M. Tech. in Electrical Engineering Stream			
Advanced Engineering Mathematics Common to EPS, EPE, ESE and EVT			
Course Code	1MEEMAT101	Scheme	2026
Type of Course	Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Apply direct, iterative, and eigenvalue methods to solve systems of linear equations and matrix eigenvalue problems.

CO2: Analyse vector spaces, subspaces, linear independence, basis, and linear transformations.

CO3: Apply orthogonalization techniques, QR decomposition, and singular value decomposition to solve engineering problems.

CO4: Analyse probability distributions, joint distributions, covariance, and correlation for engineering applications.

CO5: Evaluate moments, transformations of random variables, characteristic functions, and entropy-based measures in engineering systems.

Module-1

Linear Algebra: Solution of Systems of Linear Equations: Direct Methods-Partition method, Croute's Triangularisation method. Iterative method- relaxation method. Eigen values and Eigen vectors. Bounds on Eigen Values. Jacobi method & Givens method for symmetric matrices.

Number of Hours:09

Module-2

Vector Space 1: Introduction to vectors paces and sub-spaces, definitions column, Null spaces. Linearly independent and dependent vectors-Basis definition and problems. Linear transformations definitions. Matrix form of linear Transformations.

Number of Hours:08

Module-3

Vector Space 2: Orthogonal vectors and orthogonal bases. Gram-Schmidt Orthogonalization process. QR decomposition, Singular value decomposition. Applications.

Number of Hours:08

Module-4

Probability distribution functions: Review of basic probability theory. Random variables, Probability distributions: Binomial, Poisson, uniform, and Normal (Gaussian) and Erlang distributions. Joint probability distribution (discrete and continuous). Independent random variables, covariance and correlation.

Number of Hours:09

Module-5

Moments and Transformation of random variables: Moments, Central moments, Transformation of random variables Characteristic functions, probability generating and moment generating functions. Engineering applications: Entropy and Source coding.

Number of Hours:08

Textbooks:

(i)Linear Algebra and its Applications, David C.Lay et al, Pearson, 5th Edition, 2015.

(ii)Numerical Methods for Scientific and Engineering Computation, M. K. Jain, et al, New Age International, 9th Edition, 2014.
(iii)Probability and Random Processes, Scott L. Miller, Donald G.Childers. Elsevier 2004

Reference Books

(i)Numerical methods for Engineers, Steven C Chapra and Raymond P Canale, McGrawHill,7th Edition, 2015.
(ii)Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 44th Edition, 2017
(iii)Advanced Engineering Mathematics, E. Kreyszig, Wiley, 10thedition, 2015.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.
A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]
A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.
In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream

Modelling and Analysis of Electrical Machines

(Common to EPS, EPE, ESE and EVT)

Course Code	1MEE102	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0: 0 :48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Model electrical machines using magnetically coupled circuits, winding inductances, and electromechanical energy conversion principles.

CO2: Develop dynamic, state-space, and block-diagram models of DC machines.

CO3: Apply reference-frame transformations to analyse electrical machine voltage and torque equations.

CO4: Model and analyse symmetrical induction machines under steady-state and dynamic conditions.

CO5: Analyse synchronous machines under steady-state and transient conditions, including transient stability using the equal-area criterion.

Module-1

Magnetically coupled circuits: Electromechanical energy conversion, machine windings and air-gap MMF, winding inductances and voltage equations of electrical machines.

Number of Hours:09

Module-2

DIRECT-CURRENT MACHINES: Introduction, Elementary Direct-Current Machine, Voltage and Torque Equations, Dynamic Characteristics of Permanent-Magnet and Shunt DC Motors, Time-Domain Block Diagrams and State Equations.

Number of Hours:08

Module-3

REFERENCE-FRAME THEORY: Introduction, Background, Equations of Transformation:Changes of Variables, Stationary Circuit Variables Transformed to the Arbitrary Reference Frame, Commonly Used Reference Frames, Transformation Between Reference Frames, Transformation of a Balanced Set, Balanced Steady-State Phasor Relationships, Balanced Steady-State Voltage Equations, Variables Observed from Several Frames of Reference.

Number of Hours:08

Module-4

SYMMETRICAL INDUCTION MACHINES: Introduction, Voltage Equations in Machine Variables, Torque Equation in Machine Variables, Equations of Transformation for Rotor Circuits, Voltage Equations in Arbitrary Reference-Frame Variables, Torque Equation in Arbitrary Reference-Frame Variables, Commonly Used Reference Frames, Per Unit System, Analysis of Steady-State Operation, Free Acceleration Characteristics, Free Acceleration Characteristics Viewed from Various Reference Frames, Dynamic Performance During Sudden Changes in Load Torque, Dynamic Performance During a 3-Phase Fault at the Machine Terminals, Computer Simulation in the Arbitrary Reference Frame.

Number of Hours:08

Module-5

SYNCHRONOUS MACHINES: Introduction, Voltage Equations in Machine Variables, Torque Equation in Machine Variables, Stator Voltage Equations in Arbitrary Reference-Frame Variables, Voltage Equations in Rotor Reference-Frame Variables: Park's Equations, Torque Equations in Substitute Variables, Rotor Angle and Angle Between Rotors, Per Unit System, Analysis of Steady-State Operation, Dynamic Performance During a Sudden Change in Input Torque, Dynamic Performance During a 3-Phase Fault at the Machine Terminals, Approximate Transient Torque Versus Rotor Angle Characteristics, First Swing Transient Stability Limit, Critical Clearing Time, Equal-Area Criterion.

Number of Hours:09

Textbooks:

Analysis of Electric Machinery and Drive Systems, Paul C Krause, Oleg Wasynczuk, Scott D.Sudhoff, Second Edition, IEEE Press, 2002. (Refer to chapter 1,2,3,4, and 5)

Reference Books

R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall, 2001.

Reference NPTEL Video Course: Modelling and Analysis of Electric Machines, IIT Madras, Dr. Krishna Vasudevan.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
Power Electronic Converters (Common to EPS, EPE, ESE and EVT)			
Course Code	1MEE103	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0: 0 :48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

CO1: Analyse the performance of uncontrolled and controlled rectifiers under different load conditions.

CO2: Analyse and compare DC–DC converter topologies and their operating characteristics.

CO3: Analyse single-phase and three-phase inverters and their voltage-control techniques.

CO4: Apply PWM and Space Vector Modulation techniques for voltage control and harmonic reduction in inverters.

CO5: Analyse resonant inverters and converters using Zero-Current Switching (ZCS) and Zero-Voltage Switching (ZVS) techniques.

Module-1

Uncontrolled Rectifiers: Introduction, Performance Parameters, Three-Phase Bridge Rectifiers, Three-Phase Bridge Rectifier with RL Load, Three-Phase Rectifier with a Highly Inductive Load, Comparisons of Diode Rectifiers.

Controlled Rectifiers: Introduction, Single-Phase Full Converters, Single-Phase Full Converter with RL Load. Three-Phase Full Converters, Three-Phase Full Converter with RL Load. Pulse-Width-Modulation Control: PWM Control, Single-Phase Sinusoidal PWM, Three-Phase PWM Rectifier. Twelve-Pulse Converters, Design of Converter Circuits, Effects of Load and Source Inductances.

Number of Hours:09

Module-2

DC–DC Converters: Introduction, Performance Parameters of DC–DC Converters, Principle of Step-Down Operation, Generation of Duty Cycle, Step-Down Converter with RL Load, Principle of Step-Up Operation, Step-Up Converter with a Resistive Load, Frequency Limiting Parameters, Converter Classification, Switching-Mode Regulators: Buck Regulators, Boost Regulators, Buck–Boost Regulators, Cúk Regulators, Limitations of Single-Stage Conversion, Comparison of Regulators. [Power electronics devices, circuits, and applications.

Number of Hours:09

Module-3

DC–AC Converters (Inverters): Introduction, Performance Parameters, Principle of Operation, Single-Phase Bridge Inverters, Three-Phase Inverters, 180-Degree Conduction, 120-Degree Conduction, Voltage Control of Single-Phase Inverters: Multiple-Pulse-Width Modulation, Sinusoidal Pulse-Width Modulation, Modified Sinusoidal Pulse-Width Modulation, Phase-Displacement Control.

Number of Hours:08

Module-4

DC–AC Converters (Continued): Voltage Control of Three-Phase Inverters, Sinusoidal PWM, 60-Degree PWM, Third-Harmonic PWM, Space Vector Modulation, Comparison of PWM Techniques,

Harmonic Reductions, Current-Source Inverters, Variable DC-Link Inverter, Boost Inverter, Inverter Circuit Design.

Number of Hours:08

Module-5

Resonant Pulse Inverters: Introduction, Series Resonant Inverters, Series Resonant Inverters with Unidirectional Switches, Parallel Resonant Inverters, Voltage Control of Resonant Inverters, Class E Resonant Inverter, Class E Resonant Rectifier, Zero-Current-Switching Resonant Converters: L-Type ZCS Resonant Converter, M-Type ZCS Resonant Converter. Zero-Voltage-Switching Resonant Converters, Comparisons Between ZCS and ZVS Resonant Converters.

Number of Hours:08

Textbook

Power Electronics Devices, Circuits, and Applications Fourth Edition, Muhammad H. Rashid, Pearson. (Refer to chapters 3,10,5,6, and 7)

Reference Books

(i)Power Electronics: Converters, Applications, and Design, Ned Mohan, 3rd Edition, John Wiley & Sons.

(ii)Fundamentals of Power Electronics, Robert W. Erickson, 2nd Edition, Springer.

(iii)Power Electronics: Essentials and Applications, L. Umanand, Wiley India.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
Power Systems Operation, Stability, Protection and PQ (Common to EPS, EPE, and ESE)			
Course Code	1MEE104	Scheme	2026
Type of Course	Professional core Course	Semester	I
Teaching Hours/Week (L:T:P)	4:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	56:0: 0 :64	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Analyse generator voltage, frequency, and power-system stabiliser controls.

CO2: Analyse reactive-power requirements and compensation of transmission systems.

CO3: Apply protection principles and relay characteristics for protection of power-system components.

CO4: Analyse travelling waves, transient overvoltages, and insulation coordination in transmission systems.

CO5: Identify, analyse, and evaluate major power-quality disturbances and applicable standards.

Module-1

Power System Controls: Generator-Voltage Control, Turbine-Governor Control, Load-Frequency Control, Power System Stabilizer Control.

Load Compensation and Reactive Power Characteristics: Introduction: The Requirement for Compensation, Objectives in Load Compensation, The Ideal Compensator: Practical Considerations, Loads Requiring Compensation, Acceptance Standards for the Quality of Supply, Specification of a Load Compensator. Power Factor and Its Correction, Voltage Regulation, Approximate Reactive Power Characteristics, Voltage Regulation with a Varying Inductive Load, Power Factor Improvement, Reactive Power Bias, Load Compensator as a Voltage Regulator.

Number of Hours:12

Module-2

Steady-State Reactive Power Control in Electric Transmission Systems: Introduction Uncompensated Transmission Lines: Electrical Parameters, Fundamental Transmission Line Equation, Surge Impedance and Natural Loading, The Uncompensated Line on Open-Circuit, The Uncompensated Line Under Load: Effect of Line Length, Load Power, and Power Factor on Voltage and Reactive Power, The Uncompensated Line Under Load: Maximum Power and Stability Considerations. Compensated Transmission Lines, Passive and Active Compensators.

Number of Hours:10

Module-3

Power System Protection: System Protection Components, Instrument Transformers, Overcurrent Relays, Radial System Protection, Reclosers, Fuses, and Sectionalizers, Directional Relays, Protection of a Two-Source System with Directional Relays, Zones of Protection, Line Protection with Impedance (Distance)Relays, Differential Relays, Bus Protection with Differential Relays, Transformer Protection with Differential Relays, Pilot Relaying, Numeric Relaying.

Number of Hours:10

Module-4

Transmission lines transient operation: Traveling Waves on Single-Phase Lossless Lines, Boundary Conditions for Single-Phase Lossless Lines, Bewley Lattice Diagram, Discrete-Time Models of Single-Phase Lossless Lines and Lumped RLC Elements, Lossy Lines, Multiconductor Lines, Power System Over voltages, Insulation Coordination.

Number of Hours:12

Module-5

Introduction to power quality: Definition of power quality, Causes of disturbances in power systems, Classification of power quality issues, Formulations and measures used for power quality, Effects of poor power quality on power system devices, Standards and guidelines referring to power quality.

Number of Hours:12

Textbooks:

(i)Power System Analysis and Design, J. Duncan Glover, et. Al. Seventh Edition, 2022 Cengage Learning. (Refer to chapters 13, 11, and 14)

(ii)Reactive Power Control in Electric Systems, T. J. E. Miller, John Wiley & Sons, 1982. (Refer to chapters 1 and 2)

(iii)Power Quality in Power Systems, Electrical Machines, and Power-Electronic Drives, Ewald F. Fuchs and Mohammad A. S. Masoum, Third Edition, 2023. (Refer to chapter 1)

Reference Books

(i)Power System Stability and Control, Prabha Kundur, McGraw-Hill, 1994.

(ii)Power System Control and Stability, P. M. Anderson and A. A. Fouad, 2nd Edition, Wiley-IEEE Press, 2003.

(iii)Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and H. Wayne Beaty, Electrical Power Systems Quality, 3rd Edition, McGraw-Hill, 2012.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
BEVs Powertrain (For EVT only)			
Course Code	1MEVT104	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	4:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	56:0: 0 :64	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Analyse BEV architecture, vehicle dynamics, energy flow, and drivetrain configurations.

CO2: Analyse battery characteristics, models, charging, and Battery Management Systems.

CO3: Evaluate electric motor drives, power converters, and control strategies for EV propulsion.

CO4: Apply vehicle controllers, CAN communication, and functional-safety concepts in EV systems.

CO5: Analyse EV power transmission, braking, thermal management, and vehicle–grid interactions.

Module-1

Battery Electric Vehicles (BEVs): Engineering philosophy of EVs, EV concept, EV engineering philosophy Key EV technologies: Body design, Electric propulsion, Energy sources, Energy management, System optimization.

Environmental Protection Agency (EPA), Drive Cycles, BEV Fuel Consumption, Range, and mpge, An Overview of Battery Systems, BEVs: BEV architecture and energy flow.

Vehicle Dynamics: Vehicle Load Forces, Basic Power, Energy, and Speed Relationships, Aerodynamic Drag, Rolling Resistance, Vehicle Road-Load Coefficients from EPA Coast-Down Testing, Battery Electric Vehicle Range at Constant Speed, Gradability, Vehicle Acceleration, Regenerative Braking of the Vehicle, Traction Motor Characteristics, Acceleration of the Vehicle, Simple Drive Cycle for Vehicle Comparisons, Numerical.

Drivetrain layouts of electric two-wheelers: Introduction, hub-motor and mid-drive configurations; single-motor rear-wheel-drive (RWD), single-speed and two-speed transmission configurations.

Number of Hours:13

Module-2

Battery Energy Storage: Batteries in electric and hybrid vehicles, battery basics, battery cell structure, chemical reactions, Battery Parameters, Battery Capacity, Open-Circuit Voltage, Terminal Voltage, Practical Capacity, Discharge Rate, State of Charge, State of Discharge, Depth of Discharge, Battery Energy, Specific Energy, Battery Power Specific Power, Ragone Plots, Electrochemical Cell Fundamentals, Thermodynamic Voltage, Electrolysis and Faradaic Current, Electrode Kinetics, Mass Transport, Electrical Double Layer, Ohmic Resistance, Concentration Polarization, Battery Modelling, Electric Circuit Models, Basic Battery Model, Run-Time Battery Model, Impedance-Based Model, First Principle Model, Empirical Models, Range Prediction with

Constant Current Discharge, Range Prediction with Power Density Approach , Traction Batteries, Lead Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery,

Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulfur Battery, Sodium-Metal-Chloride Battery. Battery Pack Management, Battery Management System, SoC Measurement, Battery Cell Balancing, Battery Charging.

Number of Hours:13

Module-3

Electric propulsion: EV considerations, concept of electric motors, classification of traditional and recent EV motors, Power electronics; EV power devices, EV power converters, Soft-switching EV converters, microelectronics, control strategies, DC motor drives; system configurations. DC motors, DC-DC converters, Speed control.

Induction motor drives: system configurations, Induction motors, inverters, speed control; Variable-voltage variable-frequency control (VVVF). Permanent-magnet (PM) motor drives: PM DC motor drives, PM brushless motor drives, system configurations. Switched reluctance motor drives: Principle of operation, Control of SR motor drives.

Number of Hours:10

Module-4

Vehicle controllers and Communication: Vehicle Controllers: Microcontroller Types, Microcontroller Components, Central Processing Unit, Memory and Registers, Timers and Counters, Peripherals, Functional Safety Standard ISO 26262, Controller Software Development: AUTOSAR, Software Development Tools, Application Controller Implementation, Motor Controller Vehicle Communications: OSI Seven-Layer Model, In-Vehicle Communications, Controller Area Network: CAN Transfer Protocol, CAN Transfer Layer, Bit Timing, CAN Message Frames, Message Arbitration, Error Detection and Error Signalling, CAN Physical Layer, CAN Programming.

Electric Vehicles and the Power Grid: Vehicle Grid Interface, G2V, V2G, V2V and V2H Frameworks, Electric Vehicle Charging, DC Fast Chargers, 480 V Fast Charger, MV Fast Charger, Electric Vehicle Charging Station, Grid Impacts of Fast Chargers.

Number of Hours:10

Module-5

Power Transmission, Brakes and Cooling Systems : Power Transmission Components, Electric Vehicle Powertrain, Gears: Gear Ratio, Torque-Speed Characteristics, Planetary Gear Set, Clutches, Automobile Differential, Transmission: Manual Transmission, Automatic Transmission, Torque Converter, Vehicle Brakes: Conventional Brake System, Electromechanical Brake (EMB) System, Cooling Systems: Climate Control System, Vapor Compression Refrigeration Cycle, Vehicle Air-Conditioning System, Powertrain Component Cooling System.

Number of Hours:10

Textbooks:

(i)Modern Electric Vehicle Technology, C.C. Chan, K.T. Chau, Oxford, 2001 (Refer to Chapter 1 and 5)

(ii)Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, John Wiley, 2018. (Refer to Chapters 1 and 2)

(iii)Two and Three-Wheeler Technology, Dhruv. U. Panchal, PHI Learning, 2015, (Refer to Chapter 17)

(iv)Electric and Hybrid Vehicles - Husain, Iqbal 13 ed, CRC Press, 2021. (Refer to Chapter 11, 12, and 14)

Reference books

(i) Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsani, et al, 3rd Edition, CRC Press, 2018.
(ii) Electric Vehicle Technology Explained, James Larminie and John Lowry, 2nd Edition, Wiley, 2012.
(iii) Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, 2014.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
Embedded Systems (Common to EPS, EPE, ESE and EVT)			
Course Code	1MEE105	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0: 0 :48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

CO1: Explain embedded-system architectures, hardware/software components, and system-design processes.

CO2: Analyse processor architectures, memory organisation, and wired and wireless communication interfaces.

CO3: Develop device drivers and interrupt-based programs using appropriate program-modelling techniques.

CO4: Apply RTOS concepts, task scheduling, and interprocess communication mechanisms in embedded applications.

CO5: Develop and evaluate embedded software using appropriate development tools and case-study-based approaches.

Module-1

Embedded Systems and System Design: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Embedded System-on-Chip (SoC) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design Process in Embedded System, Formulation of System Design.

Number of Hours:09

Module-2

Processor Architecture, Memory Organisation and Communication Interfaces: Introduction to Advanced Architectures, Processor and Memory Organization, Instruction-Level Parallelism, Performance Metrics, Memory Types, Memory Maps and Addresses, Processor Selection, Memory Selection, Serial Communication Devices, Serial Bus Communication Protocols, Internet Enabled Systems—Network Protocols, Wireless and Mobile System Protocols.

Number of Hours:08

Module-3

Device Drivers, Interrupts and Program Modelling: ISR Concept, Interrupt Sources, Interrupt Servicing (Handling) Mechanism, Multiple Interrupts, Context and the Periods for Context Switching, Interrupt Latency and Deadline, Direct Memory Access (DMA), Device Driver Programming, Program Models, DFG Models, State Machine Programming Models for Event-controlled Program Flow, UML Modelling.

Number of Hours:09

Module-4

Real-Time Operating Systems and Interprocess Communication: Multiple Processes in an Application, Multiple Threads in an Application, Tasks and Task States, Shared Data, Interprocess Communication, Semaphore Functions, Message Queue Functions, OS Services, Process Management, Timer Functions, Event Functions, Memory Management, Real-Time Operating Systems, Basic Design using an RTOS, RTOS Task Scheduling Models, Interrupt Latency and Response of Tasks.

Number of Hours:08

Module-5

Embedded Software Development and Case Studies: Introduction to Embedded Software Development Process and Tools, Host and Target Machines, Linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware–Software Design and Co-design, Case Study of Embedded Systems in Automobile, Case Study of Embedded System for an Adaptive Cruise Control (ACC) System in a Car, Testing on Host Machine, Simulators, Laboratory Tools.

Number of Hours:08

Textbooks:

Embedded systems, Raj Kamal, McGraw-Hill, 2008. (Refer to chapters 1,3,4,6,7,13,12,14)

Reference Books

(i) Introduction to Embedded Systems, Shibu K. V., 2nd Edition, McGraw-Hill Education, 2017.

(ii) Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid and Tony Givargis John Wiley & Sons, 2002.

(iii) An Embedded Software Primer, David E. Simon, Addison-Wesley, 1999.

(iv) Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, Jonathan W. Valvano, 5th Edition, ARM Education Media, 2018.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
Power System Monitoring (For EPS programme)			
Course Code	1MEPS106	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Explain synchronized phasor measurement, WAMS, and ICT architecture for power system monitoring and control.

CO2: Analyse power system oscillations, identify electromechanical modes, and assess small-signal stability.

CO3: Analyse measurement-based power system control, including frequency, voltage, angle control, and AVR–PSS coordination.

CO4: Analyse wide-area emergency control schemes, including voltage- and frequency-based load shedding.

CO5: Apply PMU-based state estimation and WAMS applications for voltage-stability assessment, adaptive load shedding, and grid-parameter estimation.

Module-1

Power System Monitoring: Synchronized Phasor Measurement, Power System Monitoring and Control with Wide-Area Measurements, ICT Architecture Used in Wide-Area Power System Monitoring and Control.

Oscillation Dynamics: Oscillation Characteristics in Power Systems, Eigenvalue Analysis and Participation Factor, Oscillation Characteristics in an Interconnected Power System, An Overview of Oscillation Monitoring Using Phasor Measurements, Monitoring of the Japan Power Network, Monitoring of the Southeast Asia Power Network, WAMS-Based Interarea Mode Identification, Low-Frequency Oscillation Dynamics: Electromechanical Modes characteristics, Oscillation Characteristics Analyses, an example.

Small-Signal Stability Assessment: Power System Small-Signal Stability, Oscillation Model Identification Using Phasor Measurements: Oscillation Model of the Electromechanical Mode, Dominant Mode Identification with Signal Filtering, Small-Signal Stability Assessment of Wide-Area Power System: Simulation Study, Stability Assessment Based on Phasor Measurements, Stability Assessment Based on Frequency Monitoring.

Number of Hours:09

Module-2

Power System Control: Power System Stability and Control, Angle and Voltage Control, Frequency Control: Frequency Control Dynamic, Operating States and Power Reserves. Supervisory Control and Data Acquisition, Challenges, Opportunities, and New Perspectives:

Application of Advanced Control Methods and Technologies, Standards Updating, Impacts of Renewable Energy Options, RESs Contribution to Regulation Services.

Control Design: Measurement-Based Controller Design, Controller Tuning Using a Vibration Model: A Vibration Model Including the Effect of Damping Controllers, Tuning Mechanism, Simulation Results, Wide-Area Measurement-Based Controller Design: Wide-Area Power System Identification, Design Procedure.

Number of Hours:08

Module-3

Dynamic Stability and Voltage Regulation: Need for AVR – PSS Coordination, A Survey on Recent Achievements, A Robust Simultaneous AVR – PSS Synthesis Approach: Control Framework, Developed Algorithm, Real-Time Implementation, Experiment Results. A Wide-Area Measurement-Based Coordination Approach: High Penetration of Wind Power, Developed Algorithm, An Application Example, Simulation Results.

Wide-Area Measurement-Based Emergency Control: Conventional Load Shedding and New Challenges: Load Shedding: Concept and Review, Some Key Issues. Need for Monitoring Both Voltage and Frequency, Simultaneous Voltage and Frequency-Based LS: Proposed LS Scheme, Implementation, Case Studies and Simulation Results, An Approach for Optimal UFVLS. Wave Propagation-Based Emergency Control: Proposed Control Scheme, Simulation Results.

Number of Hours:09

Module-4

State Estimation and PMUs: Introduction, Formulation of the SE Problem, SE Measurement Model: Weighted Least Squares Method, Equality-Constrained WLS, Augmented Matrix WLS, Least Absolute Value (LAV) Method, Other Methods, SE Requirements, SE Classification: Transmission vs. Distribution Systems, Choice of the State Vector, Single-Phase vs. Three-Phase Model, Centralized vs. Decentralized Architecture, Static vs. Dynamic Estimators, Role and Impact of PMU in SE: Availability of Phasor Measurements, Synchronization with Respect to the UTC, High Reporting Rate, Compliance with the Measurement of Dynamic Signals, High Accuracy. PMU Based Transmission System SE, PMU Based Distribution System SE, Optimal PMU Placement, SE Applications: Security Assessment, Automation, Provision of Data for Forecasters or Pseudo-Measurements, Power Quality Assessment.

Number of Hours:08

Module-5

Wide Area Measurement Systems: Voltage-Stability Assessment Based on the Thevenin Approach and Synchrophasor Measurements: Brief Introduction to the Thevenin Approach, Introduction for the Test Case and Setup, Discussion on the Test Results, Voltage-Stability Assessment Based on the Modal Analysis and Synchrophasor Measurements: Global Voltage-Stability Detection by Means of Modal Analysis Test Results and Discussion, Adaptive Load Shedding Taking Advantage of the Synchrophasor Measurements: Short Introduction About the Combined UFLS and UVLS, Test Setups and Discussions on the Test Results, Conclusions on Load Shedding, Estimation of Grid Parameters: Introduction, Estimation Framework, Single-Circuit Transmission Line Parameter Estimation, Grid Impedance Estimation.

Number of Hours:08

Textbook

(i)Power system monitoring and control, Hassan Bevrani, Masayuki Watanabe, Yasunori Mitani, John Wiley & Sons, 2014. (Refer to chapters 1,2,3,5,7 and 8)

(ii) Phasor Measurement Units and Wide Area Monitoring Systems from the Sensors to the System, Edited by Antonello Monti, Carlo Muscas, Ferdinanda Ponci, Elsevier, 2016. (Refer to chapters 7 and 8)

Reference Book

(i) The Wide-Area Concept, IEEE Power and Energy magazine, volume 23, Number 1, January/February 2025.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
Semiconductor Devices (For EPE Programme)			
Course Code	1MEPE106	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Explain breakdown mechanisms and edge termination techniques used in SiC and GaN power semiconductor devices.

CO2: Analyse the structure and characteristics of SiC JFETs and planar power MOSFETs.

CO3: Analyse the characteristics, structures and reliability aspects of shielded SiC MOSFETs and vertical GaN HFETs.

CO4: Analyse lateral GaN HFETs and SiC BJTs with respect to blocking, conduction and switching performance.

CO5: Evaluate the structures and operating characteristics of SiC GTOs and IGBTs for power electronic applications.

Module-1

Breakdown Mechanisms and Edge Termination Techniques: Breakdown mechanisms in power semiconductor devices: Parallel-plane breakdown. Punch-through breakdown. Open-base transistor breakdown.

Silicon carbide (SiC) device edge terminations: unterminated planar Schottky diode, floating metal field rings, resistive Schottky extension, field-plate edge termination, argon implant termination.

SiC P-N junction edge terminations: field plate, floating field rings, junction termination extension (JTE), bevel terminations. Gallium nitride (GaN) edge terminations.

Number of Hours: 09

Module-2

Silicon carbide Junction Field-Effect Transistors (JFETs): Introduction, Trench and planar metal-semiconductor JFET structures, forward blocking characteristics, on-state characteristics and resistance, experimental characteristics.

Planar SiC Power MOSFETs: Device structure, blocking characteristics, on-resistance, threshold voltage, comparison between SiC JFETs and MOSFETs, applications.

Number of Hours: 08

Module-3

Shielded SiC planar power MOSFETs: Introduction, device structure, blocking mode, inversion and accumulation channel structures, on-resistance, threshold voltage, channel mobility, experimental results, novel structures, reliability issues, commercial devices.

GaN vertical power HFETs: planar structure, on-resistance, switching performance, experimental results.

Number of Hours:09

Module-4

Lateral GaN HFETs: blocking voltage capability, on-resistance, gate control, cascode configuration, MIS-HFETs, normally-OFF GaN HFETs, MOS-HFETs, dynamic on-resistance, device passivation, chip design.

Silicon carbide Bipolar Junction Transistors (BJTs): structure and operation, breakdown voltage, current gain, emitter current crowding, on-state voltage drop, switching speed, safe operating area, bipolar degradation and device scaling.

Number of Hours: 08

Module-5

Silicon carbide Gate Turn-Off Thyristors (GTOs): structure and operation, forward blocking capability, on-state characteristics, switching characteristics, emitter turn-off thyristors.

Silicon carbide IGBTs: n-channel asymmetric structure, blocking characteristics, on-state voltage drop, turn-off characteristics, lifetime dependence, switching energy loss, maximum operating frequency, optimised structures, p-channel structures, latch-up, safe operating area, trench-gate structures.

Number of Hours:08

Textbook

Gallium Nitride and Silicon Carbide Power Devices, B. Jayant Baliga, World Scientific Publishing Co. Pte. Ltd, 2017. (Refer to chapters 3,9,11,13,14,16, and 17)

Reference Book

GaN Transistors for Efficient Power Conversion, Alex Lidow at el., Third Edition, John Wiley & Sons Ltd, 2020.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
Renewable Energy Systems and Grid Integration (For ESE Programme)			
Course Code	1MESC106	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0: 0 :48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Analyse photovoltaic cells, modules, arrays, and stand-alone PV systems.

CO2: Analyse solar power conversion systems and grid-connected PV systems using power electronic converters and control schemes.

CO3: Analyse wind energy conversion systems, maximum power extraction, and generator technologies.

CO4: Evaluate battery energy storage systems, battery characteristics, charging methods, and power electronic interfaces.

CO5: Analyse grid integration of renewable energy systems with respect to synchronisation, stability, voltage regulation, harmonics, and power quality.

Module-1

Photovoltaic Power: Building-Integrated PV System, PV Cell Technologies.

Photovoltaic Power Systems: PV Cell, Module and Array, Equivalent Electrical Circuit, Open-Circuit Voltage and Short-Circuit Current, I-V and P-V Curves, Array Design, Peak-Power Operation, System Components of Stand-Alone System.

Number of Hours: 09

Module-2

Solar Power Conversion Systems and Grid-Connected PV: Solar Power Conversion Systems: Overview, Solar power Electronics systems, Challenges.

Power Electronics: AC-DC Rectifiers, AC-DC Inverter, IGBT/MOSFET Based Converter, Control Schemes, Cycloconverter, Grid Interface Controls, Battery Charge/Discharge Converters, Power Shunts.

Number of Hours: 08

Module-3

Wind Speed and Energy: Speed and Power Relation, Power Extracted from the Wind, Rotor-Swept Area, Air Density, Wind Speed Distribution, Wind Speed Prediction.

Wind Power Systems: System Components, Turbine Rating, Power vs. Speed and TSR, Maximum Energy Capture, Maximum Power Operation, System-Design Trade-offs, System Control Requirements.

Electrical Generators: Turbine conversion systems, Synchronous Generator, Induction Generator, Doubly Fed Induction Generator, Direct-Driven Generator.

Number of Hours: 09

Module-4

Energy Storage and Power Electronic Interfaces: Energy Storage, Battery, Types of Battery, Equivalent Electrical Circuit, Performance Characteristics, Lead-Acid Battery, Battery Design, Battery Charging, Charge Regulators, Battery Management, More on Lithium-Ion Batteries.

Power Electronics: Battery Charge/Discharge Converters.

Number of Hours: 08

Module-5

Grid-Connected Renewable Energy Systems and Electrical Performance: Stand-Alone Systems, PV Stand-Alone, Wind Stand-Alone, Hybrid Systems, System Sizing.

Grid-Connected Systems: Interface Requirements, Synchronizing with the Grid, Operating Limit, Energy Storage and Load Scheduling, Wind Farm–Grid Integration, Grid Stability Issues, Distributed Power Generation.

Electrical Performance: Voltage Current and Power Relations, Component Design for Maximum Efficiency, Electrical System Model, Static Bus Impedance and Voltage Regulation, Dynamic Bus Impedance and Ripples, Harmonics, Quality of Power, Renewable Capacity Limit.

Number of Hours: 08

Textbook

(i)Wind and Solar Power Systems: Design, Analysis, and Operation, Mukund R. Patel and Omid Beik, 3rd Edition, CRC Press, 2021. (Refer to chapters 10,11,12,14,3,4,5,13,15,16, and17)

Reference Book

(i)Nick Jenkins and Janaka Ekanayake, Renewable Energy Engineering, 2nd Edition, Cambridge University Press, 2024.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream			
Power Electronics for EVs (For EVT programme)			
Course Code	1MEVT106	Scheme	2026
Type of Course	Professional Core Course	Semester	I
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Explain EV power-electronic architecture, energy sources, motor technologies, and power conversion techniques.

CO2: Analyse AC, DC, and wireless EV charging systems and their power conversion techniques.

CO3: Analyse bidirectional converter topologies for EV charging, propulsion, regenerative braking, and V2G applications.

CO4: Analyse integrated bidirectional, resonant, isolated, and T-type converters for EV applications.

CO5: Evaluate multilevel, multiphase, and wireless power converters and their control techniques for EV charging and regenerative braking.

Module-1

EV power-electronic architecture and fundamentals: Electric Vehicles: Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV), Plug-In Hybrid Electric Vehicle (PHEV), Fuel-Cell Electric Vehicle (FCEV). Configuration of an Electric Vehicle: General EV Setup. Energy Sources: Ultra-Capacitors (UCs).

Motors for EVs: Brushed DC Motor, Permanent Magnet Brushless DC Motor (BLDC), Permanent Magnet Synchronous Motor (PMSM), Induction Motor (IM), Switched Reluctance Motor (SRM), Synchronous Reluctance Motor (SynRM), Permanent magnet Assisted Synchronous Reluctance Motor, Axial Flux Ironless Permanent Magnet Motor. Power Conversion Techniques.

Number of Hours:08

Module-2

EV charging and power conversion techniques: Charging Systems: Charging, DC Charging, Wireless Charging, Power Conversion Techniques, Converters for Wired Charging, Systems for Wireless Charging.

Direct Conversion of an AC–DC Converter for Plug-In Hybrid Vehicles: Introduction, Converter Topology, Simulation.

Number of Hours:08

Module-3

Bidirectional Converter Topologies for Plug-In Electric Vehicles: Introduction, Literature Survey, Bidirectional Converters, Bidirectional AC/DC Converters for Plug-In EV with Reduced Conduction Losses, Topology Explanation, Plug-In Charging Mode, Propulsion Mode, Boost Operation, Buck Operation, Regenerative Braking Operation, Boost Operation, Buck Operation, Simulation and Results.

Bidirectional Battery Charger for an Electric Vehicle: Introduction, Literature Survey, Bidirectional Power Flow Converters, Simulation and Results.

Bidirectional Dual Active Converter for Vehicle to Grid: Introduction, Dual-Active-Bridge DC–DC Converter, Types of Bridge Converters, Types of Bidirectional DC–DC Converters (BDCs), DC

Microgrids, Electric Vehicles. Enhanced Load Step Response for a Bidirectional DC–DC Converter: Soft-Switching, Batteries, Vehicle-to-Grid (V2G) Technology: Zero-Voltage Switching (ZVS) and Zero-Current Switching (ZCS), Topologies of a DAB Converter, Simulation and Results, Triple-Phase-Shift Control.

Number of Hours:09

Module-4

Integrated Bidirectional Converters for Plug-In HEV Applications: Introduction, Literature Survey, Flow of Operation, Regenerative Braking Mode, Propulsion, AC/DC Battery Charging, DC/DC Battery Charging, Vehicle to Grid Mode, Simulation and Results, Novel Eight-Switch Inverter, Bidirectional DC/DC Interleaved Converter.

Resonant Converter for a Bidirectional EV Charger: Introduction, Literature Survey, Topology and Analysis, Simulation and Results.

Isolated Bidirectional AC–DC Converter for a DC Distribution System: Introduction, Literature Survey, Isolated Bidirectional Converter Topology, System Design Simulation and Results.

Bidirectional T-Type Converter Topology for EV Applications: Introduction, Literature Survey, 10.3 Converter Topology, Simulation and Results.

Number of Hours:09

Module-5

Multilevel Two-Quadrant Converter for Regenerative Braking: Introduction, Converter Topology, Multilevel Buck Converter, Simulation and Results.

Multiphase Integrated On-board Charger for Electric Vehicles: Introduction, Converter Topology, Simulation.

Wireless Topology for EV Battery Charging: Introduction, Literature Survey, Wireless Topology, Simulation and Results, Control Algorithms, Trends and Future Developments.

Number of Hours:08

Textbook

Power Converters for Electric Vehicles, CRC Press, L. Ashok Kumar and S. Albert Alexander, CRC Press, 2021. (Refer to chapters1,7,2,3,4,6,8,9,10,11,12, and 14)

Reference Books

(i) Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, 3rd Edition, CRC Press, 2021.

(ii) Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, 2015.

(iii)Power Electronics: Devices, Circuits, and Applications, Muhammad H. Rashid, 4th Edition, Pearson, 2014.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for passing.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation:

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of two Internal Assessment Tests (IA) shall be conducted. Each test shall be conducted for a maximum of 25 marks. The average of the two test marks shall be the marks secured by a student in IA.

In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.

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M. Tech. in Electrical Engineering Stream

Power Systems Laboratory

(Laboratory for Self-Directed Learning for EPS branch only)

Course Code	1MEPS107	Scheme	2026
Type of course	Professional Core Course Lab	Semester	I
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	**Practical**	Exam Hours	3

Course Outcomes

On successful completion of the laboratory, students will be able to:

CO1: Model and analyse EHV transmission systems and assess the effects of system-frequency variation.

CO2: Model and evaluate overcurrent and distance-relay performance for transmission-line protection.

CO3: Perform power-flow and optimal-power-flow studies using appropriate computational tools.

CO4: Analyse small-signal and transient stability of multimachine power systems.

CO5: Apply computational tools for transmission-line energization, synchrophasor-based monitoring, and voltage-stability assessment.

List of Experiments

(1) Investigation of the effects of system frequency variation on the performance of an EHV transmission system using MATLAB/Simulink.

(2) Model and analyse the performance of a distance relay for protection of an EHV transmission line using MiPower or MATLAB/Simulink.

(3) Model and analyse the performance of an overcurrent relay for protection of a simple series connected network using MiPower or MATLAB/Simulink.

(4) Power Flow Analysis of IEEE 14- or 30-, or 57-Bus Systems using Newton–Raphson and Fast Decoupled Load Flow methods, using MiPower or MATLAB/Power System Toolbox or PowerFactory.

(5) Optimal Power Flow (OPF) considering generation cost, transmission constraints, and voltage limits, using MiPower or MATPOWER or PowerFactory.

(6) Small-Signal Stability Analysis of a Multi-machine Power System using Eigenvalue Analysis, using MiPower or MATLAB or PowerFactory.

(7) Transient Stability Analysis under Three-phase Faults and Critical Clearing Time determination, using MiPower or PSCAD or PowerFactory or MATLAB.

(8) Energization of 300 km long, 400 kV transmission line, using MiPower or PSCAD.

(9) Phasor Measurement Unit (PMU)-based Wide Area Monitoring System (WAMS): State Estimation and Synchrophasor Analysis, using MATLAB Simulink.

(10) Integration of Renewable Energy Sources (Solar PV/Wind) into IEEE Bus System and Voltage Stability Assessment, using MiPower or MATLAB.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for a pass in the course.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject /course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation (CIE):
For the Professional Core Course Laboratory, the maximum marks prescribed are 100. Out of these, 50 marks are allotted for Continuous Internal Evaluation (CIE) and 100 marks for the Semester End Examination (SEE). The SEE marks obtained out of 100 shall be proportionately scaled down to 50 marks. The final result shall be declared based on the aggregate of the CIE marks (50) and the scaled-down SEE marks (50), totalling 100 marks."

Table – 1 Distribution of marks corresponding to laboratory component		
Component	**Description**	**Marks**
Allotment of marks for regular classwork		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	10 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	20 marks
	Subtotal	**30**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	10 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	10marks
	Subtotal	**20**
	Total	**50**

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M. Tech. in Electrical Engineering Stream			
Power Electronic Converters Laboratory (Laboratory for Self-Directed Learning)			
Course Code	1MEPE107	Scheme	2026
Type of course	Professional Core Course Lab	Semester	I
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	**Practical**	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Analyse the performance of controlled and uncontrolled power electronic rectifiers for different loads.

CO2: Analyse and compare DC–DC converter characteristics under continuous and discontinuous conduction modes.

CO3: Implement and evaluate PWM techniques for single-phase and three-phase inverters.

CO4: Analyse resonant converters and evaluate soft-switching performance using ZCS and ZVS techniques.

CO5: Correlate simulation and experimental results to evaluate efficiency, power quality, harmonics and switching performance of power electronic converters.

Note:(i) Wherever suitable hardware facilities are available, each experiment shall first be verified through simulation and subsequently implemented on hardware to enable correlation of theoretical, simulated and experimental results.

(ii) The tools and equipment indicated in brackets are illustrative and may be suitably substituted by equivalent simulation software, laboratory hardware, controllers and measurement instruments available in the institution.

List of Experiments

(1) Performance Analysis of Three-Phase Uncontrolled Bridge Rectifier: Determine input current, output voltage, ripple factor, efficiency and power factor for R, RL and highly inductive loads. [MATLAB/Simulink (Simscape Electrical), PSIM, PLECS, Ltspice. Three-phase diode bridge rectifier, resistive and RL loads, isolation transformer, DSO, power analyser.]

(2) Performance Evaluation of Single-Phase and Three-Phase Fully Controlled Rectifiers: Study firing angle control, output voltage regulation, input power factor and harmonic distortion. [MATLAB/Simulink, PSIM, PLECS. SCR converter kit with firing circuit, R and RL loads.]

(3) PWM Controlled Three-Phase Rectifier: Implement sinusoidal PWM control and compare with conventional controlled rectifier in terms of harmonics and power factor. [MATLAB/Simulink, PLECS, PSIM. IGBT-based PWM rectifier, DSP/FPGA controller.]

(4) Performance Analysis of Buck, Boost and Buck–Boost Converters: Determine voltage conversion ratio, efficiency, duty-cycle characteristics, ripple current and voltage under continuous and discontinuous conduction modes. [MATLAB/Simulink, PSIM, LTspice, PLECS. DC–DC converter trainer, programmable DC supply, electronic load]

(5) Performance Evaluation of Cuk Converter: Analyse voltage regulation, current ripple and efficiency. Compare its performance with Buck–Boost converter. [MATLAB/Simulink, PSIM, Ltspice. Cuk converter hardware with MOSFET/IGBT.]

(6) Single-Phase PWM Inverter: Generate SPWM waveforms, analyse output voltage, harmonic spectrum and Total Harmonic Distortion (THD) for RL load. [MATLAB/Simulink, PSIM, PLECS. IGBT inverter module with gate driver.]

(7) Three-Phase Voltage Source Inverter: Study 180° conduction, 120° conduction and Sinusoidal PWM. Compare output voltage, harmonics and efficiency. [MATLAB/Simulink, PSIM, PLECS. Three-phase inverter trainer, induction motor/RL load.]

(8) Space Vector PWM (SVPWM) Inverter: Implement SVPWM and compare with SPWM and Third Harmonic PWM based on DC bus utilisation, THD and switching losses. [MATLAB/Simulink, PSIM, PLECS. DSP-controlled inverter (TI C2000/STM32), three-phase inverter module.]

(9) Resonant Inverters: Investigate Series Resonant and Parallel Resonant Inverters. Measure resonant frequency, efficiency and Zero Current Switching (ZCS) operation. [MATLAB/Simulink, PSIM, Ltspice. Resonant inverter trainer, resonant RLC load.]

(10) Zero-Current Switching (ZCS) and Zero-Voltage Switching (ZVS) Resonant Converters: Compare switching losses, efficiency and EMI characteristics. [MATLAB/Simulink, PSIM, PLECS. ZCS/ZVS converter kit.]

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for a pass in the course.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject /course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation (CIE):

For the Professional Core Course Laboratory, the maximum marks prescribed are 100. Out of these, 50 marks are allotted for Continuous Internal Evaluation (CIE) and 100 marks for the Semester End Examination (SEE). The SEE marks obtained out of 100 shall be proportionately scaled down to 50 marks. The final result shall be declared based on the aggregate of the CIE marks (50) and the scaled-down SEE marks (50), totalling 100 marks."

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Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	10 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	10marks
	Subtotal	**20**
	Total	**50**

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M. Tech. in Electrical Engineering Stream			
Solar and Wind Energy Laboratory (Laboratory for Self-Directed Learning)			
Course Code	1MESE107	Scheme	2026
Type of course	Professional Core Course Lab	Semester	I
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	**Practical**	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Evaluate the performance and efficiency characteristics of solar PV systems under varying operating conditions.

CO2: Analyse grid-connected solar PV systems and evaluate MPPT, synchronization, power flow and power quality.

CO3: Evaluate the performance characteristics of wind energy conversion systems and MPPT techniques.

CO4: Model and simulate solar PV and wind energy conversion systems using appropriate computational tools.

CO5: Analyse battery energy storage systems and their active and reactive power exchange with the utility grid.

List of Experiments

(1) Performance analysis of Solar Photovoltaic Electricity generation system by conducting an experiment to determine:

(i) the panel tilt angle and azimuth angle corresponding to the maximum open-circuit voltage at three time intervals with a gap of 20 minutes,

(ii) the load resistance that results in maximum power output at the predetermined panel tilt angle and azimuth by using batteries as loads at each time interval, and

(iii) the conversion efficiency of the solar PV panel at each time interval.

(2) Determination of VI and efficiency characteristics and efficiency of a Solar PV system at fixed panel tilt angle.

(3) Synchronisation of a single-phase grid-tied Solar PV inverter connected to a PV system, and determination of:

(i) the time taken for grid synchronisation,

(ii) the maximum power extracted using the Maximum Power Point Tracking (MPPT) algorithm,

(iii) the inverter operating efficiency, and

(iv) the inverter operating power factor.

(4) Evaluate active and reactive power and apparent energy flow between grid tied inverter, utility grid and load, and study of the net metering concept.

(5)Determine the power characteristics of a wind turbine by plotting power output versus wind speed, and determination of cut-in, rated, and cut-out wind speeds, through hardware or software [MATLAB/Simulink (for comparison); LabVIEW (DAQ)] implementation.

(6) Using MATLAB /Simulink, plot the following characteristics of a Solar PV energy system:

(i) time versus Irradiance (W/m^2), (ii) time versus $V_{dc}\ mean$, (V) and (iii)time versus $P_{dc}\ mean$ (W) corresponding to a PV energy system.

(7) Simulation of a grid-connected solar PV system incorporating Maximum Power Point Tracking (MPPT) using MATLAB/Simulink. Plot the Power versus Voltage) and Current–versus Voltage characteristics of the PV array under MPPT operation.
(8) Model and simulate by MATLAB/Simulink (Simscape Electrical), a variable-speed Wind Energy Conversion System (WECS) using a PMSG. Plot wind speed, generator voltage, current, rotor speed, and output power.
(9)Using MATLAB/Simulink, simulate the Maximum Power Point Tracking (MPPT) control of a variable-speed wind turbine. Compare the performance of the Tip-Speed Ratio (TSR) control method and the Optimal Torque Control (OTC) method.
(10) Using MATLAB/Simulink, Model and simulate a Battery Energy Storage System (BESS) integrated with the utility grid, to determine,
(i) the charging and discharging characteristics of the battery,
(ii) the battery terminal voltage and current,
(iii) the State of Charge (SOC) variation with time;
(iv) the active and reactive power exchanged between the BESS and the grid.

Assessment Structure (both CIE and SEE)

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for a pass in the course.
A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject /course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

Continuous Internal Evaluation (CIE):

For the Professional Core Course Laboratory, the maximum marks prescribed are 100. Out of these, 50 marks are allotted for Continuous Internal Evaluation (CIE) and 100 marks for the Semester End Examination (SEE). The SEE marks obtained out of 100 shall be proportionately scaled down to 50 marks. The final result shall be declared based on the aggregate of the CIE marks (50) and the scaled-down SEE marks (50), totalling 100 marks."

Table – 1 Distribution of marks corresponding to laboratory component

Component	Description	Marks
Allotment of marks for regular classwork		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	10 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	20 marks
	Subtotal	**30**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	10 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	10marks
	Subtotal	**20**
	Total	**50**

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M. Tech. in Electrical Engineering Stream			
EV Technology Laboratory (Laboratory for Self-Directed Learning)			
Course Code	1MEVT107	Scheme	2026
Type of course	Professional Core Course Lab	Semester	I
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	**Practical**	Exam Hours	3

Course Outcomes

At the end of the course, the student will be able to:

CO1: Model and analyse EV longitudinal dynamics and powertrain performance under different operating conditions.

CO2: Compare EV powertrain configurations and evaluate their performance and energy consumption.

CO3: Analyse and control electric motor drives using appropriate power electronic converters.

CO4: Analyse EV battery charging, discharging and auxiliary power-conversion systems.

CO5: Evaluate regenerative braking and energy recovery in battery electric vehicles.

List of Experiments

(1) Develop mathematical/MATLAB-Simulink models of two-wheel and four-wheel EVs and determine rolling resistance, aerodynamic drag, grade resistance, total tractive effort, wheel torque, propulsion power and vehicle performance under different operating conditions. Examine the effects of vehicle mass, vehicle speed and road gradient on tractive effort, wheel torque and propulsion power.

(2)Using MATLAB/Simulink, model and compare two representative single-motor rear-wheel-drive (RWD) EV powertrain configurations: (i) a single-speed reduction transmission and (ii) a two-speed transmission.

Using identical vehicle, motor, battery and drivetrain parameters, subject both configurations to the same specified standard drive cycle. Determine the vehicle speed, acceleration, tractive effort, motor torque, motor speed, motor power, selected gear, battery voltage, battery current, battery power, SoC and energy consumption in kWh/km. Compare the vehicle performance, motor operating points, powertrain efficiency and energy consumption of the two configurations, and evaluate the effect of the two-speed transmission and gear-shift strategy on EV powertrain performance.

(3) Model a DC motor drive supplied through a DC-DC converter using hardware or MATLAB/Simulink and investigate its speed-control characteristics for EV propulsion. Obtain the speed–torque characteristic of the motor. Vary the converter duty ratio over a specified range and determine the corresponding average motor voltage and motor speed. Investigate the effect of load torque on motor speed at a specified duty ratio.

(4) Develop an inverter-fed 3 phase induction motor drive, (widely used in larger commercial EVs, heavy-duty trucks, electric buses, and specific passenger vehicle configurations) using MATLAB/Simulink, and investigate speed control using Variable Voltage Variable Frequency (VVVF) control.

Plot speed–torque, speed-load torque, and speed – motor efficiency under specified operating conditions.

(5)Using hardware or MATLAB/Simulink, model and analyse PMDC and permanent-magnet brushless motor drives suitable for EV propulsion. Implement appropriate power-electronic

converters for each motor drive and obtain and compare their torque–speed characteristics and speed-control responses under specified load conditions.

(6) Develop a switched reluctance motor drive model using MATLAB/Simulink and analyse its torque–speed characteristics. Investigate the effects of turn-on and turn-off angles on electromagnetic torque and torque ripple. Implement a basic closed-loop speed-control scheme and evaluate the speed response of the SRM drive for changes in reference speed and load torque.

(7) Simulate the charging and discharging of an EV battery using hardware or MATLAB/Simulink and obtain the battery voltage, current and SoC characteristics during charging and discharging. Determine the energy delivered by the battery during discharge, the energy absorbed during charging, and the variation of SoC with time.

(8)Design a DC-DC converter in hardware or model it using MATLAB/Simulink for supplying a low-voltage EV auxiliary system. Determine the output-voltage regulation under load variations and evaluate converter efficiency. Analyse the converter voltage and current waveforms under specified operating conditions.

(9) Develop an EV regenerative-braking model using MATLAB/Simulink and operate the traction motor in generating mode during vehicle deceleration. Determine regenerative braking torque, electrical power generated, energy recovered and regenerative-braking efficiency. Investigate the effect of vehicle speed and braking intensity on the recovered energy.

(10) Model a conductive EV battery-charging system using MATLAB/Simulink and analyse the power flow from the AC supply to the battery. Determine the battery charging voltage and current, SoC variation with charging time, charging time required to increase the battery SoC from a specified initial value to a specified target value under a specified charging current or power, and the charger/charging-system efficiency. The following SOCs may be assumed:

Initial SoC = 18%; Target SoC = 85%.

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