COEP Technological University Pune
(A Unitary Public University of Govt. of Maharashtra)

School of Engineering and Technology

Curriculum Structure with Evaluation Scheme
Final Year B. Tech. in

Electrical Engineering

(Final Year Structure Effective from: A.Y. 2026-27)

Curriculum and structure of Final Year B. Tech. in Electrical Engineering

Program Educational Objectives (PEOs)

After the completion of the program

- **I.** Student will be employable in the diversified sectors of the industry, government organizations, public sector and research organizations.
- **II.** Student will pursue higher education in electrical engineering or other fields oftheir interests, at institutes of repute and high ranking.
- **III.** Student will demonstrate effective communication, life long learning ability, integrity, team work, leadership qualities, concern to environment and commitment to safety, health, legal and cultural issues in the fields they choose to pursue.

Program Outcomes (POs):

Engineering Graduate will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problem.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science, and engineering sciences.

PO3: Design/Development Solution: Design solution for complex engineering problems and design system component or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, social and environmental conditions.

PO4: Conduct Investigation of Complex Problem: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusion.

PO5: Method, Tool Usage: Create, select and apply appropriately technique, resources,and modern engineering and IT tools including prediction and modeling to complex engineering activities with understanding the limitation.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to access societal health, safety, legal and cultural and consequent responsibility relevantto the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solution in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principle and commitment to professional ethics and responsibilities and norms of the engineering practices.

PO9: Individual and Team Work: Function effectively as an individual, and as themember or leader in diverse team and multidisciplinary setting.

PO10: Communication: Communicate effectively on complex engineering activities withthe engineering community and with society at large, such as, and being able to comprehend and write effective reports and design documentation and effective presentationand give and receive clear instructions.

PO11: Project management and Finance: Demonstrate knowledge & understanding of the engineering and management principles and apply these to ones work, as the member and the leader in a team to manage projects and in multidisciplinary environment.

PO12: Lifelong Learning: Recognize the need for, and have the preparation and abilityto engage in independent and lifelong learning in broadest context of technological change.

Program Specific Outcome for Undergraduate (PSOs):

PSO13: To design and develop power electronics hardware and its control to cater the needsof industry such as electric vehicles, renewable interconnections, smart grid and micro-grid.

PSO14: To analyze and solve the problems related to smart grid using modern techniquesand tools.

PSO15: To design, simulate, and make prototype of special purpose machines for enhancing the Performance.

List of Abbreviations

Abbreviation	Title
BS	Basic Science Course
ESC	Engineering Science Course
PCC	Programme Core Course (PCC)
PEC	Programme Elective Course (PEC)
OE/SE	Open/School Elective (OE/SE) other than particular program
MDM	Multidisciplinary Minor (MD M)
VSEC	Vocational and Skill Enhancement Course (VSEC)
HSMC	Humanities Social Science and Management
IKS	Indian Knowledge System (IKS)
VEC	Value Education Course (VEC)
RM	Research Methodology (RM)
--	Internship
--	Project
CEA	Community Engagement Activity (CEA)/Field Project
CCA	Co-curricular & Extracurricular Activities (CCA)

Final Year B. Tech. in Electrical Engineering

Semester -VII

Sr. No.	Course Code	Course Title	L	T	P	S	Cr	Category
01	PCC-17	Electric Drives	3	0	0	1	3	PCC
02	PCC-14	Control System Design	3	0	2	1	4	PCC
03	PEC-03	Program Specific Elective III a) Converters for Electric Vehicles b) Condition Monitoring of Electrical Machines c) Smart Grid Technologies d) Intelligent Control e) Solar and Wind Energy f) Vehicle Dynamics and Testing g) Any other course offered by faculty	3	0	0	1	3	PEC
05	RM	Research Methodology	2	0	0	1	2	RM
06	OJT-02	Internship	-	-	2	-	1	OJT
07	VSEC- 03	Project Stage III	0	0	10	-	5	VSEC
08	MDM- 04	Multidisciplinary Minor – IV Multidisciplinary Project	0	0	6	2	3	MDM
Total			**11**	**00**	**20**	**06**	**23**	

Semester –VIII (Option A)

Sr. No.	Course Code	Course Title	L	T	P	S	Cr	Category
01	OJT-03	Industry Internship	-	-	-	--	3	OJT
02	PEC-04	Program Specific Elective IV MOOC- I*	3	0	0	--	3	PEC
03	PEC-05	Program Specific Elective V MOOC- II*	3	0	0	--	3	PEC
04	PEC-06	Program Specific Elective VI MOOC- III*	3	0	0	--	3	PEC
Total			**09**	**00**	**00**	**00**	**12**	

* These courses must be of at least 12-week duration.

Semester –VIII (Option B)

Sr. No.	Course Code	Course Title	L	T	P	S	Cr	Category
01	OJT-03	Inhouse Project	-	-	-	--	3	OJT
02	PEC-04	Program Specific Elective IV MOOC- I	3	0	0	--	3	PEC
03	PEC-05	Program Specific Elective V MOOC- II	3	0	0	--	3	PEC
04	PEC-06	Program Specific Elective VI MOOC- III	3	0	0	--	3	PEC
Total			**09**	**00**	**00**	**00**	**12**	

Electrical Drives					
Course Code	PCC-17	**Examination Scheme**			
Teaching Scheme	3-0-0-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Explain the fundamentals, components, and operating principles of electric drive and analyze motor-drive systems.
2. Estimate motor ratings and evaluate thermal performance for various duty cycles and load requirements.
3. Design and evaluate DC motor drive circuits for speed control, starting, braking, and multi-quadrant operation.
4. Design and evaluate induction motor drive systems using variable voltage, variable frequency, and slip power recovery techniques.
5. Explain and evaluate the performance of various motor drives and analyze electric traction and renewable energy integrated drive systems.

Unit 1: Basics of Electric Drives **[8 Hrs]**

Introduction, advantages of electrical drives, components of electric drive system, selection factors, various quadrant operation of electric drives, types of industrial loads, Equivalent values of drive parameters, load torque components, nature and classification of load torque

Unit 2: Dynamics of Electrical Drives **[8 Hrs]**

Motor-Load Dynamics, speed torque conventions, constant torque and constant power operation, steady state stability, load equalization, time and energy loss calculation, Thermal model of motor for heating and cooling, classes of motor duty, determination of motor ratings for various operation duty cycle.

Unit 3: DC Motor Drives **[8 Hrs]**

DC motors and their performance starting, transient analysis, speed control, Ward-Leonard drives, single phase and three phase controlled and uncontrolled rectifier fed drives, multi quadrant operation, Chopper controlled drives, closed loop speed control of DC motor, starting and braking of dc motors

Unit 4: Induction Motor Drives **[8 Hrs]**

Induction motor analysis, industrial applications, operation with non-sinusoidal, unbalanced voltage and single phasing, starting and braking methods, variable voltage and frequency control, VSI and CSI based drives, V/F control, slip power recovery – Static Kramer and Scherbius drive.

Unit 5: Synchronous Motor and Brushless DC Motor Drives **[8 Hrs]**

Synchronous motor types, operation with fixed frequency, variable speed drives, vector control, PMAC and BLDC motor drives, Stepper motor drives, switch reluctance motor drives, industrial applications.

Textbooks:

[1] G. K. Dubey, Fundamentals of Electrical Drives, Second edition (sixth reprint), Narosa Publishing house, 2001

Reference Books:

[1] M. H. Rashid, "Power Electronics -Circuits, devices and Applications", 3rd Edition, PHI Pub. 2004.

[2]	B. K. Bose, "Modern Power Electronics and AC Drives" Pearson Education, Asia, 2003.

Control System Design						
Course Code	PCC-14		**Examination Scheme**			
Teaching Scheme	3-0-2-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	4		**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Define and evaluate performance specifications of linear control systems using transfer functions, state-space representations, and discrete-time models.
2. Design cascade compensators in the time domain using root locus techniques to meet transient response goals.
3. Synthesize Lead, Lag, and Lag-Lead compensators in the frequency domain using Bode plots to improve system relative stability margins.
4. Apply state-space concepts to evaluate controllability, observability, and design state feedback controllers and observers for continuous-time systems.
5. Analyze the stability, mathematical difference equations, and steady-state accuracy of discrete-time control loops using Jury's stability criterion.

Unit 1: Linear Control Methods **[8 Hrs]**

Introduction to process control loops. Proportional-Integral-Derivative (PID) control architectures and classical design methods. Controller tuning parameters (Ziegler-Nichols, Cohen-Coon methods). Practical implementation of PID controllers: Windup prevention and filtering. Special control structures: Feedforward control systems, ratio control strategies, predictive control overview, and cascade control loops.

Unit 2: Control System Design in the Time Domain **[8 Hrs]**

Time-domain and frequency-domain design specifications and their cross-correlation parameters. Use of cascade compensation to improve steady-state and dynamic system performance. Operational mechanics of Lead, Lag, and Lag-Lead compensators and their distinct roles in modifying system behavior. Complete design steps for Lead, Lag, and Lag-Lead compensators in the time domain using the Root Locus technique.

Unit 3: Control System Design in the Frequency Domain **[8 Hrs]**

Review of open-loop frequency response parameters (Gain Margin, Phase Margin, crossover frequencies). Detailed frequency-domain design procedures for cascade Lead compensators and Lag compensators using Bode plots. Design methodologies for composite Lag-Lead compensators in the frequency domain to meet specific relative stability indices.

Unit 4: State Space Analysis of Continuous Systems **[8 Hrs]**

Review of state variable representations for continuous-time LTI systems. Transformations: Conversion of state variable models to transfer functions and vice-versa. Classical solution of state equations and computational derivation of the State Transition Matrix. Definitions and testing procedures for system Controllability and Observability. Design of state feedback controllers via pole placement and formulation of full-order state observers.

Unit 5: Discrete-Time Systems and Stability Analysis **[8 Hrs]**

Introduction to discrete systems and discrete-time signals. State variable modeling and transfer function representations of discrete systems; mutual mathematical conversions. Engineering modeling of sample-and-hold circuits. Direct analytical solution of state difference equations. Evaluation of discrete steady-state accuracy. Stability analysis of

discrete systems: Mapping from the s-plane to the z-plane, Jury stability criterion, and Bilinear Transformation workflows with Routh-Hurwitz validation.	
Textbooks:	
[1]	I.J. Nagrath and M. Gopal, Control Systems Engineering, New Age International.
[2]	M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill.
[3]	Benjamin C. Kuo, Digital Control Systems, Saunders College Publishing.
Reference Books:	
[1]	Ajit K. Mandal, Introduction to Control Engineering: Modeling, Analysis and Design, New Age International.
[2]	S. Mukhopadhyay, S. Sen, and A. K. Deb, Industrial Instrumentation, Control and Automation, Jaico Publication House.
List of Experiments:	
[1]	PID control design, parameter tuning, and transient verification for a process temperature control system using MATLAB/Simulink.
[2]	Comprehensive controller design, constraint entry, and performance optimization using the interactive SISO Design Tool in MATLAB.
[3]	Cascade Lead/Lag compensator design in the time domain using Root Locus graphical techniques to meet targeted damping ratios and settling times.
[4]	Cascade controller design in the frequency domain using Bode plots to satisfy specific relative stability metrics (Gain Margin and Phase Margin).
[5]	Closed-loop Position Control of a DC Motor, evaluating steady-state tracking errors and transient profiles under varying load torque parameters.
[6]	Speed control verification of a DC Motor plant to analyze the performance of inner current loops vs. outer speed tracking loops.
[7]	Structural evaluation of continuous systems: Scripting algorithmic matrices in MATLAB to determine complete system Controllability and Observability.
[8]	Synthesis of multi-variable state-space networks using Pole Placement by State Feedback via Ackermann's formulation in MATLAB.
[9]	Dynamic modeling, linearization, and stabilization loop design for a non-linear, inherently unstable Magnetic Levitation system.
[10]	Discretization and study of a practical system, mapping discrete root migrations to evaluate the direct effect of variable sampling time on system stability bounds.
Note:	
[1] [2] [3] [4] [5]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc. To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc. To measure CO3, questions will be based on applications of core concepts. To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc. To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Program Specific Electives-III

Converters for Electric Vehicles						
Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand electric vehicle powertrain architecture and the role of power electronic converters in EV applications.
2. Design and analyse the operation of DC–DC converters used in battery interfacing and regenerative braking systems.
3. Design and evaluate inverter topologies and motor drive converters used for EV propulsion systems.
4. Understand EV charging technologies and advanced converter systems including SiC/GaN based converters.
5. Apply modelling and control techniques for analysis and simulation of EV power electronic converters top of Form

Unit I: Introduction to Electric Vehicles and Powertrain **[8 Hrs]**

Overview of BEV, HEV, PHEV and FCEV architectures, EV powertrain components, energy storage systems and role of power electronic converters in electric mobility applications.

Unit II: DC–DC Converters for EV Applications **[8 Hrs]**

Buck, boost, buck-boost and bidirectional DC-DC converters, isolated and non-isolated topologies, converter operating modes, battery interfacing, voltage regulation and regenerative braking applications.

Unit III: Inverters and Motor Drive Converters **[8 Hrs]**

Voltage source inverters, PWM techniques, multilevel inverters and converter-fed BLDC, PMSM and induction motor drives for EV propulsion systems.

Unit IV: EV Battery Chargers and Advanced Converter Technologies **[8 Hrs]**

On-board and off-board chargers, fast charging, wireless charging, G2V and V2G operations, power factor correction, soft-switching converters, resonant converters and SiC/GaN based converter technologies.

Unit V: Modelling, Control and Emerging Trends **[8 Hrs]**

Modelling and digital control of converters, closed-loop control strategies, MATLAB/Simulink based analysis, thermal management, EMI issues and emerging trends in EV power electronics.

Textbooks:

[1] Ned Mohan, Tore M. Undeland and William P. Robbins – Power Electronics: Converters, Applications and Design, Wiley.
[2] M. H. Rashid – Power Electronics Handbook, Butterworth-Heinemann.
[3] L. Umanand – Power Electronics: Essentials and Applications, Wiley India.
[4] Iqbal Husain – Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.
[5] Bimal K. Bose – Modern Power Electronics and AC Drives, Pearson Education.
[6] R. Krishnan – Electric Motor Drives: Modeling, Analysis and Control, Prentice Hall

Reference Books:

[1] Erickson and Maksimovic – Fundamentals of Power Electronics, Springer.
[2] Daniel W. Hart – Power Electronics, McGraw Hill.

[3]	Ali Emadi – Advanced Electric Drive Vehicles, CRC Press.
[4]	Ehsani, Gao and Emadi – Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press.
[5]	Marian K. Kazimierczuk – Pulse Width Modulated DC–DC Power Converters, Wiley.
[6]	B. K. Bose – Power Electronics and Motor Drives: Advances and Trends, Academic Press.
[7]	Fang Lin Luo and Hong Ye – Advanced DC/DC Converters, CRC Press.
[8]	Bin Wu – High Power Converters and AC Drives, Wiley-IEEE Press.

Condition Monitoring of Electrical Machines						
Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand the necessity of condition monitoring and reliability.
2. Have knowledge about the conventional and modern methodologies/techniques.
3. Develop basic functional models for condition monitoring system to different kind of power apparatus.
4. Know about application of Condition Monitoring System and determination of life expectancy of that equipment.

Unit I: Basic Considerations and Maintenance **[8 Hrs]**

Basic definitions, terminologies, symbolic representation, Necessity from technical social, financial aspect, types off faults in electrical equipment {Electrical equipment such as transformer, CT/PT and rotating electrical machines, CBs, etc.}, maintenance strategies, breakdown maintenance, planned, preventative and condition based maintenance. Diagnostic Testing: Routine tests, type tests, special tests, offline tests, Causes of failure and remedies.

Unit II: Analysis Tools **[8 Hrs]**

Frequency Response Analysis (SFRA), Partial Discharge (PD), Time Domain Dielectric Response (TDDR), Frequency Domain Spectroscopy (FDS), Chemical analysis. Image processing techniques.

Unit III: Online Condition Monitoring and Instrumentation **[8 Hrs]**

Recent methods (online), vibration, chemical and temperature monitoring, sensor and data acquisition system, Modern algorithms, GA, and signal processing techniques. Application to various equipment's such as transformer, induction motor, synchronous generator and motor, DC motor, CT and PT, case studies.

Unit IV: Reliability and Failure e Rate Assessment **[8 Hrs]**

Calculation of Power Equipment Reliability for Condition-based Maintenance Decision-making, Optimum Reliability- Centered Maintenance, and Cost Related Reliability Measures for Power System Equipment, Reliability based replacement refurbishment/planning.

Unit V: AI & Machine Learning in Condition Monitoring **[8 Hrs]**

Data preprocessing, Feature selection, Fault classification using: ANN, SVM, Deep learning basics and Predictive maintenance models.

Textbooks:

[1]	P.Vas, "Parameter estimation, condition monitoring and diagnosis of electrical machines", Clarendon Press Oxford, 1993.

[2]	P.Tavner, Li Ran, J. Penmanand H. Sedding, “Condition monitoring of rotating electrical machines”, IET press, 2008.
[3]	B.K.N. Rao, “Handbook of Condition Monitoring”, Elsevier Advanced Technology, Oxford, 1996.
[4]	H.A. Toliyat, S. Nandi, S. Choi and H. Meshgin-Kelk, “Electric Machines: Modeling, Condition Monitoring, and Fault Diagnosis”, CRC Press, Boca Raton, 2013.
Reference Books:	
[1]	1. Xose M Lo´pez, Ferna´ndez, H Bu¨ lent Ertan, J Turowski, “Transformers analysis, design, and measurement”, CRC Press,2012.
[2]	S.V. Kulkarni and S.A. Khaparde, “Transformer Engineering: Design, Technology and Diagnostics”, Second edition, CRC Press, 2013.
[3]	R. Billinton and R.N. Allan, “Reliability Evaluation of Power Systems, 2nded.NewYork”, NY, USA: Plenum, 1996.
Online Resources:	
[1]	Videos on Transformer condition evaluation with ABBs Mature Transformer Management Program
[2]	Induction motor condition monitoring with ABBs, Siemens, General Electricals (source You Tube)

Smart Grid Technologies						
Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Explain the fundamentals and challenges of Smart Grid systems..
2. Understand communication technologies and cyber security in Smart Grids.
3. Analyse smart transmission technologies and wide area monitoring systems.
4. Describe smart substations and substation automation standards.
5. Evaluate smart distribution systems, energy storage, and microgrids.

Unit 1: Introduction to Smart Grid **[6 hrs]**

Concept, definitions, difference between conventional and smart grid, challenges in smart grid implementation, Overview of the technologies required for the Smart Grid.

Unit 2: Information and Communication Technology **[8 hrs]**

Communication requirements in smart grid, overview of smart grid standards, Wired and wireless communication, Zigbee, Wireless mesh, Cellular Network Communication, Power line Communication, Digital Subscriber Lines, Wi-Max, Wide Area Network, Neighborhood Area Network, and Home Area Network, information technology, cyber security, standards.

Unit 3: Smart Transmission System: **[8 hrs]**

Phasor Measurement unit, Phasor data concentrators, Wide are a measurement control and protection, Wide area measurement systems and its applications, Flexible Alternating Current Transmission Systems. High-voltage Direct-current Transmission.

Unit 4: Smart Substation **[8 hrs]**

International Electro-technical Communication 61850 standards and benefits, IEC Generic Object Oriented Substation Event -GOOSE, IEC 61850 Substation model Intelligent Electronic Devices integration, Substation LAN, WAN, SCADA, Substation automation.

Unit 5: Smart Distribution Systems and Energy Storage:	[10 hrs]
Introduction to Smart Meters, Real-time pricing, Smart appliances, Automatic meter reading (AMR), Demand response, Battery storage, Plug in Hybrid electric vehicles, compressed air, pumped hydro, ultra-capacitors, flywheels, fuel cells. Carbon Footprint, Renewable Resources: Wind and Solar, Micro grid Architecture, Issues of interconnection, protection &control of microgrid, Islanding.	
Textbooks:	
[1]	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, March 2012.
[2]	Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley Blackwell, 2012.
Reference Books:	
[1]	Smart Grid: Fundamentals of Design and Analysis (IEEE Press Series on Power Engineering) by James Momoh, Mar20, 2012.
[2]	Ali Keyhani, Mohammad N.Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley, November2009.
[3]	Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press, October 2012.
[4]	Recent literature on Smart Grid.

Intelligent Control						
Course Code	<tbd>		**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: 50	ESE: 50	--
Course Outcomes: Students will be able to:						

1. Understand the fundamentals of intelligent control systems and soft computing techniques.
2. Apply fuzzy logic methods for analysis and control of engineering systems.
3. Develop Artificial Neural Network (ANN)-based models and intelligent controllers.
4. Analyse and implement optimization techniques such as Genetic Algorithms and Particle Swarm Optimization.
5. Design intelligent control solutions for real-world engineering applications using simulation tools.

Unit 1: Introduction to Intelligent Control	[8 Hrs]
Conventional and Intelligent Control Systems, Artificial Intelligence in Control Engineering, Knowledge-Based Systems, Expert Systems, Applications of Intelligent Control.	
Unit 2: Fuzzy Logic Systems	**[8 Hrs]**
Crisp and Fuzzy Sets, Membership Functions, Fuzzy Operations and Relations, Fuzzification and Defuzzification, Fuzzy Inference Systems, Mamdani and Sugeno Models, Design of Fuzzy Controllers.	
Unit 3: Artificial Neural Networks	**[8 Hrs]**
Biological Neuron Model, Perceptron, Multilayer Perceptron, Feedforward and Recurrent Neural Networks, Learning Algorithms, Backpropagation, ANN-Based Modeling and Control	
Unit 4: Evolutionary and Optimization Techniques	**[8 Hrs]**

Genetic Algorithms, Selection, Crossover and Mutation, Particle Swarm Optimization, Ant Colony Optimization, Intelligent Optimization for Controller Tuning	
Unit 5: Advanced Intelligent Control Applications	**[8 Hrs]**
Neuro-Fuzzy Systems, Adaptive Intelligent Control, Intelligent Robotics and Automation, Intelligent Process Control, Pattern Recognition, Simulation and Case Studies.	

Textbooks:	
[1]	Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, CA, 1998.
[2]	Stanislaw H. Zak, Systems & Control, Oxford University Press, 2003.
Reference Books:	
[1]	K. Passino, *Biomimicry for Optimization, Control and Automation*, Springer-Verlag, 2005.
[2]	Antsaklis P.J. and Passino K. M., *An Introduction to Intelligent and Autonomous Control*, Kluwer Academic Publishers, Norwell, MA, 1993.
[3]	Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, Wiley, 1995.
[4]	Rossiter, J.A., *Predictive Control: A Practical Approach*, CRC Press, 2003.
Note:	
[1]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc.
[2]	To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.
[3]	To measure CO3, questions will be based on applications of core concepts.
[4]	To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.
[5]	To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Solar and Wind Energy						
Course Code	RM		**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Analyse the potential of various renewable energy systems.
2. Analyse solar thermal systems and their engineering applications.
3. Design and evaluate solar photovoltaic systems for various applications.
4. Analyse the performance of wind energy system.
5. Develop and assess hybrid renewable energy systems considering technical, economic, and environmental aspects.

Unit 1: Fundamentals of Renewable Energy:	**[8 Hrs]**
Introduction to renewable energy sources, Energy scenario: Global and Indian perspective, Environmental impacts of conventional energy sources, Renewable energy policies and sustainable development, Energy storage fundamentals	
Unit 2: Solar Thermal Systems:	**[8 Hrs]**

Solar radiation geometry, Measurement of solar radiation, Solar thermal energy conversion, Flat plate and concentrating collectors, Solar water heating systems, Solar dryers, cookers, and thermal applications, Thermal energy storage systems	
Unit 3: Solar Photovoltaic Systems:	**[8 Hrs]**
Principle of photovoltaic conversion, Solar cell materials and characteristics, PV modules, arrays, and efficiency, Maximum power point tracking (MPPT), Standalone and grid-connected PV systems, Batteries and energy storage for PV systems, Applications of solar PV systems.	
Unit 4: Wind Energy Conversion Systems	**[8 Hrs]**
Nature and characteristics of wind, aerodynamics of wind turbines, Types of wind turbines, Components of wind energy conversion systems, Power coefficient and Betz limit, height, air density effects, Wind farm layout and performance analysis, wind speed distribution	
Unit 5: Hybrid Renewable Energy Systems and Applications	**[8 Hrs]**
Solar-wind hybrid systems, Grid integration of renewable energy, Power electronics for renewable energy systems, Smart grids and distributed generation, Economic and environmental analysis, Operation and maintenance of renewable systems, Case studies of solar and wind power plants.	

Textbooks:

[1]	G. M. Masters, Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004
[2]	S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage‖, McGraw Hill, 1984.

Reference Books:

[1]	C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, 3rd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2015.
[2]	M. R. Patel, Wind and Solar Power Systems: Design, Analysis, and Operation, 2nd ed. Boca Raton, FL, USA: CRC Press, 2006.
[3]	C. S. Solanki, Renewable Energy Technologies: A Practical Guide for Beginners. New Delhi, India: PHI Learning Pvt. Ltd., 2009.

Vehicle Dynamics and Testing

Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Analyse the potential of various renewable energy systems.
2. Analyse solar thermal systems and their engineering applications.
3. Design and evaluate solar photovoltaic systems for various applications.
4. Analyse the performance of wind energy system.
5. Develop and assess hybrid renewable energy systems considering technical, economic, and environmental aspects.

Unit 1: EV Modelling and Analysis	**[8 Hrs]**
EV modelling approaches including component-level modelling of battery, motor, controller, drivetrain, and vehicle dynamics; methods for developing mathematical and simulation models; introduction to modelling environments for EV performance studies; modelling assumptions, limitations, and validation techniques..	
Unit 2: Simulation of Electric Two-Wheeler and Three-Wheeler EVs	**[8 Hrs]**

Development of EV models for two-wheelers and three-wheelers; creation of drivetrain and vehicle load models; simulation of acceleration, gradeability, energy consumption, and range; interpretation of simulation results; sensitivity studies for motor power, battery capacity, vehicle weight, and control strategies.	
Unit 3: Electric Vehicle Range and Influencing Factors	**[7 Hrs]**
Definition of EV range; range estimation methods; key factors affecting EV range including battery characteristics, driving patterns, road gradients, aerodynamics, rolling resistance, temperature effects, accessory loads, and driver behavior; theoretical and practical considerations for accurate range prediction.	
Unit 4:Vehicle Testbed and Chassis Dynamometer for 2W/3W	**[8 Hrs]**
Overview of EV testbeds; construction, types, and operating principles of chassis dynamometers for two wheelers and three-wheelers; load simulation methods including inertia simulation, road-load coefficient methods, and power-absorption systems; sensors, instrumentation, and measurement systems; safety protocols and calibration procedures; introduction to test cycles used for EV range evaluation.	
Unit 5: Conducting Range Tests on Testbed and Drive Cycle Emulation	**[9 Hrs]**
Setup and configuration of chassis dynamometer for range testing; data acquisition systems, communication protocols, and measurement accuracy; steps for conducting range tests; interpreting logged data and generating performance reports; identifying inefficiencies using test data; strategies for improving EV range; Electrical Engineering Department drive cycle emulation using testbeds including MIDC, IDC, and custom cycles; homologation requirements and compliance testing.	

Textbooks:	
[1]	Mehrdad Ehsani, Yimin Gao, Sebastien Gay, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, 2nd Edition, CRC Press, 2018.
[2]	Sheldon S. Williamson, Electric Vehicle Machines and Drives: Design, Analysis and Application, 1st Edition, Wiley, 2015.
[3]	Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021.
Reference Books:	
[1]	James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition, Wiley, 2012.
[2]	Wolfgang Steiger et al., Testing and Validation of Electric Vehicle Systems, 1st Edition, SAE International, 2019.
[3]	Amitava Chattopadhyay, Automotive Testbeds and Dynamometers, 1st Edition, McGraw-Hill, 2017.
[4]	AIS 040, AIS 039, BIS Standards, MIDC – Government of India EV Range & Drive Cycle Evaluation Standards, latest revisions.

Research Methodology						
Course Code			**Examination Scheme**			
Teaching Scheme	2-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	2		**Laboratory**	CIE: --	ESE: --	--
Course Outcomes: Students will be able to:						
1. Explain the core objectives, types, and ethical considerations of the academic research process to identify valid engineering research problems.						

2. Conduct systematic literature surveys to isolate research gaps, formulate testable hypotheses, and select appropriate sampling designs. 3. Apply statistical analysis tools and software frameworks to interpret, present, and validate collected empirical datasets. 4. Compose structured technical research papers, thesis reports, and project funding proposals following precise citation styles and plagiarism standards. 5. Evaluate Intellectual Property Rights (IPR) pathways, patenting frameworks, and commercialization strategies for engineering research outcomes.	
Unit 1: Introduction to Research Methodology	**[5 Hrs]**
Meaning and objectives of research, Types of research: Fundamental, Applied, Experimental, Research process and research ethics, Identification and formulation of research problems	
Unit 2: Literature Review and Research Design	**[6 Hrs]**
Literature survey techniques, Research gap identification, Research design and planning, Hypothesis formulation, Sampling methods	
Unit 3: Data Collection and Analysis	**[6 Hrs]**
Methods of data collection, Questionnaire and survey methods, Statistical tools for analysis, Data interpretation and presentation, Use of software tools for research analysis	
Unit 4: Technical Paper and Report Writing	**[6 Hrs]**
Structure of technical papers and thesis, Abstract, introduction, methodology, results, and conclusion, Referencing styles and citation methods, Plagiarism and intellectual property rights, Presentation and communication skills	
Unit 5: Research Applications and Case Studies	**[5 Hrs]**
Research funding and project proposal writing, Patents and publication process, Case studies in engineering research, Emerging trends in interdisciplinary research, Research outcomes and commercialization	

Textbooks:	
[1]	C.R. Kothari — Research Methodology: Methods and Techniques
[2]	Ranjit Kumar — Research Methodology: A Step-by-Step Guide for Beginners
[3]	Panneerselvam R. — Research Methodology
[4]	Uma Sekaran and Roger Bougie — Research Methods for Business
[5]	Garg B.L., Karadia R., Agarwal F., Agarwal U.K. — An Introduction to Research Methodology
Reference Books:	
[1]	John W. Creswell — Research Design: Qualitative, Quantitative and Mixed Methods Approaches
[2]	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams — The Craft of Research
[3]	Kate L. Turabian — A Manual for Writers of Research Papers, Theses and Dissertations
[4]	Day R.A. and Gastel B. — How to Write and Publish a Scientific Paper
Online Resources:	
[1]	NPTEL course on " Research Methodology" by Prof. S. P. Thyagarajan, Professor, IIT Madras
[2]	NPTEL course on "Introduction to Research" by Prof. Prof. R. Sarathi, Professor, IIT Madras

Internship-III (after semester VI, Summer Internship)						
Course Code			**Examination Scheme**			
Teaching Scheme			**Theory**	TA: --	MSE: --	ESE: --
Credits	1		**Laboratory**	CIE: --	ESE: --	--

Sr. No.	**Items**	**Type of Internship to be undertaken**
1	Nature of Internship	Industry / R and D labs / Education institutes (HEI less than 100 NIRF rank) This should be decided by the nature of Project-I selected by the group of students in the 5th semester. A project guide should assist in grooming the student group in relevant areas to enhance their knowledge and skills.
2	End Semester Evaluation process	Individual student / Group of students shall submit a report followed by viva voce by the department level faculty members on the project report prepared by them. A template for report writing and evaluation format will be provided by the Nodal Officer, COEP Tech.

Project Stage - III					
Course Code		**Examination Scheme**			
Teaching Scheme	0-0-10-0	**Theory**	TA: --	MSE: --	ESE: --
Credits	5	**Laboratory**	CIE: --	ESE: --	--

Sr. No.	**Items**	**Description of activity**
1	Scope (TRL-Upto 4)	Continuation of Project Stage-II involving integration, testing, validation, performance analysis, optimization and demonstration of the developed hardware/software prototype in relevant application environment. Preparation of technical paper/poster, documentation and implementation of industry/research standards.
2	Self-Study material for the student	The department shall recommend relevant online/offline self-study materials on product development, research publications, IPR, entrepreneurship, startup ecosystem, advanced simulation/design tools and prototype validation techniques.
3	End Semester Evaluation process	The end semester evaluation shall be based on project demonstration, technical presentation, project report, research paper/poster and viva-voce examination. The evaluation shall be carried out by a panel of faculty members, at least three members including the project guide and one external/internal domain expert.

MDM – IV: Multidisciplinary Project					
Course Code		**Examination Scheme**			
Teaching Scheme	0-0-6-2	**Theory**	TA: --	MSE: --	ESE: --

Credits	3	Laboratory	CIE: --	ESE: --	--

Sr. No.	Items	Description of Activity
1	Scope (TRL-Upto 4)	It involves execution of a multi-domain engineering solution. The project demands the synthesis of electrical/electronic systems with cross-disciplinary tracks (e.g., software engineering, data analytics, mechanical housing, thermal management, or economic policy frameworks). The scope covers product requirement mapping, architectural system design, inter-module interface validation, data processing, and physical or simulated execution of the concept. Activities include technical project archiving, system assembly, user-interface mapping, and validation against localized cross-disciplinary standards.
2	Self-Study material for the student	The coordinating department shall recommend contextual, field-specific online/offline self-study pathways. Recommended areas encompass: systems engineering principles, multidisciplinary design optimization (MDO) frameworks, interface communication protocols, hardware-software co-design methods, intellectual property (IP) landscape mapping, and domain-specific regulatory, safety, and operational standards.
3	End Semester Evaluation process	The evaluation schema tracks performance metrics split across Continuous Internal Evaluation (CIE) and End Semester Evaluation (ESE). The final assessment is based on a functional project demonstration, cross-disciplinary technical review presentation, clean project dossier/report, and an oral viva-voce examination. Evaluation is executed by an institutional panel comprising a minimum of three members, including the designated project supervisor/mentor and internal or external domain experts representing the engineering disciplines involved.

Internship-IV (Semester VIII)					
Course Code		**Examination Scheme**			
Teaching Scheme		**Theory**	TA: --	MSE: --	ESE: --
Credits	3	**Laboratory**	CIE: --	ESE: --	--

Sr. No.	Items	Type of Internship to be undertaken
1	**Nature of Internship**	Industry / R and D labs / Education institutes (less than 100 NIRF) / International Internship / Replacement
2	**Scope of internship**	a) The project student group can pursue innovation (TRL > 4) on carry forward ideas / Proof of concept derived from Project - III for scaling up the model/ prototyping/ product development / Start-up. OR

		b) Students can pursue international internship abroad / Preplacement / Internship in Industry / Education institutes (less than 100 NIRF) / R and D labs.
2	**End Semester Evaluation process**	Students shall submit Internship report followed by voce viva, power point presentation by the department level faculty members. A template for report writing will be provided by the Nodal Officer, COEP Tech.

MOOCs Identified – NPTEL- PEC - V, VI, VII

Sr. No	Course Name	Weeks	Level	NOC (URL)
1	DC Microgrid and Control System	12	UG	https://onlinecourses.nptel.ac.in/noc20_ee84/preview
2	Electrical Distribution System Analysis	12	UG	https://onlinecourses.nptel.ac.in/noc19_ee61/preview
3	Electrical Equipment and Machines: Finite Element Analysis	12	UG	https://onlinecourses.nptel.ac.in/noc20_ee81/preview
4	Control And Tuning MethodsIn Switched Mode Power Converters	12	UG	https://archive.nptel.ac.in/courses/108/105/108105180/
5	Power System Dynamics, Control and Monitoring	12	UG	https://onlinecourses.nptel.ac.in/noc21_ee16/preview
6	Design And Simulation of DC-DC Converters UsingOpen-Source Tools	12	UG	https://archive.nptel.ac.in/noc/courses/noc16/SEM1/noc16-ec07/
7	Industrial Automation And Control	12	UG	https://archive.nptel.ac.in/courses/108/105/108105062/
8	High Power Multilevel Converters - Analysis, Design And Operational Issues	12	UG	https://archive.nptel.ac.in/courses/108/102/108102157/
9	Data Analytics using Python	12	UG	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs46/
10	Linear Dynamical Systems	12	UG	https://onlinecourses.nptel.ac.in/noc20_ee47/preview
11	Linear System Theory	12	UG	https://archive.nptel.ac.in/courses/108/106/108106150/
12	Deep Learning	12	UG	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs54
13	Embedded System Designwith ARM	12	UG	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs15/
14	Electrical Equipment and Machines: Finite Element Analysis	12	UG	https://onlinecourses.nptel.ac.in/noc24_ee91/