics — Poornima M. Charantimath, Oxford University Press, ISBN 978-81-7758-260-4.</p> <p>Reference Books</p> <p>1. Entrepreneurship — Robert D. Hisrich, Michael Peters & Dean Shepherd, McGraw Hill, 939011330X · 9789390113309, 11th Edition, Published: July 20, 2020.</p> <p>2. Entrepreneurship Development (5th Edition) — S. S. Khanka, S. Chand Publications, ISBN: 9789369582396</p>		