Marathwada Mitra Mandal's College of Engineering

Karvenagar, Pune- 52

An Autonomous Institute Affiliated to SPPU

Curriculum for

Third Year B. Tech Electrical Engineering

A.Y. 2026-27

Permanently Affiliated to SPPU | Accredited with A++ grade by NAAC
Recipient of Best College award by SPPU | Accredited by NBA
Recognized under 2(f) and 12(B) of UGC Act 1956
www.mmcoe.edu.in

CONTENTS

Institute Vision

To be a globally renowned institution through excellence in engineering education for holistic and sustainable development

Institute Mission

M1: Empower students with cutting-edge technologies and global competencies

M2: Foster culture of research and entrepreneurial mindset

M3: Imbibe social and professional values

M4: Provide an inclusive environment for lifelong learning

Department Vision

To be center of excellence in electrical engineering by developing globally skilled professionals through innovation, sustainability and technological growth.

Department Mission

M1: To provide quality education in electrical engineering through multidisciplinary, practical and industry oriented learning.

M2: To develop ethical and skilled engineers with expertise in emerging electrical technologies.

M3: To nurture lifelong learning and adaptability for addressing global, societal and future challenges.

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes (PO)

1. **PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5. **PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10. **PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for
    i) independent and life-long learning ii) adaptability to new and emerging technologies and
    iii) Critical thinking in the broadest context of technological change. (WK8)

Program Educational Objectives (PEO)

Engineering Graduates will be able to:

PEO1: Impart innovation and core knowledge to identify, analyze and solve the electrical engineering problems.

PEO2: Excel in Research and enhance their industry oriented professional skills.

PEO3: Demonstrate leadership qualities to lead diverse teams and exhibit commitment towards societal and global needs.

Program Specific Outcomes (PSOs)

After successfully completing the degree program, electrical engineering graduates will be able to :

PSO1: Design and validate efficient electrical system through core and professional skills.

PSO2: Exhibit multidisciplinary skills in the area of robotics, AI and machine Learning for Electrical engineering applications.

PSO3: Formulate sustainable solutions for research in societal and industrial needs pertaining to green technology.

Abbreviations

BSC:	Basic Science Course
UG:	Undergraduate Programme
ESC:	Engineering Science Course
PCC:	Program Core Courses
PEC:	Program Elective Courses
MDM:	Multidisciplinary Minor Courses
OE:	Open Elective
VSC:	Vocational Skill Course
SEC:	Skill Enhancement Course
AEC:	Ability Enhancement Course
IKS:	Indian Knowledge System
VEC:	Value Education Course
FP:	Field Project
CC:	Co-Curricular Course
IT:	Internal Tool
ET:	External Tool
ETE:	End –Term Examination
CIE:	Continuous Internal Evaluation
TW:	Term work
OR:	Oral Examination
PR:	Practical Examination
L:	Lecture
P:	Practical
T:	Tutorial
OL:	Online Teaching
ODL:	Open Distance Learning

Third Year B. Tech Electrical Engineering - SEMESTER - V																	
Course Code	Couse Name	Course Type	Teaching Scheme (Hrs/week)				Examination Scheme						Credits				
			L	P	T	ODL	CIE	ETE	TW	PR	OR	Total	L	P	T	ODL	Total
EE24PCC301	Electrical Machines-II	PCC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PCC302	Power System- II	PCC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PCC303	Basics of Industrial Automation	PCC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PEC304A	High Voltage Engineering	PEC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PEC304B	Advanced Microcontroller and Embedded System																
EE24PEC304D	Renewable Energy Sources																
EE24MDM305	*(Multidisciplinary Minor Theory)	MDM	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PCC306	Electrical Machines-II Lab	PCC	-	2	-	-	-	-	-	50	-	50	-	1	-	-	1
EE24PCC307	Power System- II Lab	PCC	-	2	-	-	-	-	-	50	-	50	-	1	-	-	1
EE24PCC308	Engineering Design and Innovation –I Lab (EDI -1)	PCC	-	4	-	-	-	-	25	-	-	25	-	2	-	-	2
EE24MDM309	*(Multidisciplinary Minor Lab)	MDM	-	2	-	-	-	-	25	-	-	25	-	1	-	-	1
EE24OEL310	*(Open Elective Theory)	OEL	-	-	-	2	-	-	50	-	-	50	-	-	-	2	2
EE24AEC311	Reasoning and Aptitude Development - 1	AEC	-	-	1	-	-	-	25	-	-	25	-	-	1	-	1
Total			**15**	**10**	**1**	**2**	**200**	**300**	**125**	**100**	**-**	**725**	**15**	**5**	**1**	**2**	**23**

***Refer Separate Booklet for MDM and OEL**

Abbreviations:

L- Lecture | P- Practical | T- Tutorial | CIE-Continuous Internal Evaluation

ETE - End Term Examination | TW- Term work | PR- Practical | OR- Oral

L : 1 Hr.= 1 credit | P: 2 Hr. = 1 Credit | T: 1 Hr. = 1 Credit

Third Year B. Tech Electrical Engineering - SEMESTER -VI

Course Code	Couse Name	Course Type	Teaching cheme (Hrs/week)				Examination Scheme						Credits				
			L	P	T	ODL	CIE	ETE	TW	PR	OR	Total	L	P	T	ODL	Total
EE24PCC351	Control System Engineering	PCC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PCC352	Advanced Electric Drives	PCC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PCC353	PLC SCADA and its Applications	PCC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PEC354A	Design of Solar PV and Wind Energy Sources	PEC	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PEC354B	HVDC and FACTS																
EE24PEC354D	Design of Electrical Machines																
EE24MDM355	*(Multidisciplinary Minor Theory)	MDM	3	-	-	-	40	60	-	-	-	100	3	-	-	-	3
EE24PCC356	Control System Engineering Lab	PCC	-	2	-	-	-	-	-	50	-	50	-	1	-	-	1
EE24PCC357	Advanced Electric Drives Lab	PCC	-	2	-	-	-	-	-	50	-	50	-	1	-	-	1
EE24PCC358	Engineering Design and Innovation –2 Lab (EDI -2)	PCC	-	2	-	-	-	-	25	-	-	25	-	1	-	-	1
EE24OEL359	*(Open Elective Theory)	OEL	-	-	-	2	-	-	50	-	-	50		-	-	2	2
EE24VSE360	Internet of Things	VSE	-	4	-	-	-	-	50	-	-	50		2	-	-	2
EE24AEC361	Reasoning and Aptitude Development - 2	AEC	-	-	-	1	-	-	25	-	-	25	-	-	-	1	1
Total			**15**	**10**	**-**	**3**	**200**	**300**	**150**	**100**		**750**	**15**	**5**	**-**	**3**	**23**

***Refer Separate Booklet for MDM and OEL**

Abbreviations

L- Lecture	P- Practical	T- Tutorial	CIE-Continuous Internal Evaluation
ETE - End Term Examination	TW- Term work	PR- Practical	OR- Oral
L : 1 Hr.= 1 credit	P: 2 Hr. = 1 Credit	T: 1 Hr. = 1 Credit	

SEMESTER V

Third Year B. Tech. Electrical Engineering														
Semester -V														
Course Code: EE24PCC301								Course Name: Electrical machines II						
Teaching Scheme (Hours/Unit)					Examination Scheme						Credits			
L	P	T	OL	ODL	CIE	ETE	TW	OR	PR	TOTAL	L	P	T	TOTAL
3	-	-	-	-	40	60	-	-	-	100	3	-	-	3

Course Pre-Requisite: Basics of electronics engineering, knowledge of physics

Course Objectives:

- To understand the working principle, constructional details and testing of three phase induction motor.
- To learn different types of single phase induction motor and reluctance motors, their characteristics and applications.
- To analyze of synchronous generator and motor which play important role in electrical power generation
- To study the permanent magnet synchronous motor and its applications.

Course Outcomes:

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

CO1: Explain construction, working and testing of three phase and single phase induction motor.

CO2: Summarize reluctance motors and describe it operation.

CO3: Classify alternator and analyze cylindrical alternator.

CO4: Analyze regulation of alternator by different methods and develop phasor diagram for salient pole alternator

CO5: Demonstrate characteristics of synchronous motor, explain its features and describe PMSM and its working.

Unit	Contents	Duration (Hrs.)
1	**Induction Motors:** **Three Phase Induction Motor:** Working principle, rotating magnetic field, Constructional details, Types, Torque equation, power flow diagram, speed control methods, No Load and block rotor test, efficiency, regulation, equivalent circuit and circle diagram, crawling, cogging. **Single Phase Induction Motor:** Double field revolving theory, Types, No Load and block rotor test, applications.	8
2	**Reluctance Motors** : **Stepper Motor:** Features, Working principle, Constructional details, Types, Applications. **Switched Reluctance Motor:** Features, Working principle, Constructional details Types, Applications.	8
3	**AC Generator I :** Constructional details, armature winding and related terms, Cylindrical and Salient Pole Rotor, Relation between mechanical and electrical angle, Armature reaction, Voltage drop due to armature resistance, leakage flux and synchronous reactance. Per phase equivalent circuit and phasor diagram.	8
4	**AC Generator II:** Direct and indirect voltage regulation methods, Blondel's two reaction theory for salient pole alternators, Direct-axis and quadrature-axis synchronous reactance's and their determination by slip test. Phasor diagram of salient-pole generator and calculation of voltage regulation.	8

5	**Synchronous Motor:** Starting methods, Phasor diagrams under different power factors, V and inverted V curves, synchronization, synchronous condensers, damper winding and hunting phenomenon, power-angle characteristics. **Permanent Magnet Synchronous Motor:** Features, Working principle, Constructional details, Types, Applications.	8
	Total Hours	**40**

Text Books

1. Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill.
2. T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Clarendon press, London, 1989
3. R. Krishnan - Switched Reluctance Motor Drives_ Modeling, Simulation, Analysis, Design, And Applications -CRC Press (2001).

Reference Book

1. B. L Theraja –Electrical Technology, Vol II , S. Chand publication.
2. P. S. Bimbhra, Electric Machinery, Khanna Publications.
3. T.Kenjo, ' Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000 Dekker (2009)
4. E G Janardanan, Special Electrical Machines, Prentice Hall of India.

Online References

1. NPTEL Course on : Electrical Machines II: by Prof. Tapas Kumar Bhattacharya, IIT Kharadpur. (nptel.ac.in/courses/108105131)

Third Year B. Tech. Electrical Engineering

Semester-V

Course Code: EE24PCC302 | **Course Name: Power System-II**

Teaching Scheme (Hours/Week)					Examination Scheme						Credits					
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**OL**	**ODL**	**TOTAL**
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3

Prerequisite: Power System-1, Network Analysis

Course Objectives:
- To calculate and analyze the performance of transmission lines using ABCD constants.
- To represent complex systems using per unit system and impedance diagrams.
- To perform load flow studies using Gauss-Seidel and Newton-Raphson methods.
- To analyze symmetrical faults in generators and transmission lines.
- To analyze unsymmetrical faults in generators and transmission lines.

Course Outcomes:
After learning the course, the students will be able to:
CO1: To understand the performance and modeling of transmission lines using ABCD parameters.
CO2: To learn the concept of per unit system and its use in simplifying power system calculations.
CO3: To study load flow analysis methods for system planning and operation.
CO4: To analyze symmetrical faults in power systems.
CO5: To analyze unsymmetrical faults in power systems.

Unit	Contents	Duration (Hrs.)
1	**Performance of Transmission Lines** ABCD constants and equivalent circuit representation, voltage regulation and transmission efficiency, concept of complex power, power flow using generalized constants, effect of line parameters on power flow, Sending and receiving end power circle diagrams, reactive power compensation.	8
2	**Per Unit System** Concept and significance of per unit quantities; selection of base values and derivation of base relationships; conversion of actual quantities to per unit and change of base, per unit impedance and reactance diagram and its application in fault and load flow analysis.	8
3	**Load Flow Analysis:** Network topology, concept of Z-bus and formulation of Y-bus matrix, Numerical on Y bus Matrix, classification of buses and load flow problem formulation, Load flow problem: Gauss-Seidel and Newton-Raphson methods	8
4	**Symmetrical Fault Analysis** Introduction to faults in power systems, use of per unit system for fault calculations, analysis of three-phase faults on generators and transmission lines, calculation of fault current and post-fault voltages.	8
5	**Unsymmetrical Fault Analysis** Types of unsymmetrical faults: L–G, L–L, and L–L–G; concept of symmetrical components, sequence networks and their connections for different faults, calculation of fault currents and voltages under unbalanced conditions.	8
	Total Hours	**40**

Text Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis – Tata McGraw Hill, New Delhi.
2. B R Gupta, Power System Analysis and Design, S. Chand.
3. Ashfaq Hussain, Electrical Power Systems, CBS Publication 5th Edition.
4. J. B. Gupta, A course in power systems, S.K. Kataria Publications.
5. P.S.R. Murthy, Power System Analysis, B.S. Publications.

Reference Books

1. H. Hadi Sadat, Power System Analysis, Tata McGraw-Hill New Delhi.
2. G. W. Stagg and El- Abiad, Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.
3. M. E. El- Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
4. Rakash Das Begamudre, Extra High voltage A.C. Transmission Engineering, New age publication.
5. M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw Hill Publication.

Online References

1. NPTEL Course: Prof. Debapriya Das, IIT Kharagpur, "Power System Engineering" (Link)
2. NPTEL Course: Prof. A.K. Sinha, IIT Kharagpur, "Power System Analysis" (Link)
3. NPTEL Course: Dr. M.L. Kothari, IIT Delhi, "Fluid Mechanics" (Link)

<table>
<tr><th colspan="17">Third Year B. Tech. Electrical Engineering</th></tr>
<tr><td colspan="17">Semester-V</td></tr>
<tr><td colspan="8">Course Code: EE24PEC303</td><td colspan="9">Course Name: Basics of Industrial Automation</td></tr>
<tr><th colspan="5">Teaching Scheme (Hours/Week)</th><th colspan="6">Examination Scheme</th><th colspan="6">Credits</th></tr>
<tr><th>L</th><th>P</th><th>T</th><th>OL</th><th>ODL</th><th>CIE</th><th>ETE</th><th>TW</th><th>OR</th><th>PR</th><th>TOTAL</th><th>L</th><th>P</th><th>T</th><th>OL</th><th>ODL</th><th>TOTAL</th></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>40</td><td>60</td><td>-</td><td>-</td><td>-</td><td>100</td><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td colspan="17">Prerequisite: Basic knowledge of electrical circuits and digital logic fundamentals, Basic computer operation skills.</td></tr>
<tr><td colspan="17">Course Objectives: The course aims to:
• Introduce the fundamental concepts of industrial automation systems and their components.
• Provide basic understanding of PLC programming concepts and operational behavior.
• Familiarize students with manual and automatic control strategies used in industrial processes.
• Develop foundational skills in HMI design for process monitoring and control.
• Introduce basic SCADA concepts for data acquisition, visualization, and supervisory control.</td></tr>
<tr><td colspan="17">Course Outcomes:
After completing the course, the students will be able to:
CO1: Understand the principles and components of industrial automation systems.
CO2: Develop and implement basic PLC programs for industrial applications.
CO3: Explain the architecture, communication, and functionalities of SCADA systems.
CO4: Design effective HMI screens for process control and monitoring.
CO5: Analyze and implement various communication protocols to establish seamless data exchange in industrial automation systems.</td></tr>
<tr><th>Unit</th><th colspan="14">Contents</th><th colspan="2">Duration (Hrs.)</th></tr>
<tr><td>1</td><td colspan="14">Introduction to Automation
Definition and Evolution: History, importance, and future trends in industrial automation, Types of Automation: Fixed, programmable, and flexible automation systems with examples, Components of Automation Systems: Sensors (temperature, pressure, proximity), Actuators (motors, solenoids, pneumatic systems), Controllers (basic overview of microcontrollers and PLCs), Control Systems: Open-loop vs. closed-loop systems with real-world examples, Role of feedback in automation, Role of IoT in Automation: Basics of IoT integration in industrial systems.</td><td colspan="2">8</td></tr>
<tr><td>2</td><td colspan="14">Programmable Logic Controller (PLC)
Introduction to PLC: PLC architecture: CPU, memory, I/O modules, and communication modules, working principles and scan cycle of PLC, Programming Basics: Overview of IEC 61131-3 programming languages: Ladder Logic, FBD, and STL, Development of basic PLC programs: Start/Stop operations, AND/OR logic, Hardware and Wiring: Wiring of PLC modules with field devices, Industrial Applications: Material handling systems, conveyor belts, and traffic control.</td><td colspan="2">8</td></tr>
<tr><td>3</td><td colspan="14">Supervisory Control and Data Acquisition (SCADA)
Introduction to SCADA: Purpose and components of SCADA systems (RTUs, MTUs, HMI), SCADA Architecture: Centralized vs. distributed SCADA.
Communication Protocols: MODBUS, DNP3, and OPC, Real-Time Applications: SCADA in water treatment plants, and power distribution, Data Logging and Alarming: Basics of event logging and generating alarms.</td><td colspan="2">8</td></tr>
</table>

4	**Human-Machine Interface (HMI)** Basics of HMI: Role of HMI in automation systems, Designing HMI Screens: Principles of designing user-friendly interfaces, Layout and color coding for effective monitoring, HMI and PLC Integration: Communication between HMI and PLC using protocols like Ethernet/IP, Applications: Process visualization in industries, Real-time parameter monitoring.	8
5	**Communication Protocols** Introduction to Communication Protocols: Definition and Importance, Role in Industrial Automation and PLCs, Types of Communication Protocols: Serial Communication (RS232, RS485), Fieldbus Protocols (PROFIBUS, DeviceNet), Industrial Ethernet, Overview of Protocol Layers: OSI Model and its Relevance to PLC Communication, Communication between PLCs and Field Devices: Data Exchange with Sensors and Actuators, Integration with SCADA and HMI. Practical Considerations: Cable Types and Termination, Error Detection and Troubleshooting	8
	Total Hours	40

Text Books

1. J. W. Webb and R. A. Reis, Programmable Logic Controllers: Principles and Applications, 5th ed., Prentice Hall, 2011.
2. F. Lamb, Industrial Automation: Hands-On, 1st ed., Delmar Cengage Learning, 2013.
3. S. A. Boyer, SCADA: Supervisory Control and Data Acquisition, 4th ed., ISA, 2010.
4. R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, 2nd ed., Pearson Education, 2015.
5. F. Lamb, Human Machine Interface: HMI Design, 1st ed., Delmar Cengage Learning, 2014.
6. G. Dunning, Introduction to Programmable Logic Controllers, 2nd ed., Thomson Learning, 2006.
7. R. L. Kurtz, Securing SCADA Systems, Wiley Publishing, 2005.

Reference Books

1. B. Sahoo, Introduction to Industrial Automation, 1st ed. McGraw-Hill Education, 1st Edition.
2. K. Collins, PLC Programming for Industrial Automation, 1st ed. CreateSpace Independent Publishing Platform, 1st Edition.
3. A. K. Gupta and S. K. Arora, Industrial Automation and Control, 2nd ed. Laxmi Publications, 2nd Edition.
4. N. S. Nise, Control Systems Engineering, 7th ed. John Wiley & Sons, 7th Edition.
5. G. Clark and D. Reynders, Practical Modern SCADA Protocols, 1st ed. Elsevier, 1st Edition.
6. G. L. Batten, Programmable Controllers, 2nd ed. McGraw Hill Inc., 2nd Edition.
7. S. Bennett, Real Time Computer Control, 1st ed. Prentice Hall, 1988.
8. K. Kant, Computer Based Industrial Control, 1st ed. PHI, 1st Edition.
9. P. K. Srivastava, Programmable Logic Controllers with Applications, 1st ed. BPB Publications, 1st Edition.
10. D. Popovic and V. Bhatkar, Distributed Computer Control Systems in Industrial Automation, 1st ed., 1st Edition.

Online References

1. NPTEL Course: Electrical Measurement and Electronic Instruments by Prof. Avishek Chatterjee, Dept. of Electrical Engineering, IIT Kharagpur (https: // nptel.ac.in/courses /108 /105 / 108105153/).
2. NPTEL Course: Industrial Instrumentation by Prof. Alok Barua, IIT Kharagpur: (https://nptel.ac.in/courses/108/105/108105064/).
3. Industrial Automation and Control, Instructor: Prof. Alokkanti Deb, Department of Electrical Engineering, IIT Kharagpur (https://archive.nptel.ac.in/courses/108/105/108105088/).

Third Year B. Tech. Electrical Engineering

Semester-V

Course Code: EE24PEC304A **Course Name: High Voltage Engineering**

Teaching Scheme (Hours/Week)					Examination Scheme						Credits					
L	P	T	OL	ODL	CIE	ETE	TW	OR	PR	TOTAL	L	P	T	OL	ODL	TOTAL
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3

Prerequisite: Engineering Sciences, Material Science, Power System

Course Objectives:

This course aims:

- To make students to know and compare the various processes of breakdown in solid, liquid and gaseous dielectric materials.
- To make students understand and apply various methods of generation and measurement of DC, AC, impulse voltage and current.
- To enable students to understand the charge formation and separation phenomena in clouds, the causes of overvoltage and lightning phenomena,
- To develop the ability among learners to execute testing on various high-voltage equipment as per standards.
- To introduce students to the design, layout, safety precautions, earthing, and shielding of HV laboratory.

Course Outcomes:

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

CO1: Identify, describe and analyze the breakdown theories of gaseous, solid and liquid materials.

CO2: Analyze the occurrence of over voltage and to provide remedial solutions.

CO3: Describe and use of various methods of generation of high AC, DC, impulse voltage and current.

CO4: Demonstrate the methods of measurement of high AC, DC, impulse voltage and current, tests on high voltage equipment and devices

CO5: Study design of high voltage laboratory with all safety measures.

Unit	Contents	Duration (Hrs.)
1	**Breakdown in Gas** Ionization process in gas, Townsend’s Theory, current growth equation in presence of primary and secondary ionization processes, Townsend’s breakdown criterion, primary and secondary ionization coefficients, limitations of Townsend’s theory, Streamer mechanism of breakdown, Paschen’s Law and its limitations, Corona discharges for point plane electrode combination with positive and negative pulse application, time lag for and factors on which time lag depends. (Numerical on Townsend’s theory and Paschen’s law).	8
2	**Breakdown in Liquid and Solid Dielectrics** **Breakdown in Liquid Dielectrics:** Pure and commercial liquids, Different breakdown theories: Breakdown in Pure liquid and breakdown in commercial liquids: Suspended Particle theory, Cavitations and bubble theory, Thermal mechanism of breakdown and Stressed Oil volume theory. **Breakdown in Solid Dielectrics:** Intrinsic breakdown: electronic breakdown, avalanche or streamer breakdown, electromechanical breakdown, thermal breakdown, treeing and tracking phenomenon, Chemical and electrochemical breakdown, Partial discharge, Composite dielectric material, Properties of composite dielectrics, breakdown in composite dielectrics. (Numerical on theories of liquid and solid dielectric materials)	9

3	**Lightning and Switching Over Voltages** Lightning phenomenon, Different types of lightning strokes and mechanisms of lightning strokes, Charge separation theories, Wilson theory, Simpson theory, Reynolds and Mason theory. Causes of over voltages and its effects on power systems, Over voltage due to switching surges and methods to minimize switching surges. Statistical approach of insulation coordination.	8
4	**Generation and Measurement of High Voltages and Current** **Generation:** Generation of high ac voltages-Cascading of transformers, series and parallel resonance system, Tesla coil. Generation of impulse voltages and current-Impulse voltage definition, Multistage impulse generator, Generation of high impulse current. **Measurement:** Sphere gap voltmeter, electrostatic voltmeter, generating voltmeter, peak reading voltmeter, resistive, capacitive and mixed potential divider, capacitance voltage transformer, Measurement of high power frequency a. c. using current transformer with electro-optical signal converter.	8
5	**High Voltage Testing Laboratory and Design** Testing of insulators and bushings, Power capacitors and cables testing, testing of surge arresters. Design, planning and layout of High Voltage laboratory:-Classification and layouts, earthing and shielding of H.V. laboratories.	7
	Total Hours	40

Text Books

1. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd.
2. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publication Co. Ltd. New Delhi.
3. Prof. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, "High Voltage Engineering'', Khanna Publishers, New Delhi.
4. Subir Ray, "An Introduction to High voltage Engineering" PHI Pvt. Ltd. New Delhi

Reference Books

1. Ravindra Arora, Wolf Gang Mosch, "High Voltage Insulation Engineering", New Age International.
2. High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York and Basel
3. E. Kuffel, W. S. Zaengl, J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication

Online References

1. Prof. Ravindra Arora, IIT Kanpur, "High Voltage Engineering" (https://nptel.ac.in/courses/108104048).
2. NPTEL Course: Prof. S. N. Singh, IIT Kharagpur "High Voltage DC Transmission" (https://nptel.ac.in/courses/108104013).
3. Weebly Course: Prof. Bharat Singh Rajpurohit, IIT Jodhpur "Fundamentals of High Voltage Engineering" (https://bharatsrajpurohit.weebly.com/high-voltage-engineering-course.html)

Third Year B. Tech. Electrical Engineering

Semester-V

Course Code: EE24PCC304B **Course Name: Advanced Microcontroller and Embedded System**

Teaching Scheme (Hours/Week)					Examination Scheme						Credits					
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**OL**	**ODL**	**TOTAL**
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3

Prerequisite: Knowledge of Analog and Digital Electronics, Micro-processor, Micro-controller, Basic C Programming

Course Objectives: To enable students to gain knowledge and understanding in the following aspects:

- Help Students understand Architecture of PIC 18F458 microcontroller.
- Create and enhance ability to write and Interpret Assembly and C language for PIC 18F458.
- Make students understand procedure to interface peripherals with PIC 18F458 for various Applications.
- Design and implement low-level hardware interfaces for sensors, actuators, and communication modules, integrating electrical components with microcontroller systems.

Course Outcomes:

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

CO1: Understand architecture of PIC 18F458 microcontroller, its instructions and the addressing modes

CO2: Analyze advanced PIC microcontroller features and tools required for Electrical Systems

CO3: Develop PIC Microcontroller Interfacing using basic and advanced Peripherals for different Electrical Systems

CO4: Apply serial communication concepts and it's protocols for Electrical systems

Unit	Contents	Duration (Hrs.)
1	**Microcontroller Families and Architectures** Microcontroller families (PIC18,PIC24), Introduction to 4-bit, 8-bit, 16-bit, 32-bit microcontroller, Architecture comparison (8-bit, 16-bit, 32-bit), Memory organization and management of PIC18F, Embedded C programming concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations.	8
2	**Advanced PIC Microcontroller Features and Tools** Low-power and energy-efficient features, Watchdog timers and brown-out detection, In-circuit serial programming (ICSP), Development tools and IDEs I/O Ports and related SFRs, PIC 18 Timer 0 Programing in C. Delay programming (with and without Timer0). LED Interfacing and its programming.	8
3	**PIC Microcontroller Interfacing - Basic Peripherals** GPIO and pin multiplexing, Timers and counters, PIC Analog-to-digital converters (ADC), Measurement of temperature and Power (LM35). Using PIC microcontroller, Interfacing of LCD (16x2) and it's programming in 4-bit mode.	8
4	**PIC Microcontroller Interfacing - Advanced Peripherals** Interrupt Programming, Programming of Timer0 interrupts, Programming of External interrupts INT0. Pulse-width modulation (PWM), Capture/Compare/PWM(CCP) modules, Speed control of DC motor using PWM mode of CCP module.	8

5	**Serial Communication, Protocols for PIC** Serial Communication structure and its programming (Data transmit and Receive), Communication protocols as SPI and MODE BUS, Universal Asynchronous Receiver/Transmitter (UART).	8
	Total Hours	40

Text Books

1. Muhammad Ali Mazidi, Janice Mazidi & R. D. McKinlay "The 8051 Microcontroller and Embedded Systems: Using Assembly and C" Pearson Education Publication, 2nd Edition, 2011.
2. Dogan Ibrahim, "Advanced PIC Microcontroller Projects in C: From USB to RTOS with the PIC18F Series", Newnes, 2011.
3. Myke Predko, "Programming and Customizing the PIC Microcontroller", TATA McGraw-Hill, 2017.
4. M. Rafiquzzaman "Microcontroller Theory and Applications with PIC18F", John Wiley and Sons, 2011

Reference Books

1. Raj Kamal "Embedded Systems: Architecture, Programming and Design" Tata McGraw-Hill Publications, 2008.

Online References

1. NPTEL Course: Microcontroller and Application, IIT Kharagpur, Dr. S.P. Das (https://nptel.ac.in/courses/117104072).
2. NPTEL Course: Microcontroller and Application, IIT Kharagpur , Santanu Chattopadhyay. (https://nptel.ac.in/courses/108105102)

<table>
<tr><th colspan="16">Third Year B. Tech. Electrical Engineering</th></tr>
<tr><td colspan="16">Semester-V</td></tr>
<tr><td colspan="8">Course Code: EE24PEC304D</td><td colspan="8">Course Name: Renewable Energy Sources</td></tr>
<tr><td colspan="5">Teaching Scheme (Hours/Week)</td><td colspan="6">Examination Scheme</td><td colspan="5">Credits</td></tr>
<tr><td>L</td><td>P</td><td>T</td><td>OL</td><td>ODL</td><td>CIE</td><td>ETE</td><td>TW</td><td>OR</td><td>PR</td><td>TOTAL</td><td>L</td><td>P</td><td>T</td><td>OL</td><td>ODL</td><td>TOTAL</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>40</td><td>60</td><td>-</td><td>-</td><td>-</td><td>100</td><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>3</td></tr>
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Prerequisite: Basic Electrical Engineering, Power generation Techniques, Mathematics - I and II, Engineering Physics, Engineering Mechanics.

Course Objectives:

- Impart in depth knowledge of various types of renewable energy sources
- Design and develop micro-grids using different renewable energy sources
- Understand the basic principles of operation of the various renewable energy systems

Course Outcomes:

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

CO1: Explain the different types of renewable energy sources

CO2: Build solar and wind energy conversion systems for stand-alone and grid connected systems.

CO3: Develop tidal and wave energy conversion systems.

CO4: Classify the different types of geothermal energy and biomass energy

CO5: IIlustrate the principle of operation and applications of various energy storage systems.

Unit	Contents	Duration (Hrs.)
1	**Solar Energy and Applications** Solar radiation; Solar radiation geometry and measurements; Collectors: principles, types, characteristics and efficiency; Solar energy storage; Applications, tower concept and solar pond; Photovoltaic (PV) systems: principles of PV energy conversion, PV cell, module, array, I-V and P-V characteristics, types, efficiency; Maximum power point tracking; Applications: stand-alone and grid connected systems	9
2	**Wind Energy and Applications** Energy from the wind; theory, types of wind turbines; Performance and efficiency of wind machines; Wind energy generation schemes; Maximum power point tracking; Applications: stand-alone and grid connected systems.	9
3	**Tidal and Wave Energy** Tidal energy: Energy from tides, working principles, operation methods of power generation, Wave energy: Energy from waves, Wave energy conversion devices; Design of Ocean Thermal Energy Conversion (OTEC) plant; Economics and Environmental impacts of OTEC.	8
4	**Biomass Energy :** Biomass conversion techniques: Biogas generation, classification and types of biogas plants; Energy from Industrial, municipal and agricultural wastes; Biomass gasifiers: types, gasification process, pyrolysis, thermochemical processes	6
5	**Energy storage system:** Fuel Energy Storage System and its type, Hydrogen Energy Storage: Compressed Gaseous Hydrogen Storage, Liquid Hydrogen Storage, Chemical Hydrogen Storage system its advantages and limitations. Fuel Energy Storage System	8
	Total Hours	40

Text Books

1. Frank Kreith, Susan Krumdeick, "Principles of Sustainable Energy Systems", CRC press, Taylor and Francis group, 2nd edition, 2014 .
2. Gilbert M Masters, "Renewable and efficient electric power systems", John Wiley & Sons, 2nd edition, 2013.
3. D. P. Kothari, K. C. Singhal, and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", S Chand Publication, 2013.
4. S. P. Sukhatme and J. K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage"
5. Shobh Nath Singh,"Nonconventional Energy Resources" Pearson 1st Edition, 2015.

Reference Books

1 Nonconventional Energy Resources B.H. Khan McGraw Hill 3rd Edition, 2013.
2 Renewable Energy; Power for a sustainable Future Godfrey Boyle Oxford 3rd Edition, 2012
3 Renewable Energy Sources: Their Impact on global Warming and Pollution Tasneem Abbasi S.A. Abbasi PHI 1st Edition, 2011
4 John Twidell and Tony Weir, Renewable Energy Resources, Second edition, Taylor and Francis, 2006.
5 Kothari, Dwarkadas Pralhaddas, K. C. Singal, and Rakesh Ranjan "Renewable energy sources and emerging technologies", PHI Learning Pvt. Ltd., 2011
6 Arthur Pecher and Jens Peter Kofoed, Handbook of Ocean Wave Energy, Springer Edition, 2017

Online References

1. NPTEL Course: Prof. R.Anandalaxmi , IIT Gawahati, "Renewable energy" (http://digimat.in/nptel/courses/video/103103206/L04.html)

Third Year B. Tech. Electrical Engineering														
Semester-V														
Course Code: EE24PCC306								**Course Name: Electrical Machines-II Lab**						
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**			
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**TOTAL**
-	2	-	-	-	-	-	-	-	50	50	-	1	-	1

Prerequisite: Faradays Laws, Basics of AC machines, PMSM, Stepper Motor and Switched Reluctance Motor

Course Objectives:

- To analyze performance of three phase and single phase induction motor.
- To evaluate performance of cylindrical and salient pole alternator and synchronous motor
- To develop control strategy for permanent magnet synchronous motor and stepper motor
- To analyze characteristics of switch reluctance motor.

Course Outcomes:

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

CO1: Predetermine performance of induction motors.

CO2: Classify alternator and calculate its regulation by different methods.

CO3: Demonstrate characteristics of synchronous motor and explain its features

CO4: Design control strategy for PMSM and reluctance motor.

List of Experiments

Sr. No.	Name of the Experiment	Duration (Hrs.)
1	Speed control of three phase Induction motor.	02
2	No Load and blocked rotor test on three phase Induction motor	02
3	No Load and blocked rotor test on single phase Induction motor	02
4	Regulation of three phase alternator by EMF method.	02
5	Regulation of three phase alternator by MMF method.	02
6	Perform slip test to find regulation of salient pole alternator	02
7	V and inverted V curves of Synchronous motor	02
8	Develop mathematical model of PMSM in synchronous rotating coordinate system and design control strategy algorithm for Id=0	04
9	Develop stepper motor control by sequencing coil energization.	04
10	Industrial visit	04
	Total Hours	26

Text Books
1. Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill,2002 2. T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Clarendon press, London, 1989. 3. R. Krishnan - Switched Reluctance Motor Drives_ Modeling, Simulation, Analysis, Design, and Applications -CRC Press, 2001.
Reference Books
1. B. L Theraja –Electrical Technology, Vol II , S. Chand publication, 2018. 2. P. S. Bimbhra, Electric Machinery, Khanna Publications, 2017. 3. T.Kenjo, ' Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000 Dekker, 2009. 4. E G Janardanan, Special Electrical Machines, Prentice Hall of India, 2002.
Online References
1. NPTEL Course: Prof. Tapas kumar Bhattacharya https://nptel.ac.in/courses/108105131 2. Interactive Learning Portal : https://www.nptelprep.in/courses/108105131/materials

Third Year B. Tech. Electrical Engineering														
Semester-V														
Course Code: EE24PCC307									**Course Name: Power System-II Lab**					
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**			
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**TOTAL**
-	2	-	-	-	-	-	-	-	50	50	-	1	-	1

Prerequisite: Power System-1, Network Analysis

Course Objectives:

- To study modeling and performance analysis of transmission lines using MATLAB and Simulink.
- To understand the application of the per-unit system in simplifying power system calculations.
- To develop Y-bus matrix and perform load flow analysis using MATLAB programming.
- To analyze symmetrical and unsymmetrical faults through MATLAB/Simulink simulations.
- To enhance practical understanding of power system operation and behavior using computational tools.

Course Outcomes:

After learning the course, the students will be able to:
CO1: To analyze transmission line performance using MATLAB and Simulink.
CO2: To apply per-unit system for power system calculations.
CO3: To form Y-bus matrix and perform basic load flow analysis.
CO4: To simulate symmetrical faults using Simulink.
CO5: To simulate unsymmetrical faults using Simulink.

List of Experiments

Sr. No.	Name of the Experiment	Duration (Hrs.)
1	Determination of ABCD constants for long and medium transmission lines	02
2	Performance analysis of transmission line (Voltage regulation & Efficiency)	02
3	Plot of power circle diagram for sending and receiving ends	04
4	Conversion of a multi-voltage system to per unit form	02
5	Formation of Y-bus matrix for a given power system network	02
6	Load flow analysis using Gauss-Seidel and Newton-Raphson methods	02
7	Simulation of symmetrical (3-phase) fault on a simple power system	04
8	Simulation of unsymmetrical faults (L–G, L–L, L–L–G) using sequence networks	04
9	Industrial visit to 220 KV substation	04
	Total Hours	**26**

Text Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis – Tata McGraw Hill, New Delhi.
2. B R Gupta, Power System Analysis and Design, S. Chand.
3. Ashfaq Hussain, Electrical Power Systems, CBS Publication 5th Edition.

4. J. B. Gupta, A course in power systems, S.K. Kataria Publications. 5. P.S.R. Murthy, Power System Analysis, B.S. Publications.
Reference Books
1. H. Hadi Sadat, Power System Analysis, Tata McGraw-Hill New Delhi. 2. G. W. Stagg and El- Abiad, Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi. 3. M. E. El- Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York. 4. Rakash Das Begamudre, Extra High voltage A.C. Transmission Engineering, New age publication. 5. M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw Hill Publication.
Online References
1. NPTEL Course: Prof. Debapriya Das, IIT Kharagpur, "Power System Engineering" (Link) 2. NPTEL Course: Prof. A.K. Sinha, IIT Kharagpur, "Power System Analysis" (Link) 3. NPTEL Course: Dr. M.L. Kothari, IIT Delhi, "Fluid Mechanics" (Link)

Third Year B. Tech. Electrical Engineering

Semester-V

Course Code: EE24PCC308 **Course Name:** Engineering Design and Innovation Lab – EDI 1

Teaching Scheme (Hours/Week)					Examination Scheme						Credits			
L	P	T	OL	ODL	CIE	ETE	TW	OR	PR	TOTAL	L	P	T	TOTAL
-	4	-	-	-	-	-	25	-	-	25	-	2	-	2

Prerequisite: Basic knowledge of electrical technology, electrical machines, power systems and control systems.

Preamble:

Engineering Design and Innovation (EDI) - 1 is an introductory course aimed at inculcating design thinking, creativity, and problem-solving skills among Electrical Engineering students. The course emphasizes a hands-on, learner-centric approach to engineering education, enabling students to identify real-world problems and develop innovative, feasible, and sustainable solutions using fundamental engineering principles.

This course introduces students to the engineering design process, including problem identification, need analysis, ideation, conceptual design, prototyping, testing, and validation. Special emphasis is placed on teamwork, communication skills, ethics, sustainability, and societal relevance in engineering solutions, with examples and mini-projects related to electrical and allied domains such as energy systems, smart devices, automation, and green technologies.

Through activity-based learning, case studies, and project-based evaluation, the course nurtures innovation mindset, entrepreneurship orientation, and interdisciplinary thinking, preparing students to meet contemporary engineering challenges and laying a strong foundation for advanced design and project courses in later semesters.

Scope: The course enables students to explore real-life problems related to energy systems, electrical safety, smart devices, automation, renewable energy, and sustainable technologies. It promotes interdisciplinary collaboration, encouraging integration of concepts from electrical, electronics, mechanical, and computer engineering where applicable.

Course Objectives: The course aims to:

- Develop the ability to identify and analyze real-world engineering problems by integrating knowledge acquired from multiple foundational engineering courses.
- Apply engineering principles, design methodologies, and innovation practices to develop feasible solutions in the form of systems, prototypes, software applications, processes, or experimental setups.
- Acquire proficiency in the selection and effective use of modern engineering tools, software, simulation platforms, fabrication techniques, testing instruments, and analytical methods for project implementation.
- Enhance teamwork, project planning, problem-solving, leadership, documentation, and communication skills required for collaborative engineering projects.
- Evaluate the performance of developed solutions through systematic testing, validation, optimization, and effective presentation of technical outcomes using professional engineering practices.

Course Outcomes:

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

CO1: Analyze an engineering problem or theme requiring the integration of knowledge from multiple foundational courses, and formulate system requirements, specifications, and a feasible solution approach.

CO2: Design and develop a functional system, prototype, software application, mechanism, process, or experimental setup by applying concepts from relevant foundational engineering courses..

CO3: Demonstrate the effective use of appropriate engineering tools, including CAD, programming environments, simulation software, circuit design tools, fabrication methods, database tools, testing instruments, and analytical techniques relevant to the discipline.

CO4: Collaborate effectively in multidisciplinary teams by organizing responsibilities, maintaining project documentation, resolving design issues, and integrating individual contributions to achieve project objectives.

CO5: Evaluate the performance of the developed solution through testing, validation, and iterative improvement using appropriate performance metrics, and communicate the project outcomes through technical reports, oral presentations, demonstrations, and reflective learning.

Guidelines:

1. The course shall be conducted using a **student-centric and activity-based learning approach**, focusing on design thinking and innovation rather than conventional examinations.
2. Students shall work in **teams** (typically 3–4 members) to encourage collaboration, leadership, and interdisciplinary learning.
3. Each team shall identify a **real-world problem**, preferably related to **electrical engineering, energy, sustainability, safety, or societal needs**, and propose an innovative solution.
4. The **engineering design process** shall be followed systematically, including:
    - Problem identification and need analysis
    - Literature survey and benchmarking
    - Ideation and conceptual design
    - Feasibility analysis
    - Prototype / model development (physical or virtual)
    - Testing, validation, and improvement
5. Students shall maintain a **design notebook / logbook** documenting problem statements, design iterations, calculations, sketches, and reflections throughout the course.
6. The course shall emphasize **hands-on activities**, use of basic tools, simulation software (where applicable), and low-cost prototyping techniques.
7. Faculty shall act as **mentors and facilitators**, providing continuous guidance, reviews, and formative assessment instead of only summative evaluation.
8. Regular **design reviews** shall be conducted to assess progress, creativity, technical soundness, teamwork, and communication skills.
9. **Ethics, safety, sustainability, environmental impact, and social relevance** shall be considered as integral components of the design solutions.
10. The evaluation shall be **continuous and rubric-based**, including: Problem identification and innovation, Design methodology and technical approach Prototype / model development Documentation and report writing Presentation, demonstration, and teamwork
11. Use of **open-ended problems** is encouraged; multiple solutions shall be accepted and appreciated.
12. The outcomes of this course shall provide a foundation for **research publications, patents, funded projects, advanced design courses, innovation labs, internships, entrepreneurship initiatives, and final year projects**.

Suggested List of Activities

Sr. No.	**Name of the Activities**		**Duration (Hrs.)**
	Title	**Foundational Corses**	
1	Smart Energy Meter and Load Logger	Subjects: Power System-I, Analog and Digital Electronics, Programming & Simulation, Network Analysis Focus: measurement chains, signal conditioning, load profiling, data	

		interpretation	52
2	Automatic Power Factor Monitor and Alarm	Subjects: Network Analysis, Power System-I, Analog and Digital Electronics, Programming & Simulation Focus: phasor concepts, PF computation, sensing circuits, alert logic	
3	Solar Charge Controller Test Bench	Subjects: Power Electronics, Power System-I, Analog and Digital Electronics, Programming & Simulation Focus: charging stages, converter control, renewable integration, instrumentation	
4	DC Motor Speed Control Using PWM	Subjects: Electrical Machines-I, Power Electronics, Analog and Digital Electronics, Programming & Simulation Focus: motor characteristics, switching control, sensing and feedback	
5	Controlled Rectifier Firing Circuit Trainer	Subjects: Power Electronics, Network Analysis, Analog and Digital Electronics, Programming & Simulation Focus: waveform analysis, triggering logic, converter output control	
6	Single-Phase Inverter Prototype	Subjects: Power Electronics, Network Analysis, Analog and Digital Electronics, Power System-I Focus: switching sequence, waveform quality, filtering, load testing	
7	DC-DC Buck/Boost Converter Kit	Subjects: Power Electronics, Network Analysis, Analog and Digital Electronics, Programming & Simulation Focus: converter modes, component sizing, switching response, regulation	
8	Automatic Street Lighting Controller	Subjects: Analog and Digital Electronics, Power System-I, Programming & Simulation, Electromagnetic Field Theory Focus: sensor interfacing, switching devices, system-level control, energy saving	
9	Classroom Energy Audit Dashboard	Subjects: Power System-I, Programming & Simulation, Analog and Digital Electronics, Network Analysis Focus: measurement planning, load categorization, analytics, sustainability	

10	Transformer Equivalent Circuit and Efficiency Tester	Subjects: Electrical Machines-I, Network Analysis, Analog and Digital Electronics, Programming & Simulation Focus: machine modelling, parameter estimation, test procedure, result interpretation	
11	Protected DC Power Supply for Laboratory Use	Subjects: Analog and Digital Electronics, Power Electronics, Network Analysis, Programming & Simulation Focus: rectification, regulation, sensing, protection features	
12	Smart Appliance Load Shedding Controller	Subjects: Power System-I, Power Electronics, Analog and Digital Electronics, Programming & Simulation Focus: demand management, priority control, switching logic, energy optimization	
		Total Hours	**52**

Text Books

1. Power Electronics: Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, Wiley, 2023.
2. Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid Pearson 2014.
3. Electrical Engineering Design C. W. T. McLyman CRC Press, 2011.
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering W. Bolton, Pearson, 2021.
5. Design Thinking for Engineering, John R. Karsnitz, Stephen O'Brien, John P. Hutchinson Cengage Learning, 2013.

Reference Books

1. Product Design and Development Karl T. Ulrich, Steven D. Eppinger McGraw-Hill, 2020.
2. Modern Power Electronics and AC Drives Bimal K. Bose, Pearson, 2002.
3. Electric Motors and Drives: Fundamentals, Types and Applications, Austin Hughes, Bill Drury, Newnes (Elsevier), 2019.
4. Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, Jonathan W. Valvano CreateSpace, 2017.

Online References

1. NPTEL Course: Electrical Measurement and Electronic Instruments by Prof. Avishek Chatterjee, IIT Kharagpur (https: // nptel.ac.in/courses /108 /105 / 108105153/)
2. NPTEL Course: Industrial Instrumentation by Prof. Alok Barua, IIT Kharagpur: (https://nptel.ac.in/courses/108/105/108105064/).
3. Industrial Automation and Control, Instructor: Prof. Alokkanti Deb, IIT Kharagpur (https://archive.nptel.ac.in/courses/108/105/108105088/).
4. Electromechanical Converter System, Instructor: Prof. Suman Maiti, IIT Kharagpur (https://archive.nptel.ac.in/courses/108/102/108102046/)

Third Year B. Tech Electrical Engineering																
Semester-V																
Course Code: EE24OEL311								**Course Name: Reasoning and Aptitude Development -1**								
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**					
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**OL**	**ODL**	**TOTAL**
-	-	1	-	-	-	-	25	-	-	25	-	-	1	-	-	1

Prerequisite: Basic Mathematical Concepts

Course Objectives:

- To develop fast and accurate mental calculation skills using Vedic Mathematics techniques for arithmetic operations.
- To strengthen students' understanding of number systems, divisibility rules, and numerical properties for efficient problem solving.
- To enhance competency in percentages, profit–loss, discounts, ratios, and partnerships for real-life and competitive exam applications.
- To build logical reasoning abilities through linear, circular, and complex puzzle-based arrangements.
- To improve analytical thinking by applying concepts of syllogisms, blood relations, and direction sense.
- To prepare students for aptitude-based assessments and competitive examinations by integrating speed, accuracy, and logical reasoning skills.

Course Outcomes:

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

CO1: Perform rapid mental calculations involving addition, subtraction, multiplication, squaring, square roots, and cube roots with high accuracy.

CO2: Analyze and solve number system problems involving divisibility, unit digits, factorials, HCF–LCM, and remainders.

CO3: Apply percentage, profit–loss, discount, ratio, and partnership concepts to solve quantitative aptitude problems efficiently.

CO4: Solve seating arrangement and puzzle-based problems, including linear, circular, matrix, and scheduling puzzles, using logical reasoning.

CO5: Evaluate syllogism problems and blood relation cases using Venn diagrams, family trees, and logical inference.

CO6: Demonstrate improved speed, accuracy, and confidence in quantitative and reasoning sections of placement and competitive examinations.

Unit	Contents - Foundations & Numerical Proficiency	Duration (Hrs.)
1	**Vedic Math & Mental Calculation** • Speed Addition & Subtraction (Left-to-Right method) • Base Method Multiplication (Numbers near 10, 100, 1000)	2

	• Squaring Techniques (Base 50/100 and numbers ending in 5) • Cube Roots and Square Roots of perfect numbers	
2	**Number Systems** • Classification (Rational, Irrational, Prime, Composite) • Divisibility Rules (2 to 19) • Unit Digit and Cyclicity • Factorial theory and Number of Zeroes • HCF & LCM (Models: Remainder cases) • Remainder Theorem basics	2
3	**Percentages** • Percentage Increase/Decrease and Multiplying Factors • Successive Percentage Change Formula • Product Constancy Rule	2
4	**Profit, Loss & Discount** • CP, SP, and Profit/Loss Percentage • Relation between Markup, Discount, and Profit • Successive Discounts and Single Equivalent Discount	2
5	**Ratio, Proportion & Partnership** • Ratio Scaling and Merging (A:B and B:C to A:B:C) • Mean, Third, and Fourth Proportional • Coin-based problems • Partnership: Profit sharing based on (Capital $\times$ Time) • Problems on Ages	2
6	**Linear Arrangements** • Single Row: All facing North/South • Dual Row: Facing each other • Directional cues (Left of, Second to the right, Immediate neighbours) • Ranking and Ordering (Tallest/Shortest, Top/Bottom)	2
7	**Circular & Polynomial Arrangements** • Circular: Facing Centre vs. Facing Outwards • Inward/Outward Mixed configurations • Square and Rectangular Table arrangements • Relationship-based seating (Combining Seating + Blood Relations)	2
8	**Complex Puzzles** • Grid/Matrix Puzzles (3 or 4 variables: Name, City, Profession, Color) • Scheduling Puzzles (Days of the week, Months, Years) • Floor-based Puzzles • Box-based Puzzles (Stacking logic)	2
9	**Syllogisms** • Standard Propositions (All, Some, No, Some Not) • Venn Diagram Method • "Only a Few" and "Few" cases • Possibility-based conclusions • Complementary pairs (Either-Or cases)	2
10	**Blood Relations & Direction Sense** • Family Tree Construction (Standard symbols) • Coded Blood Relations • Direction Compass and Degree Turns	2

	Total Hours	**20**
Reference Books		
Quant Basics	R.S. Aggarwal	Concept Clarity
Speed Math	M. Tyra	Time Management
Logic/Puzzles	K. Kundan / R.S. Aggarwal	Exam-specific Patterns
Critical Thinking	M.K. Pandey	Logical Derivations
DI / Advanced	Arun Sharma	Complex Data & CAT
Assessment		
Assessment will be done by Course Teacher. MCQ Test can be conducted based on the syllabus.		

SEMESTER VI

Third Year B. Tech. Electrical Engineering																
Semester-VI																
Course Code: EE24PCC351									**Course Name: Control System Engineering**							
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**					
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**OL**	**ODL**	**TOTAL**
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3

Prerequisite: Engineering Mathematics

Course Objectives:

- To understand the basic components of control system and types of control systems.
- To impart knowledge for modelling physical systems.
- To analyze behavior of systems in time and frequency domain.
- To design controller to meet desired specification.

Course Outcomes:

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

CO1: Calculate transfer function and characteristics of different Systems.

CO2: Analyze performance of physical systems using mathematical models.

CO3: Check the stability of linear systems in time and frequency domain.

CO4: Design controller to meet desired specification.

Unit	Contents	Duration (Hrs.)
1	**Introduction to Control System:** Introduction to control system block diagram, Components of control system, Classification of control systems, Concept of Transfer function, Representation of Electrical and Mechanical systems using differential equations and transfer function, Block diagram reduction, Signal flow graph.	8
2	**Time Domain Analysis:** Concept of transient and steady state response, Standard test signals, Type and order of system, Time response of first and second order systems to standard test signals, Time domain specification, Steady state error, Static error constants.	8
3	**Stability Analysis:** Concept of Stability, Effect of pole zero location on system stability, Routh Hurwitz Criteria, Construction of Root locus, Stability analysis by using Root locus.	8
4	**Frequency Domain Analysis:** Frequency domain specifications, Stability analysis by using Polar plot, Nyquist plot and Bode plot.	8
5	**Controllers and Compensation Techniques:** P, PI and PID controllers, Various compensators, Transfer function of Lag network and Lead network, Introduction of sliding mode control.	8
	Total Hours	40

Text Books

1. .J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 6th edition, 2017.
2. Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011
3. R. Anandanatrajan and P. Ramesh Babu, "Control Systems Engineering", Scitech Publication,3rd edition, 2011
4. C. D. Johnson, "Process Control Instrumentation Technology, 8th edition, PHI Learning Pvt. Ltd., 2013.

Reference Books

1. Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010.
2. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.
3. Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011.
4. B. Wayne Bequette, "Process Control: Modeling, Design and Simulation", PHI, 2003.

Online References

1. NPTEL Course: Prof. C. S.S hankar Ram, IIT Madras, "Control Systems" (nptel.ac.in/courses/107106081)
2. NPTEL Course: Prof G R Jayanth, IISc Bangalore, "Control System Design" (nptel.ac.in/courses/115108104)

Third Year B. Tech. Electrical Engineering

Semester-VI

Course Code: EE24PCC352 | **Course Name: Advanced Electric Drives**

Teaching Scheme (Hours/Week)					Examination Scheme						Credits					
L	P	T	OL	ODL	CIE	ETE	TW	OR	PR	TOTAL	L	P	T	OL	ODL	TOTAL
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3

Prerequisite: Basics of Electrical Technology, Electrical Machines, Power Electronics

Course Objectives:

- To understand motor load dynamics.
- To analyze the operation of the converter fed and chopper fed dc drives. ·
- To describe braking methods of D.C. and Induction motor drive.
- To comprehend vector control of induction motors.
- To recognise synchronous and BLDC motor drive.

Course Outcomes:

After learning the course, the students will be able to:
CO1: Explain Components and fundamental operation of drives.
CO2: Analyze speed control and braking of DC drives using controlled rectifier and Chopper.
CO3: Illustrate inverter and AC voltage regulator fed induction motor drives.
CO4: Analyze vector control for BLDC and PMSM drives.
CO5: Describe the advanced control of SRM used in electric vehicle.

Unit	Contents	Duration (Hrs.)
1	**Electrical Drives** A. Definition, components of electric drive system, types of electrical drives, factors influencing the choice of electrical drives, Industrial Applications of DC and AC drives B. Motor-Load dynamics, multi-quadrant operation, load torque components, nature and classification of load, steady-state stability.	8
2	**DC Drives** Speed control and Braking of DC motor drives using Single-phase and three-phase fully controlled converter and Chopper, Closed loop control of DC Motor Drives, Industrial Applications	8
3	**Induction Motor Drives** Scalar methods of speed control of Induction Motor drives using inverters and AC voltage controllers, Braking methods, Principle and Block diagram of vector control, Closed loop control of Induction Motor Drives, Industrial Applications	8
4	**A. BLDC drive** Speed Control and Braking in BLDC drives, closed loop control of BLDC drive (PI controller) , vector control of BLDC drive, Applications **B. PMSM Drive** Speed Control and braking, closed loop control of PMSM drive (PI controller), vector control of PMSM drive.	8
5	**Switched Reluctance Motor Drive** Principle of operation, converter Circuit, speed control and performance analysis of Switched reluctance Motor and Industrial Applications.	8
	Total Hours	40

Text Books

1. G. K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House, 2002
2. N. K. De, P. K. Sen, "Electric Drives", Prentice Hall of India Eastern Economy Edition 1999
3. S. K. Pillai, "Analysis of Thyristor Power Conditioned Motors", University Press, 1996
4. G.K. Dubey, "Power Semiconductor controlled drives", PHI publication 1989
5. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, 2001

Reference Books

1. R. Krishnan, "Electric Motor Drives – Modeling Analysis and Control", PHI India 2001
2. V. Subrahmanyam, "Electric Drives: Concepts and Application", Tata Mc-Graw Hill (An imprint of Elsevier) 2006
3. M.D. Singh and Khanchandani "Power Electronics", Tata Mc-Graw Hill 2007

Online References

1. NPTEL Course: Fundamentals of Electric Drives, I.I.T. Kanpur by Dr. S.P. Das. (https://nptel.ac.in/courses/108104140)
2. NPTEL Course: Advanced Electric Drives, I.I.T. Kanpur by Dr. S.P. Das. (https://nptel.ac.in/courses/108104011)

Third Year B. Tech. Electrical Engineering

Semester-VI

Course Code: EE24PCC353 | **Course Name: PLC, SCADA and its Applications**

Teaching Scheme (Hours/Week)					Examination Scheme						Credits					
L	P	T	OL	ODL	CIE	ETE	TW	OR	PR	TOTAL	L	P	T	OL	ODL	TOTAL
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3

Prerequisite: Basic knowledge of PLC programming, HMI, SCADA, and electrical control systems.

Course Objectives: The course aims to:

- Provide in-depth knowledge of advanced PLC programming techniques and industrial automation systems.
- Enable learners to design and implement integrated automation solutions using PLCs, HMIs, and SCADA.
- Develop competency in drive systems and motor control programming for industrial applications.
- Facilitate effective integration of PLC, HMI, SCADA, and drive systems for real-time monitoring and process optimization.
- Build analytical and problem-solving skills through industrial diagnostics, fault analysis, and practical case studies.

Course Outcomes:

After completing the course, the students will be able to:

CO1: Interface PLCs with industrial sensors, drives, and actuators for complex automation tasks.

CO2: Develop HMI screens and SCADA dashboards for effective monitoring and control of industrial processes.

CO3: Implement drive and motor control strategies for various industrial automation applications.

CO4: Apply programming concepts, control strategies, and industrial case studies to design automation solutions.

CO5: Diagnose faults, analyze system performance, and apply optimization techniques in industrial automation systems.

Unit	Contents	Duration (Hrs.)
1	**PLC-Based Industrial Applications** Advanced ladder logic and functional block programming for industrial tasks, Sequential automation projects: multi-motor sequencing, tank-level control, conveyor automation, batch processing, Interfacing PLC with analog/digital devices: sensors, actuators, and drives, Industrial programming examples: alarm handling, interlocks, timers, and counters, Case studies: packaging line, water pumping system, automated mixing plant.	8
2	**Human-Machine Interface (HMI) & Advanced Programming** HMI programming for process control: parameter setting, alarms, and operator interactions, Advanced visualization: dynamic trends, real-time data, and custom controls, Integration with PLC and Drives: sending commands, receiving process feedback, Programming examples: recipe control, motor start/stop sequences, tank filling automation, Case studies: chemical batch process, bottling plant, industrial furnace monitoring.	8
3	**SCADA Systems & Industrial Implementation** SCADA advanced programming: scripting, alarm management, data logging, trend analysis, Integration with PLC and DCS for real-time industrial monitoring, Industrial applications: power distribution, water treatment, chemical processing, and material handling, Programming examples: supervisory control, remote start/stop, event-based control, Case studies: energy management system, automated substation,	8

	refinery process monitoring.	
4	**Drives and Motor Control Programming** AC, DC, and servo drive programming for industrial automation, Motor speed, torque, and position control using PLC or HMI, Integration of drives with SCADA for monitoring and control, Industrial applications: conveyor belts, crane systems, packaging lines, robotic arms, Programming examples: coordinated motor sequences, variable speed control, fault handling.	8
5	**Industrial Diagnostics, Fault Analysis, and System Optimization** PLC and drive diagnostics, fault detection and troubleshooting techniques, analysis of alarms and events, preventive and predictive maintenance concepts, system performance monitoring, optimization of control parameters, case studies on industrial fault scenarios and recovery strategies.	8
	Total Hours	40

Text Books

1. J. W. Webb and R. A. Reis, Programmable Logic Controllers: Principles and Applications, PHI Learning, 5th Edition, 2017.
2. J. R. Hackworth and F. D. Hackworth Jr., Programmable Logic Controllers: Programming Methods and Applications, PHI Publishers, 2007.
3. S. A. Boyer, SCADA: Supervisory Control and Data Acquisition, ISA, 4th Edition, 2011.

Reference Books

1. G. Clark and D. Reynders, Practical Modern SCADA Protocols, Elsevier, 2009.
2. G. L. Batten, Programmable Controllers, McGraw Hill, 2nd Edition, 2003.
3. S. Bennett, Real Time Computer Control, Prentice Hall, 1988.
4. K. Kant, Computer Based Industrial Control, PHI., 2026.
5. P. K. Srivastava, Programmable Logic Controllers with Applications, BPB Publications, 2010.

Online References

1. Electrical Measurement and Electronic Instruments – Prof. Avishek Chatterjee, IIT Kharagpur (https://nptel.ac.in/courses/108/105/108105153)
2. Industrial Instrumentation – Prof. Alok Barua, IIT Kharagpur (https://nptel.ac.in/courses/108/105/108105064)
3. Industrial Automation and Control – Prof. S. Mukhopadhyay & Prof. S. Sen, IIT Kharagpur (https://nptel.ac.in/courses/108/105/108105063)
4. Electromechanical Converter System – Dr. K.R. Rajagopal, IIT Delhi (https://nptel.ac.in/courses/108/102/108102046)

Third Year B. Tech. Electrical Engineering

Semester-VI

Course Code: EE24PEC354A **Course Name: Design and Maintenance of Solar and Wind system**

Teaching Scheme (Hours/Week)					Examination Scheme						Credits					
L	P	T	OL	ODL	CIE	ETE	TW	OR	PR	TOTAL	L	P	T	OL	ODL	TOTAL
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3

Prerequisite: Basic Electrical Engineering, Power generation Techniques, Renewable Energy fundamentals or prior introductory course, Mathematics (differential equations, numerical methods), Basic Mechanical Engineering / Fluid Mechanics (for wind).

Course Objectives:

- Impart in depth knowledge of Solar PV and Wind Mills
- Understand the basic principles of operation of the various renewable energy systems
- Design and modeling of Solar PV and Wind Mills

Course Outcomes:

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

CO1: Estimate energy yields, and perform site feasibility studies.

CO2: Design PV arrays, select inverters, sizing of cables, protection, mounting structures, and select storage.

CO3: Design wind turbines (aerodynamics, blade design, generator matching, tower & foundation).

CO4: Integrate PV and wind systems (hybrid systems), grid-tied or off-grid configurations.

CO5: Execute installation, commissioning, testing, and maintenance procedures in the field.

Unit	Contents	Duration (Hrs.)
1	**Introduction & Resource Assessment:** Overview of energy systems; role of solar & wind; resource fundamentals, measurement of solar irradiance and wind (anemometry); data sources and use of climate / weather data.	6
2	**Solar PV Fundamentals and PV System Design:** Physics of solar cells, I-V and P-V curves, temperature effects, module characteristics, losses, wiring of modules in series/parallel. System configurations (standalone, grid-tied, hybrid), balance-of-system components, sizing of array, inverters, batteries, cables, protection, maximum power point tracking (MPPT).	9
3	**PV Installation, Commissioning & Maintenance:** Mechanical mounting, electrical wiring, grounding, safety, commissioning tests, monitoring, fault diagnosis, operations & maintenance. Introduction to MPPT.	8
4	**Wind Energy Fundamentals:** Wind as a resource, statistical distributions (Weibull, Rayleigh), atmospheric boundary layer, site selection, wind potential estimation.	8
5	**Wind Turbine Design & Modeling:** Aerodynamics (blade element theory, Betz limit), rotor design, blade geometry, performance curves, structural loading, gearbox, generator selection. Wind energy systems and its type, doubly fed induction generator.	9
	Total Hours	40

Text Books

1. B.H. Khan, "Nonconventional Energy Resources" McGraw Hill 3rd Edition 2014
2. Godfrey Boyle, "Renewable Energy" Oxford 3rd Edition, 2012.

3.D. P. Kothari, K. C. Singhal, and Rakesh Ranjan, "Renewable Energy Sources and Emerging, Technologies", S Chand Publication, 2013.
Reference Books
1.Shobh Nath Singh,"Nonconventional Energy Resources" Pearson 1st Edition, 2015 Renewable Energy, 2015. 2. Renewable Energy Sources: Their Impact on global Warming and Pollution Tasneem Abbasi S.A. Abbasi PHI 1st Edition, 2011. 3. S. P. Sukhatme and J. K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage", 2013.
Online References
1.NPTEL Course: Prof. R.Anandalaxmi , IIT Gawahati, "Renewable energy" (http://digimat.in/nptel/courses/video/103103206/L04.html)

Third Year B. Tech. Electrical Engineering														
Semester-VI														
Course Code: EE24PEC354B										**Course Name: HVDC and FACTS**				
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**			
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**TOTAL**
3	-	-	-	-	40	60	-	-	-	100	3	-	-	3

Prerequisite: Basic Electronics and Circuit Theory, Power Electronics, Power system.

Course Objectives:

- Understand the fundamentals, need, and advantages of HVDC transmission systems in modern power networks.
- Comprehend the operation and control of various converter configurations and their control schemes used in HVDC systems.
- Analyze reactive power control, power flow, and system stability aspects associated with HVDC transmission.
- Apply basic concepts, principles of FACTS controllers for enhancing AC transmission performance.
- Explain in detail about shunt, series, and combined compensation techniques implemented using static compensators.

Course Outcomes:

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

CO1: Explain the fundamental concepts, necessity, and benefits of HVDC transmission systems in modern power networks.

CO2: Illustrate the operation, characteristics, and control strategies of various converter configurations used in HVDC systems.

CO3: Acknowledge reactive power control, power flow, and stability issues in HVDC transmission systems.

CO4: Utilize the basic principles and functions of FACTS controllers for improving AC transmission system performance.

CO5: Evaluate the performance and effectiveness of shunt, series, and combined compensation techniques using static compensators.

Unit	Contents	Duration (Hrs.)
1	**Introduction to HVDC Transmission System (HVDCTS):** Definition of HVDC transmission system, Need for HVDC Transmission, Comparison of AC and DC Transmission, HVDC Components, Types of HVDC Links, Typical Layout of HVDC Converter Station, Advantages and Disadvantages of HVDC transmission system, Applications of HVDC Transmission system.	8
2	**HVDC Converters in HVDC systems.** Introduction to HVDC Converters, Types of converters: Line Commutated Converters (LCC), Voltage Source Converters (VSC),Pulse number and converter bridge configurations, Analysis of Graetz circuit with and without overlap, Converter characteristics: rectifier and inverter operation, Equivalent circuits for 6-pulse and 12-pulse converters.	8
3	**HVDC Converter Control and Power Flow:** Introduction to HVDC Converter Control, Control Strategies in HVDC Systems(CCC, CEAC,CFAC), Rectifier and Inverter Control Characteristics, Power Flow in HVDC Systems, Reactive Power Control in HVDC Systems, Multi-Terminal HVDC Systems, Case Studies / Applications(Example of a long-distance HVDC link with CEAC and CCC, Reactive power management in VSC-HVDC links).	8

4	**Introduction to FACTS (Flexible AC Transmission Systems)** Definition of FACTS, Need for FACTS Controllers, Operating Principles of FACTS devices, Classification of FACTS Devices, Examples of FACTS Devices, Advantages and Disadvantages of FACTS, Applications of FACTS.	8
5	**FACTS, Power Flow Control and Compensators:** Concept of reactive power control in power systems, Limitations of conventional methods of power flow control, Basic types of FACTS controllers and their comparison, Power flow in AC systems – Effect of series and shunt compensation, Classification of shunt compensators, Static Series Compensators, Combined Series–Shunt Controllers.	8
	Total Hours	40

Text Books

1. N. G. Hingorani and L.Gyugyi,"Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems",IEEE Press,2000
2. Padiyar K.R.,"FACTS Controllers for Transmission and Distribution systems",New Age International Publishers, 1st Edition, 2007.
3. S. Kamakshaiah and V. Kamaraju, "HVDC Transmission," TMH Publications, 2011.
4. V.K.Sood, "HVDC and FACTS controllers–Applications of Static Converters in Power System", Kluwer Academic Publishers,2004.

Reference Books

1. R. Mohan Mathur and Rajiv K. Varma,"Thyristor-Based FACTS Controllers for Electrical Transmission Systems",Wiley-IEEE Press,2002.
2. J. Arrillaga,"High Voltage Direct Current Transmission",IET Power and Energy Series",1998.

Online References

1. NPTEL Course:Dr.S.N.Singh, IIT Kanpur,"High Voltage DC Transmission"(https://nptel.ac.in/courses/ 108104013)
2. NPTEL Course:Prof.Avik Bhattacharya,IIT Roorkee,"Facts Devices" "(https://nptel.ac.in/courses/ 108107114)

Third Year B. Tech. Electrical Engineering																	
Semester-VI																	
Course Code: EE24PCC354D											**Course Name: Design of Electrical Machines**						
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**						
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**OL**	**ODL**	**TOTAL**	
3	-	-	-	-	40	60	-	-	-	100	3	-	-	-	-	3	

Prerequisite: Electrical Machine-1, Electrical Machine-2

Course Objectives:
- To understand the fundamental principles and constructional features of electrical machines.
- To learn the selection and properties of materials used in electrical machine design.
- To develop the ability to design DC machines, transformers, and AC machines using standard equations.
- To study heating, cooling, and performance aspects influencing machine rating and efficiency.
- To introduce computer-aided tools for the design and performance estimation of electrical machines.

Course Outcomes:
After learning the course, the students will be able to:
CO1: To identify the key parts, materials, and design objectives of electrical machines.
CO2: To apply the principles of magnetic circuits and winding design in machine construction.
CO3: To design the main components of DC machines and transformers based on given specifications.
CO4: To analyze performance characteristics like efficiency, voltage regulation, and temperature rise.
CO5: To utilize basic computational tools for machine design and performance evaluation.

Unit	Contents	Duration (Hrs.)
1	**Fundamentals of Electrical Machine Design** Major parts of electrical machines, design objectives, types of materials (conductors, core, and insulation), heating and cooling of electrical machines, rating of machines based on temperature rise.	8
2	**Magnetic Circuits and Windings** Design of magnetic circuits, calculation of mmf, flux density, and losses; types of windings – lap, wave, concentric, distributed; design of slots, coils, and insulation	8
3	**Design of DC Machines** Output equation, main dimensions, choice of specific magnetic and electric loadings, design of field system and commutator, performance and efficiency estimation.	8
4	**Design of Transformers** Output equation, core and winding design, calculation of no-load current and losses, cooling methods, temperature rise and insulation, performance estimation.	8
5	**Design of AC Machines** Output equation and main dimensions; design of stator slots, windings, and insulation; design of squirrel-cage and slip-ring rotors; estimation of performance parameters like torque, efficiency, and power factor; introduction to computer-aided design using MATLAB	8
	Total Hours	**40**

Text Books

1. A. K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai & Co., New Delhi, 2017.
2. Juha Pyrhonen, Tapani Jokinen & Valéria Hrabovcova, Design of Rotating Electrical Machines (2nd Edition), John Wiley & Sons, 2016.

3. S. K. Sen & S. C. Bhatia, Principles of Electrical Machine Design with Computer Programs, Oxford & IBH Publishing Co., 2009.
4. A. Shanmugasundaram, G. Gangadharan & R. Palani — Electrical Machine Design Data Book, New Age International, 2011.

Reference Books

1. H. Hadi Sadat, Power System Analysis, Tata McGraw-Hill New Delhi., 2007.
2. M. G. Say, Performance and Design of AC Machines, CBS Publishers & Distributors, 2014.
3. R. K. Agarwal, Principles of Electrical Machine Design, S. Chand & Company, 2006.
4. S. K. Sen, Electrical Machine Design with Computer Programmes, Oxford & IBH, 2011.
5. Balbir Singh, Electrical Machine Design, Brite Publications, Pune,2014.

Online References

1. NPTEL Course: Prof. Bhim Singh, IIT Delhi, "Computer-Aided Design of Electrical Machines" (Link)
2. NPTEL Course: Prof. Prathap Reddy, IISc Bangalore, "Design Of Electric Motors" (Link)
3. NPTEL Course: Prof. B. Prathap Reddy, IISc Bangalore, "Electrical Machine Windings Design" (Link)

Third Year B. Tech. Electrical Engineering														
Semester-VI														
Course Code: EE24PCC356						**Course Name: Control System Engineering Lab**								
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**			
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**TOTAL**
-	2	-	-	-	-	-	-	-	50	50	-	1	-	1

Prerequisite: Engineering Mathematics

Course Objectives:

- To understand the basic components of control system and types of control systems.
- To analyze behavior of systems in time domain.
- To analyze behavior of systems in frequency domain.
- To design controller to meet desired specification.

Course Outcomes:

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

CO1: Calculate system transfer function and system characteristics of different Systems.

CO2: Analyze performance of physical systems using mathematical models.

CO3: Check the stability of linear systems in time and frequency domain.

CO4: Design controller to meet desired specification.

List of Experiments

Sr. No.	Name of the Experiment	Duration (Hrs.)
1	Simulation and analysis of time response of a first order and second order system.	04
2	Simulation and analysis of frequency response of a first order and second order system.	02
3	Stability analysis using Root locus.	02
4	Stability analysis using Nyquist plot.	02
5	Stability analysis using Bode plot.	02
6	Effect of addition of pole-zero on root locus of second order system.	02
7	Effect of P, PI and PID controllers on time response of second order system.	04
8	Analysis of closed loop DC position control system using PID controller.	02
9	Effect of addition of dominant and non-dominant poles on step response of second order system.	02
10	Design Proportional-Integral-Derivative (PID) Controller for desired application.	04
	Total Hours	26

Text Books
1. I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 6th edition, 2017. 2. Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011 3. R. Anandanatrajan and P. Ramesh Babu, "Control Systems Engineering", Scitech Publication,3rd edition, 2011 4. C. D. Johnson, "Process Control Instrumentation Technology, 8th edition, PHI Learning Pvt. Ltd., 2013
Reference Books
1. Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010. 2. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005. 3. Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011. 4. B. Wayne Bequette, "Process Control: Modeling, Design and Simulation", PHI, 2003.
Online References
1. NPTEL Course: Prof. C. S.S hankar Ram, IIT Madras, "Control Systems" (nptel.ac.in/courses/107106081) 2. NPTEL Course: Prof G R Jayanth, IISc Bangalore, "Control System Design" (nptel.ac.in/courses/115108104)

Third Year B. Tech. Electrical Engineering														
Semester-VI														
Course Code: EE24PCC357								**Course Name: Advanced Electric Drives Lab**						
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**			
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**TOTAL**
-	2	-	-	-	-	-	-	-	50	50	-	1	-	1

Prerequisite: Fundamentals of speed control of DC motor, Induction motor, Power Electronics converters, Basics of Matlab.

Course Objectives:
- To apply fundamentals of drives for the speed control of motor.
- To apply fundamentals of drives for the braking operation of motor.
- To analyze the performance of motors on the basis of various speed control and braking operation.
- To simulate and analyze the performance parameters of AC and DC drives.

Course Outcomes:
After learning the course, the students will be able to:
CO1: Apply the fundamentals of DC drives for the braking of DC motors.
CO2: Demonstrate and analyze the speed control methods of DC motors.
CO3: Apply the fundamentals of AC drives for the braking of Induction motors.
CO4: Demonstrate and analyze the speed control methods of Induction motors.
CO5: Simulate and analyze the performance of DC, Induction, BLDC and PMSM drives.

List of Experiments

Sr. No.	**Name of the Experiment**	**Duration (Hrs.)**
1	Electrical braking of D.C. Shunt motor (Rheostatic/Plugging).	02
2	Speed control characteristics of single phase fully controlled converter fed D.C. shunt motor	02
3	Speed control characteristics of 3-ph fully converter fed separately excited D.C. motor.	02
4	Speed control of Chopper fed D.C. series/separately motor	02
5	Speed control of characteristics VSI fed 3 phase Induction motor (using V/f control PWM inverter)	02
6	DC Dynamic Braking of Electrical braking of 3 phases Induction Motor	02
7	Simulation of Induction Motor Vector Control.	02
8	Simulation of starting of DC motor	02
9	Simulation of starting of Induction motor.	02
10	Simulation of closed loop control of BLDC / PMSM drive.	02
11	Study of constant torque and constant power characteristic of induction motor	02
12	Study of speed control of BLDC / PMSM drive	02
13	Simulation of vector control of PMSM/BLDC motor	02
14	Industrial visit	02
	Total Hours	28

Text Books
1. G. K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House, 2002 2. N. K. De, P. K. Sen, "Electric Drives", Prentice Hall of India Eastern Economy Edition 1999 3. S. K. Pillai, "Analysis of Thyristor Power Conditioned Motors", University Press, 1996 4. G.K. Dubey, "Power Semiconductor controlled drives", PHI publication 1989 5. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, 2001
Reference Books
1. R. Krishnan, "Electric Motor Drives – Modeling Analysis and Control", PHI India 2001 2. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education 2001 3. V. Subrahmanyam, "Electric Drives: Concepts and Application", Tata Mc-Graw Hill (An imprint of Elsevier) 2006 4. M.D. Singh and Khanchandani "Power Electronics", Tata Mc-Graw Hill 2007
Online References
1. NPTEL Course: Fundamentals of Electric Drives, I.I.T. Kanpur by Dr. S.P. Das. (https://nptel.ac.in/courses/108104140) 2. NPTEL Course: Advanced Electric Drives, I.I.T. Kanpur by Dr. S.P. Das. (https://nptel.ac.in/courses/108104011)

Third Year B. Tech. Electrical Engineering														
Semester-VI														
Course Code: EE24PCC358					**Course Name: Engineering Design and Innovation Lab – EDI 2**									
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**			
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**TOTAL**
-	2	-	-	-	-	-	-	25	-	25	-	1	-	1

Prerequisite: Basic knowledge of electrical technology, electrical machines, power systems and control systems.

Preamble:

Engineering Design and Innovation (ED2) - 2 is a course aimed for inculcating design thinking, creativity, and problem-solving skills among Electrical Engineering students. The course emphasizes a hands-on, learner-centric approach to engineering education, enabling students to identify real-world problems and develop innovative, feasible, and sustainable solutions using fundamental engineering principles.

This course introduces students to the engineering design process, including problem identification, need analysis, ideation, conceptual design, prototyping, testing, and validation. Special emphasis is placed on teamwork, communication skills, ethics, sustainability, and societal relevance in engineering solutions, with examples and mini-projects related to electrical and allied domains such as energy systems, smart devices, automation, and green technologies.

Through activity-based learning, case studies, and project-based evaluation, the course nurtures innovation mindset, entrepreneurship orientation, and interdisciplinary thinking, preparing students to meet contemporary engineering challenges and laying a strong foundation for advanced design and project courses in later semesters.

Scope: The course enables students to explore real-life problems related to energy systems, electrical safety, smart devices, automation, renewable energy, and sustainable technologies. It promotes interdisciplinary collaboration, encouraging integration of concepts from electrical, electronics, mechanical, and computer engineering where applicable.

Course Objectives: The course aims to:

- Develop the ability to identify and analyze real-world engineering problems by integrating knowledge acquired from multiple foundational engineering courses.
- Apply engineering principles, design methodologies, and innovation practices to develop feasible solutions in the form of systems, prototypes, software applications, processes, or experimental setups.
- Acquire proficiency in the selection and effective use of modern engineering tools, software, simulation platforms, fabrication techniques, testing instruments, and analytical methods for project implementation.
- Enhance teamwork, project planning, problem-solving, leadership, documentation, and communication skills required for collaborative engineering projects.
- Evaluate the performance of developed solutions through systematic testing, validation, optimization, and effective presentation of technical outcomes using professional engineering practices.

Course Outcomes:

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

CO1: Analyze an engineering problem or theme requiring the integration of knowledge from multiple foundational courses, and formulate system requirements, specifications, and a feasible solution approach.

CO2: Design and develop a functional system, prototype, software application, mechanism, process, or experimental setup by applying concepts from relevant foundational engineering courses..

CO3: Demonstrate the effective use of appropriate engineering tools, including CAD, programming environments, simulation software, circuit design tools, fabrication methods, database tools, testing instruments, and analytical techniques relevant to the discipline.

CO4: Collaborate effectively in multidisciplinary teams by organizing responsibilities, maintaining project documentation, resolving design issues, and integrating individual contributions to achieve project objectives.

CO5: Evaluate the performance of the developed solution through testing, validation, and iterative improvement using appropriate performance metrics, and communicate the project outcomes through technical reports, oral presentations, demonstrations, and reflective learning.

Guidelines:

1. The course shall be conducted using a **student-centric and activity-based learning approach**, focusing on design thinking and innovation rather than conventional examinations.
2. Students shall work in **teams** (typically 3–4 members) to encourage collaboration, leadership, and interdisciplinary learning.
3. Each team shall identify a **real-world problem**, preferably related to **electrical engineering, energy, sustainability, safety, or societal needs**, and propose an innovative solution.
4. The **engineering design process** shall be followed systematically, including:
   - Problem identification and need analysis
   - Literature survey and benchmarking
   - Ideation and conceptual design
   - Feasibility analysis
   - Prototype / model development (physical or virtual)
   - Testing, validation, and improvement
5. Students shall maintain a **design notebook / logbook** documenting problem statements, design iterations, calculations, sketches, and reflections throughout the course.
6. The course shall emphasize **hands-on activities**, use of basic tools, simulation software (where applicable), and low-cost prototyping techniques.
7. Faculty shall act as **mentors and facilitators**, providing continuous guidance, reviews, and formative assessment instead of only summative evaluation.
8. Regular **design reviews** shall be conducted to assess progress, creativity, technical soundness, teamwork, and communication skills.
9. **Ethics, safety, sustainability, environmental impact, and social relevance** shall be considered as integral components of the design solutions.
10. The evaluation shall be **continuous and rubric-based**, including: Problem identification and innovation, Design methodology and technical approach Prototype / model development.
11. Documentation and report writing Presentation, demonstration, and teamwork
12. Use of **open-ended problems** is encouraged; multiple solutions shall be accepted and appreciated.
13. The outcomes of this course shall provide a foundation for **research publications, patents, funded projects, advanced design courses, innovation labs, internships, entrepreneurship initiatives, and final year projects**.

Suggested List of Activities

Sr. No.	**Name of the Activities**		**Duration (Hrs.)**
	Title	**Foundational Corses**	
1	Battery Charge-Discharge Profile Analyzer	Subjects: Power Electronics, Analog and Digital Electronics, Programming & Simulation, Power System-I Focus: battery characteristics,	

		instrumentation, plotting and safety limits	52
2	Three-Phase Sequence and Voltage Imbalance Monitor	Subjects: Power System-I, Network Analysis, Analog and Digital Electronics, Programming & Simulation Focus: three-phase concepts, measurement logic, protection indication, diagnostics	
3	Relay-Based Motor Starter with Protection	Subjects: Electrical Machines-I, Power System-I, Analog and Digital Electronics, Network Analysis Focus: starter logic, protection coordination, control wiring, safety	
4	Distribution Feeder Fault Indicator Simulator	Subjects: Power System-I, Network Analysis, Analog and Digital Electronics, Programming & Simulation Focus: fault identification, feeder sections, indicator logic, event recording	
5	Harmonic Visualization for Rectifier Loads	Subjects: Power Electronics, Network Analysis, Programming & Simulation, Analog and Digital Electronics Focus: waveform decomposition, THD estimation, measurement and plotting	
6	Electromagnetic Lifting Coil Design	Subjects: Electromagnetic Field Theory, Electrical Machines-I, Analog and Digital Electronics, Network Analysis Focus: magnetic circuits, coil sizing, thermal limits, actuation testing	
7	Battery State-of-Charge Estimator	Subjects: Analog and Digital Electronics, Power Electronics, Programming & Simulation, Network Analysis Focus: measurement, estimation models, calibration, user display	
8	Solar-Powered Water Pump Drive Simulator	Subjects: Power Electronics, Electrical Machines-I, Power System-I, Programming & Simulation Focus: renewable source matching, machine drive, converter sizing, performance evaluation	
9	BLDC Speed Control Demonstrator for EV Concept	Subjects: Electrical Machines-I, Power Electronics, Programming & Simulation, Analog and Digital Electronics Focus: motor commutation, PWM control, measurement and visualization	
10	Power Electronics Based Fan Regulator	Subjects: Power Electronics, Analog and Digital Electronics, Network Analysis, Programming & Simulation Focus: phase control or PWM control, load response, safety and usability	
11	Line Parameter and Voltage Drop Analyzer	Subjects: Power System-I, Network Analysis, Programming & Simulation,	

		Analog and Digital Electronics Focus: line modelling, drop calculations, what-if studies, reporting	
12	Microgrid Source-Load Matching Trainer	Subjects: Power System-I, Power Electronics, Programming & Simulation, Network Analysis Focus: source scheduling, load balance, converter role, energy management	
13	Substation Annunciator and Status Panel	Subjects: Power System-I, Analog and Digital Electronics, Programming & Simulation, Network Analysis Focus: status logic, alarm handling, mimic panels, sequencing	
		Total Hours	**52**

Text Books

1. Power Electronics: Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, Wiley, 2023.
2. Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid Pearson 2014.
3. Electrical Engineering Design C. W. T. McLyman CRC Press, 2011.
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering W. Bolton, Pearson, 2021.
5. Design Thinking for Engineering, John R. Karsnitz, Stephen O'Brien, John P. Hutchinson Cengage Learning, 2013.

Reference Books

1. Product Design and Development Karl T. Ulrich, Steven D. Eppinger McGraw-Hill, 2020.
2. Modern Power Electronics and AC Drives Bimal K. Bose, Pearson, 2002.
3. Electric Motors and Drives: Fundamentals, Types and Applications, Austin Hughes, Bill Drury, Newnes (Elsevier), 2019.
4. Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, Jonathan W. Valvano CreateSpace, 2017.

Online References

1. NPTEL Course: Electrical Measurement and Electronic Instruments by Prof. Avishek Chatterjee, IIT Kharagpur (https: // nptel.ac.in/courses /108 /105 / 108105153/)
2. NPTEL Course: Industrial Instrumentation by Prof. Alok Barua, IIT Kharagpur: (https://nptel.ac.in/courses/108/105/108105064/).
3. Industrial Automation and Control, Instructor: Prof. Alokkanti Deb, IIT Kharagpur (https://archive.nptel.ac.in/courses/108/105/108105088/).
4. Electromechanical Converter System, Instructor: Prof. Suman Maiti, IIT Kharagpur (https://archive.nptel.ac.in/courses/108/102/108102046/)

Third Year B. Tech. Electrical Engineering														
Semester-VI														
Course Code: EE24VSE360										**Course Name: Internet of Things**				
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**			
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**TOTAL**
-	4	-	-	-	-	-	50	-	-	50	-	2	-	2

Prerequisites:

Course Objectives:

- To understand the basic concept, architecture, and importance of the Internet of Things.
- To study IoT communication models, layers, and network structures.
- To learn various IoT protocols and communication technologies.
- To explore sensor and actuator technologies used in IoT systems.

Course Outcomes:

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

CO1: Explain the concept, characteristics, and layered architecture of the Internet of Things.
CO2: Describe various IoT communication networks and their roles in system connectivity.
CO3: Analyze IoT protocols across physical, MAC, network, and application layers.
CO4: Illustrate the working principles of IoT sensors and actuators in different applications.
CO5: Evaluate design, security, and data management challenges in IoT-based systems.

Contents

1	**Introduction to Internet of Things:** Definition and importance, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Three-layer and Five-layer model of IoT.
2	**IoT Communication network:** Architecture of IoT, Communication network: Home Area Network (HAN), Neighborhood Area Network (NAN), Field Area Network (FAN), Wide Area Network (WAN), Wireless Sensor Networks (WSNs)
3	**IoT Protocols:** IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRa WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT
4	**IoT Sensors/Actuators and IoT Challenges:** Sensor Technology, Mobile Phone Based Sensors, Medical Sensors, Neural Sensors, Environmental and Chemical Sensors, Radio Frequency Identification, Actuators, IoT Challenges: Design challenges, Development challenges, Privacy and Security challenges, Data Management and Other challenges

List of Tutorial (Any 8)

Sr. No.	Name of the Tutorial	Duration (Hrs.)
1	**IoT Definition, Importance, and Characteristics** • Explain IoT with examples. • Identify 5 characteristics of IoT. • Activity: List 3 real-life IoT applications and their benefits.	2

2	**Physical & Logical Design of IoT** • Describe physical components: sensors, actuators, communication modules, etc. • Explain logical design with functional blocks (Device, Gateway, Cloud, Application). • Activity: Draw labeled block diagram of IoT physical and logical design.	2
3	**IoT Architecture Models** • Explain 3-layer and 5-layer models with neat diagrams. • Activity: Compare both models (functions of each layer).	2
4	**IoT Communication Architecture** • Describe architecture of IoT communication network. • Identify roles of sensors, gateways, and cloud.	2
5	**Types of IoT Networks (HAN, NAN, FAN, WAN)** • Define each network type. • Activity: Make a table comparing range, use, and example of each.	2
6	**Wireless Sensor Networks (WSN)** • Explain components and topology of WSN. • Activity: Draw a typical WSN diagram and explain data flow.	2
7	**IoT Protocols** • IoT Access Technologies and IEEE Standards • Explain Physical & MAC layer roles. • Compare IEEE 802.15.4, 802.15.4e, 802.15.4g, 802.11ah, LoRaWAN in table (range, data rate, use).	2
8	**IoT Sensors and Actuators Overview** • Classify sensors (mobile-based, medical, environmental, neural). • Activity: Give 1 application example for each type.	4
9	**RFID and Data Collection in IoT** • Explain working of RFID and its role in IoT systems. • Activity: Case study—RFID-based inventory tracking.	4
10	**IoT Design and Security Challenges** • Discuss design, development, privacy, and data management challenges. • Activity: Write short notes on three major IoT security issues and mitigation.	4
	Total Hours	26

Text Books

1. Rajkamal, "Internet of Things", Tata McGraw Hill Publications, 2007.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, Universal Press, 2014.

Reference Books

1. Hakima Chaouchi, "The Internet of Things: Connecting Objects", Wiley Publications, 2017.
2. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things – Key Applications and Protocols", Wiley Publications, 2012

Online References

1. NPTEL Course: Prof. Sudip Misra ,Introduction to internet of things [https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_cs17]

Third Year B. Tech Electrical Engineering																
Semester-VI																
Course Code: EE24AEC361								**Course Name: Reasoning and Aptitude Development -2**								
Teaching Scheme (Hours/Week)					**Examination Scheme**						**Credits**					
L	**P**	**T**	**OL**	**ODL**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**TOTAL**	**L**	**P**	**T**	**OL**	**ODL**	**TOTAL**
-	-	-	-	1	-	-	25	-	-	25	-	-	-	-	1	1

Prerequisite: Basic Mathematical Concepts

Course Objectives:

- To develop numerical computation skills using averages, alligation, time–speed–distance, and time–work concepts for solving real-life quantitative problems.
- To apply mathematical reasoning techniques to special cases involving trains, boats & streams, circular motion, and work-based systems.
- To interpret and analyze data presented in tables, pie charts, bar graphs, and line graphs using efficient calculation and approximation techniques.
- To strengthen logical and analytical reasoning abilities through coding–decoding, series analysis, and structured critical reasoning problems.
- To understand and apply principles of permutations, combinations, and probability to solve counting and chance-based problems accurately.
- To build exam-oriented problem-solving strategies including time management, question selection, elimination methods, and decision-making under constraints.

Course Outcomes:

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

CO1: Solve average and alligation problems involving weighted averages and mixture applications in profit, interest, and speed scenarios.

CO2: Analyze and compute time–speed–distance and time–work problems, including special cases such as trains, boats & streams, circular tracks, and pipes & cisterns.

CO3: Accurately interpret data and assess data sufficiency, applying logical checks and efficient calculation strategies to reach valid conclusions.

CO4: Identify patterns and logical relationships in coding–decoding, number series, and alphanumeric sequences to derive correct solutions.

CO5: Evaluate arguments and deductions critically, distinguishing between strong and weak reasoning in assumptions, conclusions, and cause–effect relationships.

CO6: Apply strategic problem-solving and decision-making techniques to optimize accuracy and time efficiency in competitive and placement examinations.

Unit	Contents - Foundations & Numerical Proficiency	Duration (Hrs.)
1	**Averages & Alligations** • Arithmetic Mean of Series (Consecutive numbers) • Concept of Weighted Average • Deviation Method (Assumed Mean) • Alligation Rule (Cross method for mixing two groups) • Application of Alligation in Profit, Interest, and Speed	2

2	**Time, Speed & Distance (TSD)** • Basic Formula and Unit Conversions (km/hr to m/s) • Average Speed (Total Distance / Total Time) • Harmonic Mean for equal distance intervals • Late/Early arrival logic (Constant Distance) • Relative Speed (Same direction vs. Opposite direction)	2
3	**TSD Special Cases** • Trains: Crossing poles, platforms, and other trains • Boats & Streams: Upstream and Downstream • Circular Tracks: First meeting point and meeting at starting point	2
4	**Time & Work** • Efficiency and Days (Inverse Relationship) • LCM Method for calculating total work • Alternate day working models • Negative Work (Pipes and Cisterns / Leaks)	2
5	**Data Interpretation & Sufficiency** • Calculation Hacks for DI (Approximation/Elimination) • Pie Charts (Degree to Percentage conversion) • Bar Graphs and Line Graphs (Growth rates) • Table-based DI (Missing data) • Data Sufficiency Logic (Check Statement 1, 2, then Both/Either/Neither)	2
6	**Coding-Decoding & Series** • Letter-to-Letter and Letter-to-Number coding • Number Series (Difference, Double difference, Square/Cube patterns) • Alphanumeric Series and Symbol sequences	2
7	**Critical Reasoning I (Arguments)** • Identifying Premises, Conclusions, and Intermediate Conclusions • Assumption Identification (Negation Test) • Strengthening and Weakening Arguments	2
8	**Critical Reasoning II (Deductions)** • Statement & Conclusion • Statement & Course of Action • Cause and Effect relationships • Assertion and Reason • Strong vs. Weak Arguments	2
9.	**Permutation, Combination & Probability** • Fundamental Principles of Counting (Addition vs. Multiplication) • Arrangements (Word formation, Circular Permutation) • Selection (Combinations) • Probability basics (Coins, Dice, Playing Cards) • Probability of "At least" and "At most" cases	2

10.	**Strategy & Decision Making** • Question Selection (Identifying "Low-Hanging Fruit") • Elimination Techniques for Puzzles • Time-boxing for different sections • Decision Making (Criterial-based selection sets) • Full-length Mock Review	2
	Total Hours	**20**

Reference Books

Quant Basics	R.S. Aggarwal	Concept Clarity
Speed Math	M. Tyra	Time Management
Logic/Puzzles	K. Kundan / R.S. Aggarwal	Exam-specific Patterns
Critical Thinking	M.K. Pandey	Logical Derivations
DI / Advanced	Arun Sharma	Complex Data & CAT

Assessment

Assessment will be done by Course Teacher. MCQ Test can be conducted based on the syllabus.