Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure

Third Year B. Tech. (Electrical Engineering)

with effect from Academic Year 2024-25

Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405
Ph. No.: 02563 259 802, web: www.rcpit.ac.in

Vision of the Institute

To become a leading Institute in Technical education fostering innovation, research, ethical values, and sustainable development for the betterment of society.

Mission of the Institute

To impart high quality Technical Education through:

- **M1:** Innovative and Interactive learning process and high quality, globally recognized instructional programs.
- **M2:** Fostering a collaborative scientific temper among students with ethical responsibility towards the society.
- **M3:** Preparing students from diverse backgrounds to have aptitude for employment, entrepreneurship and research with a spirit of professionalism.
- **M4:** To contribute to the nation's sustainable development.

Vision of the Electrical Engineering Department

To produce competent Electrical Engineers committed to innovation, sustainability and service to society.

Mission of the Electrical Engineering Department

- **M1:** Deliver innovative, interactive learning fostering excellence in Electrical Engineering and emerging technologies.
- **M2:** Cultivate scientific inquiry, ethical responsibility, and interdisciplinary collaboration to address energy, automation, and societal challenges.
- **M3:** Empower diverse students with skills for employment, entrepreneurship, and research, nurturing professionalism and lifelong learning.

Program Educational Objectives

The educational objectives of the Undergraduate Programmes of Electrical Engineering are:

- **PEO1:** Graduates will apply electrical engineering knowledge and innovation to solve complex industrial and societal problems.
- **PEO2:** Graduates will demonstrate ethical leadership and collaborate across disciplines to promote sustainable and inclusive development.
- **PEO3:** Graduates will pursue careers in employment, entrepreneurship, or research, embracing professionalism and lifelong learning.

Third Year B. Tech. Electrical Engineering Semester-V (with effect from 2024-25)

S. N.	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credits	
							Continuous Assessment (CA)				ESE			
				L	T	P	TA	Term Test-I (TT-I)	Term Test-II (TT-II)	Average of TT-I and TT-II				
							[A]			[B]	[C]	[A+B+C]		
1	PC	22PCEE5010T	Electrical Machine-II	3			25	10	10	10	65	100	3	4
	PC	22PCEE5010L	Electrical Machine-II Laboratory			2	25				25	50	1	
2	PC	22PCEE5020T	Power System Analysis	3			25	10	10	10	65	100	3	4
	PC	22PCEE5020L	Power System Analysis Laboratory			2	25				25	50	1	
3	PC	22PCEE5030T	Electromagnetic Engineering	3	1		25	10	10	10	65	100	4	4
4	PC	22PCEE5040T	Electric Traction and Utilization	3			25	10	10	10	65	100	3	3
5	PE#	22PEEE5051T	Solar Power Plant Design and Installation	3			25	10	10	10	65	100	3	4
		22PEEE5051L	Power Plant Design and Installation Laboratory			2	25				25	50	1	
		22PEEE5052T	IoT and It's Application in Electrical Engineering	3			25	10	10	10	65	100	3	
		22PEEE5052L	IoT and It's Application in Electrical Laboratory			2	25				25	50	1	
		22PEEE5053T	Signal and System	3			25	10	10	10	65	100	3	
		22PEEE5053L	Signal and System Laboratory			2	25				25	50	1	
6	PC	22PCEE5060L	E CAD Laboratory			2	25				25	50	1	1
7	MC	22MCEE5070T	Environment Engineering	1									Audit	Audit
8	PJ	22PJEE5080L	Semester Project-III			2	25				25	50	1	1
9	HM	22HMEE5090L	Employability Skill Development Program-II			2	50					50	1	1
			Total	**16**	**1**	**12**	**300**			**50**	**450**	**800**		**22**

PC : Programme Core, PE# : Any 1 Programme Elective, HM: Humanities and Management, PJ: Project, TA: Teachers Assessment

Prepared by
Mr. Y. K. Kirange

Checked by
Mr. Nadeem Akhtar

BOS Chairman
Dr. S. A. Patil

Dean Academic / Dy. Director
Prof. Dr. P. J. Deore

C.O.E.
Prof. S. P. Shukla

Director
Prof. Dr. J. B. Patil

R. C. Patel Institute of Technology, Shirpur
SES
Autonomous

Third Year B. Tech. Electrical Engineering Semester-VI (with effect from 2024-25)

S. N.	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credits	
							Continuous Assessment (CA)				ESE			
				L	T	P	TA	Term Test-I (TT-I)	Term Test-II (TT-II)	Average of TT-I and TT-II				
							[A]			[B]	[C]	[A+B+C]		
1	PC	22PCEE6010T	Control System	3			25	10	10	10	65	100	3	5
	PC	22PCEE6010L	Control System Laboratory			2	25				25	50	1	
2	PC	22PCEE6020T	Power Electronics	3			25	10	10	10	65	100	3	4
	PC	22PCEE6020L	Power Electronics Laboratory			2	25				25	50	1	
3	PC	22PCEE6030T	Electrical Machine Design	3			25	10	10	10	65	100	4	5
	PC	22PCEE6030L	Electrical Machine Design Laboratory			2	25				25	50	1	
4	PC	22PCEE6040T	Power System Operation and Control	3			25	10	10	10	65	100	4	5
	PC	22PCEE6040L	Power System Operation and Control Laboratory			2	25				25	50	1	
5	PE#	22PEEE6051T	Digital Signal Processing	3			25	10	10	10	65	100	3	3
		22PEEE6051L	Digital Signal Processing Laboratory			2	25				25	50	1	
		22PEEE6052T	Electrical Mobility	3			25	10	10	10	65	100	3	
		22PEEE6052L	Electrical Mobility Laboratory			2	25				25	50	1	
		22PEEE6053T	Programmable Logic Control	3			25	10	10	10	65	100	3	
		22PEEE6053L	Programmable Logic Control Laboratory			2	25				25	50	1	
6	PJ	22PJEE6060L	Project Stage-I			4	25				25	50	2	2
7	PC	22HMEE6090L	Professional and Business Communication Tutorial		2		25					25	2	2
			Total	**15**	**2**	**14**	**300**			**50**	**475**	**825**		**24**

PC : Programme Core, PE# : Any 1 Programme Elective, HM: Humanities and Management, PJ: Project, TA: Teachers Assessment

Prepared by	Checked by	BOS Chairman	Dean Academic / Dy. Director	C.O.E.	Director
Mr. Y. K. Kirange	Mr. Nadeem Akhtar	Dr. S. A. Patil	Prof. Dr. P. J. Deore	Prof. S. P. Shukla	Prof. Dr. J. B. Patil

R. C. Patel Institute of Technology, Shirpur, Autonomous

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Electrical Machines-II (22PCEE5010T)		
Electrical Machines-II Laboratory (22PCEE5010L)		

Prerequisites: Knowledge of Electrical Machine-I.

Course Objectives

1. To introduce the constructional and operational details of cylindrical and salient pole rotor type synchronous machines working in generator and motor modes.
2. To present the procedure for analysis of synchronous generator and synchronous motor during the (a) steady state, (b) transient state (3-phase short-circuit) and (c) unbalanced operating conditions using Phasor diagrams and machine equations.
3. To introduce the methods of synchronization and analysis when alternators are connected to an infinite bus and in parallel with each other.
4. To determine the performance indices of AC series and single-phase motors by experimentation.
5. To study the applications of different machines in industrial, commercial, and social sectors.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply basic knowledge of science and engineering to understand electrical machines.	L3	Apply
CO2	Explain the construction, concepts, principles of operation, testing, and applications of synchronous machines, induction motors, and special function motors.	L2	Understand
CO3	Explain the behavior of synchronous machines on infinite bus and analyze data for qualitative and quantitative parameters to determine machine characteristics by performing practicals..	L4	Analyze
CO4	Analyze and perform professional duties in teams involving manufacturing, testing, operation, and maintenance with an emphasis on safety precautions.	L4	Analyze
CO5	Apply knowledge to related technological subjects such as utilization of electrical energy, switchgear, and machine design for economical and sustainable development.	L3	Apply

Electrical Machines-II (22PCEE5010T)
Course Contents

Unit-I 08 Hrs.

Synchronous Generator: Principle of generator, construction, excitation system, rotating MMF waves in AC machines, EMF equation, winding factors, alternator on-load. Synchronous reactance and synchronous impedance, armature reaction and its effect under different load power factors, Voltage regulation of non-salient pole alternator.

Unit-II 09 Hrs.

Synchronous Generator Analysis: Two reaction theory for salient pole machines, slip test for finding x_d, x_q. Parallel operation of alternators. Effect of changing mechanical torque and excitation on alternator. Load sharing between two parallel connected alternators. Alternator on an infinite bus, induction generator.

Unit-III 08 Hrs.

Synchronous Motors: Principle of operation of synchronous motor, power development, operation of 3-phase synchronous motor with constant load and variable excitation, operation with constant excitation and variable load, 'V' curves and 'inverted V' curves. Synchronous condenser, phenomenon of hunting and its remedies. Applications of 3-phase synchronous motors.

Unit-IV 09 Hrs.

Polyphase Induction Machines: Construction and principle of operation of squirrel cage and slip ring induction motors. Steady state analysis: torque-speed characteristics, torque-slip characteristics, maximum torque, and starting torque. Power stages, losses and efficiency, methods of starting of slip ring and cage rotor induction motors. Types of starters, circle diagram and computation, double squirrel cage motors, cogging, crawling, speed control of induction motors. Comparison of 3-phase synchronous motor with 3-phase induction motor.

Unit-V 08 Hrs.

Introduction to Special Machines: Single phase induction motor: Construction, double field revolving theory, equivalent circuit and torque-slip characteristics. Types of single-phase Induction Motor. Special machines: hysteresis motor, repulsion motor, linear induction motor, AC servomotors, AC series motor.

Electrical Machines-II Laboratory (22PCEE5010L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Determination of voltage regulation and efficiency of a three-phase alternator by direct load test.
2. Open and short circuit tests on three-phase alternator: determination of its regulation by EMF and MMF methods.
3. Determination of direct axis and quadrature axis reactance by slip test on a synchronous machine.
4. Synchronizing alternators using lamp methods and synchroscope.
5. Characteristics of synchronous motor at constant load and variable excitation.
6. Characteristics of synchronous motor at constant excitation and variable load.
7. Determination of performance of a three-phase induction motor by direct load test.
8. Load test on single-phase induction motor.
9. Speed control of three-phase slip ring induction motor.
10. Study of different types of starters for three-phase squirrel cage induction motor.
11. Simulation of three-phase induction motor on MATLAB to obtain its performance.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books

1. Ashfaq Hussain, "Electrical Machines", Dhanpat Rai and Company, 3rd Edition, 2016.
2. I. J. Nagrath and D. P. Kothari, "Electrical Machinery", Tata McGraw-Hill Education, 5th Edition, 2020.
3. M. V. Deshpande, "Electrical Machines", Prentice Hall of India, 2011.
4. V. K. Mehta and Rohit Mehta, "Principles of Electrical Machines", S. Chand Publication, 1st Edition, 2014.

Reference Books

1. P. S. Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 7th Revised Edition, 2021.
2. M. G. Say, "Theory and Performance and Design of A.C. Machines", ELBS London, 2002.
3. J. B. Gupta, "Theory and Performance of Electrical Machines", S. K. Kataria Publications, 1st Edition, 2015.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Power System Analysis (22PCEE5020T)		
Power System Analysis Laboratory (22PCEE5020L)		

Prerequisites: Fundamental of Electrical Energy Generation System, Power System Transmission and Distribution

Course Objectives

1. To understand the concepts of per-unit system and modeling of power system.
2. To understand and analyze the different types of faults in Power system.
3. To understand basic electricity market principles and power exchange.
4. To study concept of power system stability and its analysis.
5. To understand and study the modern power system concepts like SCADA, PMU, Security analysis.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze three phase fault for small power systems.	L4	Analyze
CO2	Apply the concept of symmetrical components and evaluate the symmetrical components under fault conditions.	L3	Apply
CO3	Analyze unsymmetrical faults for small power networks.	L4	Analyze
CO4	Explain electricity market concepts of a deregulated power system and demand side management.	L2	Understand
CO5	Apply the knowledge for stable operation of power system and analyze the stability of power system.	L3	Apply

Power System Analysis (22PCEE5020L)
Course Contents

Unit-I 08 Hrs.

Representation of Power System: Representation of power system components , per unit quantities – single phase and three phase selection of base quantities, advantages of PU systems, complex power, sequence networks of power system, regulating transformers, generators, transmission line, phase shift in star-delta transformer, sequence impedance of transmission line, transformer and generators.

Unit-II 08 Hrs.

Symmetrical Fault Analysis and Components: Transient on a transmission line, Symmetrical fault analysis without and with pre-fault load currents, selection of circuit Breakers ratings, current limiting reactors, Symmetrical Component transformation, Operator a, Three phase power in unbalanced circuit in terms of symmetrical component, formation of sequence network of power system.

Unit-III 08 Hrs.

Unsymmetrical Fault Analysis: Introduction, Single line to ground fault (LG) on an unloaded generator, line to line fault (LL) on an unloaded generator, double line to ground fault (LLG) on an unloaded generator, unsymmetrical fault on power systems, Single line to ground fault (LG) on a power system, line to line fault (LL) on a power system , double line to ground fault(LLG) on a power system, Shunt type and series type faults.

Unit-IV 09 Hrs.

Load Flow Analysis : Introduction, Analysis of power flows, Network model formation, Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non-linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations, Comparison of load flow studies, Computational Issues in Large-scale Power Systems.

Unit-V 09 Hrs.

Power System Economics, Stability and Management: Basic Pricing Principles, Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing, Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services, Regulatory framework.

Concepts of Stability, classification of Power System stability, Dynamics of a synchronous machine, Importance of Stability analysis in power system planning and operation, angle and voltage stability, Transient stability analysis, factor affecting transient stability, Methods to Improve transient stability, Single Machine Infinite bus (SMIB), Swing equation and its expression.

Power System Analisis Laboratory (22PCEE5020L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To study the effect of VAR compensation on voltage profile of transmission line using capacitor bank.
2. Load Flow Analysis using Newton Raphson (NR) Method Experiment.
3. Load Flow Analysis using Fast Decoupled (FD) Method.
4. Load Flow Analysis using Gauss Seidel (GS) Method.
5. Measurement of Direct axis and Quadrature axis reactance of synchronous machine.
6. Formation and calculation of Y BUS .
7. Formation and calculation of Z BUS .
8. Simulation and analysis for a symmetrical three phase fault.
9. Simulation and analysis of unsymmetrical fault LL.
10. Simulation and analysis of unsymmetrical fault LG.
11. Simulation and analysis of unsymmetrical fault LLG.
12. To study Transient and small signal stability analysis of Single Machine connected to infinite bus.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books

1. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
2. C. L. Wadhwa, "Electrical Power System” New Age International Publishers, 2017.
3. V. K. Mehta, Rohit Mehta, “Principles of Power System”, S.Chand Publications, 4th Edition , 2021.

Reference Books

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis” Pearson Education Inc., 1999.
4. Hadi Sadat, ”Power System Analysis” Tata McGraw Hill, 3rd Edition, 2016
5. L. P. Singh, ”Advanced Power System Analysis and Dynamics” New Age International, 2006.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Electric Traction and Utilization (22PCEE5040T)		

Prerequisite: Basics of Electrical Engineering and Electrical Machine-I.

Course Objectives

1. To understand energy conversion process.
2. To impart knowledge of principles of electrical traction .
3. To explore various electrical subsystems of traction .
4. To possess knowledge of advanced and emerging topics in traction mechanism and applications.
5. To meet desired needs of locomotive industry within realistic constraints.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the types of traction systems.	L2	Understand
CO2	Interpret various power supply in electric traction.	L4	Analyze
CO3	Analyze various traction motors.	L4	Analyze
CO4	Analyze methods of traction motor control.	L4	Analyze
CO5	Evaluate train movement and braking in traction system.	L5	Evaluate

Electric Traction and Utilization (22PCEE5040T)
Course Contents

Unit-I 08 Hrs.

Electric Traction System: Requirements of Ideal Traction Systems. Types of eclectic drives, choice of motors, classification of loads. Electrical transmission system supplying traction motors, Advantages of electric traction over other systems of traction, Ideal choice of traction system. Track electrification: D.C. System, single phase low frequency A.C. system, single phase high frequency A.C. system, 3 phase A.C. system and composite system, Latest Developments with special reference to locomotives.

Unit-II 08 Hrs.

Power Supply for Electric Traction: Current collection system, current collectors for Over Head Systems, Overhead construction for Tramways and trolley buses and railways, Traction substations, location of substations, feeding and distributing system, substation equipment's. Block Diagram of AC Electric locomotive, Signaling.

Unit-III 09 Hrs.

Traction Motors: Characteristics of traction motors, straight D.C. series motor, suitability of series motor for traction duty, constructional details of D.C. Traction Motors, suitability of shunt motor for traction duty, single phase series motors, Three phase Induction motor , Linear Induction motor.

Unit-IV 08 Hrs.

Traction Control : Traction control: Duty cycle, Methods of traction motor control, series-Parallel and other types of controllers, use of interlocks, run back prevented, multiple unit control, Master controllers, and use of Metadyne.

Unit-V 09 Hrs.

Train Movement and Braking: Speed time curve for different services, schedule speed and factors affecting it, train resistance and its components. Tractive effort calculations, average acceleration and speed, energy output and consumption. Mechanical versus electric breaking, Plugging, Rheostatic braking, Regenerative braking method and energy saved in the process, Magnetic track brakes.

Text Books

1. C. L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", New Age international Publishers, 2015.
2. Gonzalo Abad, "Power Electronics and Electric Drives for Traction Applications", Wiley, 201
3. E. Openshaw Taylor, "Utilization of Electric Energy", Orient Longman,2006.

Reference Books

1. J. B. Gupta, "Utilization of Electrical Power and Electic Traction", Kataria & Sons, 2013.

2. H. Partab, "Modern Electric Traction", Dhanpat Rai & Company, 2017.

3. Edward P. Burch, "Electric Traction for Railway Trains", McGraw Hill Book Company, 2007.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Solar Power Plant Design and Installation (22PEEE5051T)		
Solar Power Plant Design and Installation Lab (22PEEE5051L)		

Prerequisites: Knowledge of Basics of materials science and engineering.

Course Objectives

1. To Acquire knowledge on solar radiation principles with respect to solar energy estimation.
2. To familiarize the students with design methods of solar thermal and photovoltaic systems.
3. To Identify various energy technologies, codes, certifications and their relationship with solar photovoltaic system.
4. To learn the fundamentals, design and application of solar photovoltaic systems for power generation on small and large scale electrification.
5. To Analyze solar photovoltaic system energy and building resources.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply solar radiation principles for accurate estimation of solar energy potential.	L3	Apply
CO2	Design solar thermal and photovoltaic systems using appropriate methodologies.	L6	Design
CO3	Analyze energy technologies, standards, codes, and certifications and assess their impact on solar photovoltaic system implementation.	L4	Analyze
CO4	Analyze and design solar photovoltaic systems for small-scale and large-scale power generation applications.	L4	Analyze
CO5	Evaluate and compare materials and methods used in solar photovoltaic systems for performance and reliability.	L5	Evaluate

Solar Power Plant Design and Installation (22PEEE5051T) Course Contents

Unit-I 08 Hrs.

Basics of Solar Cell : Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell. Fundamental of semiconductor, Charge Carries and their motion in Semiconductor, Semiconductor properties, energy levels, basic equations. P N Junction Diode.

Unit-II 08 Hrs.

Design of Solar Cells: Upper limits of cell parameters, Losses in Solar cell, Solar cell design, Design for High Isc, Design for high Voc. Design for high FF, Analytical Techniques.

Unit-III 09 Hrs.

Solar Cell Technologies: Production of Si, Si Water based solar cell technology-Processes used in solar cell technology, High efficiency si solar cells. Thin film solar cell technologies –generic advantages of thin film technologies, Materials for thin film technologies. Microcrystalline si thin film technology.

Unit-IV 09 Hrs.

Photovoltaic System Design : Stand Alone PV System Configurations, Design Methodology of PV System, wire sizing in PV System, Hybrid PV System, Grid Connected PV System, and Lifecycle Costing.

Unit-V 08 Hrs.

Solar Photovoltaic Applications: Solar Radiation-the sun and earth movement, Angle of Sunrays on solar collector, Sun Tracking, Solar Photovoltaic Modules: Solar PV Modules from solar cell, Design and structure of PV Modules. PV Module Power Output.

Solar Power Plant Design and Installation Laboratory (22PEEE5051L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Study on Solar Cell Characteristics.
2. Simulation study on Solar PV Energy System.
3. Experiment on V-I Characteristics and Efficiency of 1 kWp Solar PV System.
4. Effect of shading on solar panel performance.
5. Performance study on different types of solar flat plate collector.
6. Identifying and measuring the parameters of a solar PV module in the field.
7. Study of effect of surrounding temperature and tilt angle on the performance of solar PV panel.
8. Study of Solar Street Lighting and Lanterns.
9. Field visit to solar generation system.
10. Workout power flow calculations of stand-alone PV system with combined DC and AC load with battery.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books

1. D. Yogi Goswami, “Principles of Solar Engineering”, CRC Pres, 3rd Edition, 2015.
2. Edward E. Anderson, “Fundamentals for Solar Energy Conversion”, Addison Wesley Publication, 1983.

Reference Books

1. S. P. Sukhatme, J. K. Nayak, "Solar Energy”, Tata McGraw Hill, 4th Edition, 2017.
2. G. N. Tiwari, “Solar Energy Fundamentals, Design, Modeling and Applications, Narosa Publication, 2005.
3. Chetan Singh Solanki,”Solar Photovoltaics Fundamentals, Technologies and Applications", PHI Learning Pvt. Ltd, 3rd Edition, 2015.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
IoT and Its Applications in Electrical Engineering (22PEEE5052T)		
IoT and Its Applications in Electrical Engineering Laboratory (22PEEE5052L)		

Prerequisite: Basic Electrical and Electronics Engineering,Electrical Measurement.

Course Objective

1. To provide an overview of concepts, trends, and challenges of the Internet of Things.
2. To impart knowledge of sensors and embedded systems.
3. To describe IoT deployment levels and M2M technologies.
4. To facilitate the use of hardware and software technologies related to the Internet of Things.
5. To provide knowledge of IoT communication models and protocols.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the knowledge of sensors and embedded systems.	L2	Understand
CO2	Apply the concepts of different IoT processors and controllers.	L3	Apply
CO3	Apply the basic sensor network concepts to IoT.	L3	Apply
CO4	Analyze the IoT communication models and protocols.	L4	Analyze
CO5	Design and develop small IoT applications to create smart objects.	L6	Create

IoT and Its Applications in Electrical Engineering (22PEEE5052T) Course Contents

Unit-I 08 Hrs.

Transducers, Sensors and Actuators: Introduction and classification of Transducers, Sensors and Actuators, Types of Sensors: Motion Detectors, Force Sensors, Temperature and Humidity Sensors, Light Sensor, Level Sensor, Ultrasonic Sensor,Current and voltage Sensor, Types of Actuators, Solenoid, DC Motor, AC Motor and Stepper motor.

Unit-II 08 Hrs.

Introduction to Arduino and Raspberry Pi–Arduino: Pin configuration and architecture, Device and platform features, Concept of digital andanalog ports, Familiarizing with Arduino Interfacing Board and its types, Arduino platform.

Raspberry Pi : Introduction to Raspberry Pi, Comparison of various Rpi Models, Understanding SoC architecture and SoCs used in Raspberry Pi, Pin Description of Raspberry Pi, On-board components of Rpi.

Unit-III 08 Hrs.

Introduction to WSN and IoT: Introduction to WSN and its Technologies, Architecture and characteristics of WSN, Scalability issues and challenges of a Wireless Sensor Network. Introduction to Internet of Things, Characteristics and applications of IoT, IoT Reference Model, Security issues in the IoT, Disambiguation of IoT vs IoE vs M2M vs others.Overview of Cloud and Fog Computing, Definition, Difference between Fog and Cloud.

Unit-IV 10 Hrs.

IoT Communication Technologies and Protocols: Introduction to communication Technologies like Wi-Fi, Bluetooth, RFID, Z-Wave, Zigbee. IoT Levels and Deployment Templates, Various operating systems, TinyOS, Contiki OS, Protocol Classification, MQTT, XMPP, DDS, AMQP, COAP, REST, IPv6, 6LoWPAN, Comparison of protocols.

Unit-V 08 Hrs.

IoT Applications: IoT applications in home, infrastructures, buildings, security, smart grid, Industries, Home appliances, other IoT electronic equipments, Industry 4.0 concepts.

IoT and Its Applications in Electrical Engineering Laboratory (22PEEE5052L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Study and install IDE of Arduino and different types of Arduino.
2. Write program using Arduino IDE for Blink LED.
3. LCD interfacing with Arduino.
4. Write program to monitor temperature and humidity using Arduino.
5. Design of digital AC voltmeter and ammeter.
6. Interfacing of relay with Arduino.
7. Measurement of power and energy.
8. Traffic signal control.
9. Railway gate control using stepper motor.
10. Direction and speed control of DC motor.
11. Over/under voltage protection of home appliances.
12. Reading sensor data and sending it to cloud platform for temperature and humidity sensor.

Any other experiment based on syllabus may be included which would help the learner to understand the topic/concept.

Practical examination will be based on the entire syllabus including the practicals performed during laboratory sessions.

Text Books

1. Srinivasa K. G., Siddesh G. M., Hanumantha Raju R., "Internet of Things", Cengage Publication, 1st Edition, 2018.
2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Wiley Publications, 2013.
3. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011.
4. Parikshit N. Mahalle and Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, 2015.

Reference Books

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-On Approach", Universities Press, 1st Edition, 2014.

2. . Raj Kamal, "Internet of Things : Architecture and Design Principles", McGraw Hill Education, 1st Edition, 2017.

3. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", Willy Publications, 2nd Edition, 2012.

4. Fang Zhaho, Leonidas Guibas, "Wireless Sensor Network: An Information Processing Approach", Elsevier, 1st Edition, 2014.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Signals and Systems (22PEEE5053T)		
Signals and Systems Laboratory (22PEEE5053L)		

Prerequisite: Basic Electrical Engineering and mathematics.

Course Objectives

1. This course intends to provide basic knowledge of theoretical structure, formal representation, computational methods, notation, and vocabulary of linear models.
2. It is aimed to impart skills to perform signal analysis with reference to spectrum analysis of deterministic signals.
3. Imparting basic knowledge of signals and systems analysis.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Classify signals and systems based on their properties and analyze their implications in practical contexts	L4	Apply
CO2	Perform mathematical operations on signals to construct complex signals using elementary signals	L3	Perform
CO3	Explain mathematical principles of continuous-time and discrete-time systems and their applications in signal processing	L2	Understand
CO4	Calculate the response of linear systems in time domain using convolution, Laplace transform, and Z-transform	L3	Apply
CO5	Compute Fourier series and transforms for signals and apply their properties to analyze a broader class of signals	L3	Evaluate

Signals and Systems (22PEEE5053T))
Course Contents

Unit-I 08 Hrs.

Introduction to Signals and Systems: Continuous and discrete time representation of elementary signals, operations on signals (shift, invert, scale) Classification of signals: Continuous and discrete time, deterministic and non-deterministic, periodic and aperiodic, symmetric (even) and asymmetric (odd) Introduction to systems: Definition, Classification of systems: Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems, Invertible and Non-Invertible Systems

Unit-II 09 Hrs.

Time Domain Analysis of Continuous and Discrete Time Systems Representation of systems using differential equation, Impulse response and convolution integral, properties of convolution, signal responses to CT-LTI system, system stability Impulse, step and, system stability Response of Discrete Time-LTI System: Representation of systems using difference equation, Impulse response characterization and convolution sum, Properties of convolution summation, Impulse response of DT-LTI system and its properties, step response, system stability.

Unit-III 08 Hrs

Fourier Domain Analysis of Continuous Time Signal Trigonometric Fourier series, Compact Trigonometric Fourier series, Exponential form, Dirichlet Conditions, Frequency domain representation of periodic signals, Fourier Transform representation of aperiodic signals, Properties of CFT duality, time reversal, Convolution – time and frequency domain, etc.

Unit-IV 08 Hrs

Fourier Domain Analysis of Discrete Time Signal Sampling theorem, sampling of continuous time signals, Nyquist Criterion, concept of aliasing, Discrete time Fourier Transform, Properties of DTFT: time reversal, Linear Convolution time and frequency domain, conjugate symmetry.

Unit-V 09 Hrs.

Analysis of Discrete Time Signals and System Need of Z-Transform, definition of unilateral and bilateral Z Transform, Z- Transform of finite and infinite duration sequences, properties, Inverse Z-Transform, relation between discrete time Fourier Transform and Z-Transform, Z Transform of standard signals, ROC for ZT, plotting poles and zeros of transfer function, Analysis of discrete time LTI systems using Z-Transform: Transfer Function, causality and stability of systems, relation between Laplace Transform and Z–Transform.

Signals and Systems Laboratory (22PEEE5053L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To generate and plot continuous and discrete-time signals (e.g., unit step, ramp, exponential, sine, cosine).
2. To classify systems based on properties such as static vs. dynamic, time-variant vs. time-invariant, linear vs. nonlinear, causal vs. non-causal, and stable vs. unstable.
3. To determine the impulse response and perform convolution integral for continuous-time LTI systems.
4. To analyze the step response and stability of discrete-time LTI systems.
5. To compute and plot the trigonometric and exponential Fourier series of periodic signals.
6. To compute and analyze the Fourier transform of aperiodic signals.
7. To demonstrate the sampling theorem, Nyquist criterion, and aliasing effects.
8. To perform linear convolution of discrete-time signals in both time and frequency domains.
9. To determine the ROC for Z-transforms and plot poles and zeros of transfer functions.
10. To analyze discrete-time LTI systems using Z-transform, including transfer function, causality, and stability.
11. Real-Time Audio Signal Processing and Effects using MATLAB or Python (Innovative).

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing A Practical Approach", Pearson Education, 2nd Edition, 2002.A.V. Oppenheim, A.S. Willsky, S.H. Nawab, "Signals and Systems", Prentice Hall, 2nd Edition, 1998.
2. B. P. Lathi, "Principles of Linear systems and signals, Oxford University press, 2nd Edition, 2005.

Reference Books

1. M. J. Roberts, “Signals and systems”, Tata Macgraw Hill, 3rd Edition, 2011.

2. Simon Haykin, Barry Van Veen, “Signals and systems”, Wiley, 2nd Edition, 2007.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
E CAD Labaratory (22PCEE5060L)		

Course Objectives

1. To understand the fundamentals of technical drawing.
2. To learn to design basic electrical symbols and diagrams.
3. To acquire skills to effectively represent various electrical machines.
4. To learn to draw and analyze complex systems such as three-point and four-point DC starters, transmission towers, and other related infrastructure.
5. To apply theoretical knowledge to practical applications.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Use technical drawing tools and software to prepare accurate and detailed electrical diagrams.	L3	Apply
CO2	Design and interpret electrical diagrams, including house wiring and machine layouts, for residential, commercial, and industrial applications.	L4	Analyze
CO3	Represent mechanical and electrical components of machinery accurately using standard diagrammatic techniques.	L3	Apply
CO4	Design and analyze electrical systems based on specified technical requirements.	L4	Analyze
CO5	Evaluate and apply electrical engineering concepts and technical drawing principles to solve real-world engineering problems.	L5	Evaluate

E CAD Labaratory (22PCEE5060L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To study introduction to AutoCAD.
2. To draw basic shapes like lines, arcs, curves, and shape filling.
3. To draw basic electrical symbols.
4. To draw house wiring diagrams and layouts.
5. To draw electrical machine winding diagrams.
6. To draw transmission towers.
7. To draw construction features of a DC motor.
8. To draw the basic construction of a transformer.
9. To draw 3-point and 4-point DC starters.
10. To draw lamps used in illumination.
11. To draw the single-line diagram of a power system.
12. To draw simple power and control circuit diagrams.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. Frederick E. Giesecke, *Technical Drawing with Engineering Graphics*, Prentice Hall, USA, 15th Edition, 2018.
2. S. K. Bhattacharya and Debashis De, *Electrical Engineering Drawing*, New Age International Private Limited, 3rd Edition, 2016.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Environmental Engineering (22MCEE5070T)		

Course Objectives

1. Understand environmental issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Familiarise environment related legislation.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe how human activities affect environment.	L2	Understand
CO2	Describe the various technology options that can make a difference.	L2	Understand

Environmental Engineering (22MCEE5070T)
Course Contents

Unit-I 04 Hrs.

Social Issues and Environment Ecological footprint and Carrying Capacity, Depleting nature of Environmental resources such as soil, water minerals and forests ,Carbon emissions and Global Warming.

Unit-II 05 Hrs.

Directive Principles of State Policy Technological growth for Sustainable Development: Social, Economic and Environmental aspects of Sustainable Development, Renewable Energy Harvesting ,Concept of Carbon credit, Green Building ,Power and functions of Central Pollution Control Board and State Pollution Control Board.

Unit-III 05 Hrs.

Environmental impact due to technology Environmental impact due to technology: Impact of Energy on Environment, Flow of Energy in Ecological system, Environment Degradation due to Energy, Control of pollution from Energy, Consumerelectronics, power saving devices, energy from waste, energy use and conservation.

Text Books

1. R. Rajagopalan, "Environmental Studies: From Crisis to Cure", Generic, 3rd Edition, 2015.
2. Erach Bharucha, "Textbook for Environmental Studies for Undergraduate Courses of All Branches of Higher Education", Orient Blackswan Pvt. Ltd., 3rd Edition, 2019.
3. I. V. Murali Krishna, Valli Manickam, Anil Shah, Naresh Davergave, "Environmental Management: Science and Engineering for Industry", Butterworth-Heinemann, 2017.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Semester Project-III (22PJEE5080L)		

Course Objectives

1. To design, simulate/implement a project based on the knowledge acquired from subject areas like Control System, Electrical Machines, Power System, Electromagnetic, Internet of Things, Signals and Systems, Database Management System.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze a survey of several available literatures in the preferred field of study.	L4	Analyze
CO2	Describe various/alternate approaches to complete a project.	L2	Understand
CO3	Apply a collaborative project environment by interacting and dividing project work among team members.	L3	Apply
CO4	Use technical communication skills to present project work in the form of a technical report/paper.	L3	Apply
CO5	Apply teamwork and project management skills to plan, execute, and manage the research study.	L3	Apply

Semester Project-III (22PJEE5080L)
Course Contents

Syllabus:

Semester Project: The purpose of introducing semester project at Third Year level is to provide exposure to students with a variety of projects based on the knowledge acquired from the semester subjects. This activity is supposed to enrich their academic experience and bring enough maturity in student while selecting the project. Students should take this as an opportunity to develop skills in implementation, presentation and discussion of technical ideas/topics. Therefore, proper attention shall be paid to the content of semester project report which is being submitted in partial fulfillment of the requirements of the Third Year and it is imperative that a standard format be prescribed for the report. Each student shall work on project approved by departmental committee approved by the Head of Department, a group of 03 to 05 students (max allowed: 5 students in extraordinary cases, subject to the approval of the department committee and the Head of the department) shall be allotted for each Semester Project. Each group shall submit at least 3 topics for the Semester Project. The departmental committee shall finalize one topic for every group. Semester Project Title or Theme should be based on knowledge acquired during current semester. The project work shall involve sufficient work so that students get acquainted with different aspects of knowledge acquired from semester subjects

Guidelines:

Student is expected to:

- Select appropriate project title based on acquired knowledge from current semester subjects.
- Maintain Log Book of weekly work done(please see attached log book format).
- Report weekly to the project guide along with log book

Assessment Criteria:

- At the end of the semester, after confirmation by the project guide, each project group will submit project completion report in prescribed format for assessment to the departmental committee (including project guide).
- Assessment of the project (at the end of the semester) will be done by the departmental committee (including project guide).
- Oral examination should be conducted by Internal and External examiners. Students have to give presentation and demonstration based on their project.

Prescribed Project Report Guidelines:

Size of report shall be of minimum 25 pages. Project Report should include appropriate content for:

- Introduction
- Literature Survey
- Related Theory

- Implementation details
- Project Outcomes
- Conclusion
- References

Assessment criteria for the departmental committee (including project guide) for Continuous Assessment:

Table 1: Log Book Format

S. N.	Week (Start Date : End Date)	Work Done	Sign of Guide	Sign of Coordinator
1				

Table 2: Continuous Assessment Sheet

S. N.	Exam Seat No	Name of Student	Student Attendance (5)	Log Book Maintain (5)	Literature Review (5)	Depth of Understanding (5)	Report (5)	Total (25)

Table 3: Evaluation Sheet

S. N.	Exam Seat No	Name of Student	Project Selection (5)	Design / Simulation / Logic (5)	PCB / Hardware / Programming (5)	Result Verification (5)	Presentation (5)	Total (25)

Each review consists of 25 marks. Average of the marks scored in both the two reviews will be considered for final grading. The final certification and acceptance of CA ensures the satisfactory performance on the below mentioned aspects.
Each group will be reviewed twice in a semester by faculty guide and faculty coordinator based on the following criteria:

- Project progress
- Documentation/Technical paper writing
- Key findings
- Validation of results
- Product Development

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Employability Skill Development Program-II (22HMEE5090L)		

Prerequisite: Basic Mathematics, Basic knowledge of C programming

Course Objectives

1. To enhance the problem solving skills with real life examples.
2. To enable the students to express their thoughts and knowledge on various platforms.
3. Able to describe the basic database management system.
4. Able to implement basic programming project using python.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Solve logical problems based on words, Venn diagrams, etc.	L4	Analyze
CO2	Solve English comprehension, sentence completion, and sentence correction problems.	L4	Analyze
CO3	Illustrate the concepts of Exception Handling and Garbage Collection.	L3	Apply
CO4	Describe the fundamentals of DBMS, NoSQL, and MongoDB.	L2	Understand

Employability Skill Development Program-II (HMEE5080L)
Course Contents

Unit-I 10 Hrs.

Reasoning : Data sufficiency, Logical Deductions, Logical Sequence of Words, Logical Venn Diagrams, Statement and Arguments, Statement and Assumptions, Statement and Conclusions Syllogism.

English: Reading Comprehension, Para Jumbles, Cloze Test, Tenses/ Voice/ Speech, Prepositions/ SVA/ Articles, Vocab /Verbal Analogy, Sentence completion, Sentence Correction

Unit-II 10 Hrs.

Modules Introduction, Importance of Modularity programming, Import keyword, User defined modules creation, Function based modules, Classes based modules, Connecting modules, 'from' keyword.

Files Handling Reading file char by character, Reading file line by line, Modes of files, Writing into file, Append data to a file, Reading CSV file, Pickling and Un pickling

Garbage collection Introduction, Importance of manual GC, Self-referenced objects, 'gc' module, Collect() method, Threshold function

Unit-III 8 Hrs.

Collections Framework Introduction to collection of data types, Importance of Data processing, DS algorithms introduction.

List Create a list, Adding elements, Deleting elements, Pre-defined functionality of List, Nested List, Immutability and Mutability of List.

Set The functionality of Set object, Frozen set, Dictionaries, Create a dictionary, Adding elements

Dict Pre-defined functions of Dict class, Programs using Collection types .

Unit-IV 08 Hrs.

Tkinter – GUI Types of Layouts , Create Labels and Display images, Create Buttons, Create Events, StringVar class, Calculator program using GUI.

Basic ML AI including Projects Iterators, Nested functions, Generators, Closures, Decorators, Basic ML and AI, PIP, Visualization etc.

Project Domain(Per domain 1 or 2 project)

- ML/AI Based Projects
- Data Analysis Based projects
- Test Summarization based projects
- Web scrapping and crawling

Unit-V 10 Hrs.

DBMS Using Python Introduction to Mysql, Mysql – Python connectivity, DDL, DRL, DML, Transaction management examples (rollback and commit), GUI - Database connectivity.

NoSql Using Python Installation and Configuration, MongoDB Tools, Collection and Documents, CRUD and the MongoDB Shell, Introduction to CRUD, Introduction to the MongoDBAPI, Creating a Database, Collection and Documents.

Data Modelling and Schema Design MongoDB Database References Model Tree Structures, MongoDB Analysing Queries, Atomic Operations, Map Reduce, Text Search, Regular Expression, Capped Collections.

Administration MongoDB Deployment and Cluster setup, MongoDB GridFS, Trident Spout, Working with Replica Sets, MongoDB Sharding.

Reference Books

1. Dr. R S Aggarwal, "Quantitative Aptitude for Competitive Examinations", S Chand Publication.
2. M. G. Venkateshmurthy, "Programming Techniques through C", Pearson Publication, 1st edition, 2002.
3. Behrouz Forouzan, "A Computer Science Structure Programming Approaches using C", Cengage Learning, 3rd edition, 2007.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Control System (22PCEE6010T))		
Control System Laboratory (22PCEE6010L)		

Prerequisite: Electrical Measurement, Signal and System.

Course Objectives

1. To know different basic concepts and components of a control system.
2. To model physical systems mathematically.
3. To derive transfer functions of basic control system components.
4. To perform stability analysis using time domain and frequency domain response on a given system.
5. To learn the various approach for the state space analysis.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the basic concepts of control systems and derive the mathematical models of different types of systems.	L2	Understand
CO2	Solve transfer function for a given control system using block diagram reduction techniques and signal flow graph method.	L3	Apply
CO3	Determine time response of systems for a given input and perform analysis of first and second order systems using time domain specifications.	L3	Apply
CO4	Analyze the stability of a system in the time domain using Routh-Hurwitz criterion and Root-locus technique.	L4	Analyze
CO5	Analyze the stability of a system in the frequency domain using Nyquist and Bode plots.	L4	Analyze
CO6	Solve various transfer functions of digital control system using state variable models.	L3	Apply

Control System (22PCEE6010T)
Course Contents

Unit-I 06 Hrs.

Mathematical Modeling of Control Systems: Concept of open and closed loop control system, Transfer Function: a) Concept of system: physical system, Physical model, Linear and non-linear systems, Time variant and invariant system. b) Equations of physical systems (Mass-Spring-Dashpot system, R-L-C series and parallel circuit) transfer function, transfer function of DC servo motor – AC servo motor – synchro, transmitter and receiver.

Unit-II 08 Hrs.

Block diagrams and Signal Flow Graphs: Block Diagram reduction, and Numerical examples.

Signal flow graph: Masons gain formula for deriving overall transfer function of systems.

Feedback characteristics of control system: Concept of negative and positive feedback, Sensitivity of the system to parameter variation, using negative and positive feedback.

Unit-III 10 Hrs.

Time Domain Analysis and Stability of System:

Time domain analysis: Typical test signals, Time domain specifications, Steady state response, Types of system, Steady state error constants and steady state error, Numerical examples, transient response, Numericals, Concept of stability.

Stability: Definition of stability, Routh and Hurwitz criterion. Definition of Root Locus, Construction of root locus, and Stability from root locus plots, Root counters, Effect of addition of poles and zeros on root locus plots.

Unit-IV 10 Hrs.

Frequency Domain Analysis: Introduction to frequency response, Advantages of frequency domain analysis, Bode plots, Nyquist criterion, Relative stability from Nyquist criterion, Numericals.

Unit-V 06 Hrs.

State Space Analysis of LTI Systems: Concepts of state, state variables and state model, state space representation of transfer function, diagonalization, solving the time invariant state equations, State Transition Matrix and it's Properties, concepts of controllability and observability.

Control System Laboratory (22PCEE6010L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To determine speed-torque characteristics of an AC servomotor.
2. To determine an error using a potentiometer.
3. Experimental analysis of DC motor position control system.
4. To obtain output vs. input characteristics for synchro-transmitter and receiver.
5. Experimental analysis of stepper motor.
6. To determine time-domain response of a second-order system for step input and obtain performance parameters using MATLAB.
7. To plot root locus diagram of an open-loop transfer function and determine the range of gain k for stability using MATLAB.
8. To plot a Bode diagram of an open-loop transfer function using MATLAB.
9. To draw a Nyquist plot of an open-loop transfer function and examine the stability of the closed-loop system using MATLAB.
10. To construct a Simulink diagram to calculate the response of a mass-spring system.
11. To study the effect of addition of zeros to the forward path transfer function of a closed-loop system.
12. Simulink-based control system mini project (Innovation).

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. K. A. Tsuhiko Ogata, "Modern Control System Engineering", Prentice Hall, 5^{th} Edition, 2010.
2. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 6^{th} Edition, 2017.
3. R. Anandanatrajan and P. Ramesh Babu, "Control Systems Engineering", Scitech Publication,3^{rd} Edition, 2011
4. R. V. Jalgaonkar, Sisir Mazumder, "Feedback Control System", Everest Publishing House, 12^{th} Edition, 2004.

Reference Books

1. B. C. Kuo, "Automatic Control System", Wiley India, 8th Edition, 2003.
2. Richard C. Dorf and Robert H. Bishop, "Modern Control System", Pearson Education, 12th Edition, 2011.
3. D. Roy Choudhary, "Modern Control Engineering", PHI Learning, 9th Edition, 2005
4. B. Wayne Bequette, "Process Control: Modeling, Design and Simulation", PHI, 1st Edition, 2003.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Power Electronics (22PCEE6020T)		
Power Electronics Laboratory (22PCEE6020L)		

Prerequisite: Basic Electrical and Electronics Engineering, Circuit theory.

Course Objectives

1. Understand semiconductor devices and circuits including SCRs and their characteristics.
2. Explore power electronic converter circuits including semi-controlled and fully controlled converters.
3. Learn inverter configurations and their applications.
4. Develop simulation and analysis skills for power electronic circuits.
5. Explore innovative applications of power electronic circuits.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the interdisciplinary nature and various applications of Power Electronics, and critically evaluate its significance in modern engineering systems	L2	Apply
CO2	Analyze and interpret the operating principles, characteristics, and triggering methods of power electronic devices such as thyristors, BJTs, MOSFETs, GTOs, IGBTs, and MCTs	L3	Analyze
CO3	Evaluate and synthesize phase-controlled rectifiers, including half-wave and full-wave configurations, and devise solutions for different loads and triggering schemes	L4	Evaluate
CO4	Critically assess the operation of chopper circuits, including duty ratio control and frequency control strategies, and predict their steady-state performance	L4	Evaluate
CO5	Synthesize the operation of voltage source inverters and AC voltage controllers, including various topologies such as half bridge, full bridge, and pulse width modulated inverters, and develop strategies for harmonic reduction	L4	Evaluate

Power Electronics (22PCEE6020T)
Course Contents

Unit-I 06 Hrs.

Introduction: Power Electronics Scope and Applications, Interdisciplinary Nature of Power Electronics, Types of power electronics circuits, Thyristor Characteristics, Two transistor analogy, Gate Characteristics, Methods of triggering and commutation, Ratings and protection of devices, Introduction to power electronic devices like Power BJT, MOSFET, GTO, IGBT, MCT etc.

Unit-II 08 Hrs.

Phase Controlled Rectifiers: Principle of phase control, half wave controlled rectifiers, half wave controlled rectifiers with R, R-L, R-L-E load, single phase full wave controlled converters, 2-pulse mid-point converters, 2-pulse half and fully controlled bridge converters with R, R-L, R-L-E load, Three phase converter system with diodes, 3 phase half and fully controlled bridge converters, triggering scheme, Effect of source impedance on the performance or the converters, Dual converters.

Unit-III 10 Hrs.

Choppers: Basic principle of chopper operation, Control strategies – Duty Ration Control and Frequency Control, Types of idealized chopper circuits, Steady state time domain analysis of Type A choppers, Step up chopper.

Unit-IV 10 Hrs.

Inverters: Introduction to frequency response, Forced commutated inverters, Single phase voltage source inverters, Half bridge inverters, full bridge inverters, Steady state analysis, Voltage control in single phase inverters, 3-phase bridge inverters, Pulse width modulated inverters, Reduction of harmonics in Inverter.

Unit-V 06 Hrs.

AC Voltage Controllers: Principle of AC Voltage Controllers – Integral Cycle Control and Phase Control, Types of AC voltage controllers, Analysis of 1-phase Integral Cycle Control AC controllers with R load, Analysis of 1-phase Phase Control AC controllers with R and R-L load.

Power Electronics Laboratory (22PCEE6020L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Study of V-I characteristic of SCR.
2. Study of SCR gate triggering circuits.
3. Study of turn-off methods of SCR.
4. Analysis of semi converter (with R, R-L load).
5. Analysis of fully controlled converter (with R, R-L load and freewheeling diode).
6. Study of step-up chopper.
7. Study of step-down chopper.
8. Study of series inverter.
9. Study of parallel inverter.
10. Simulation of single-phase half-wave controlled rectifier.
11. Simulation of single-phase full-wave controlled rectifier.
12. Simulation of single step-up chopper.
13. Simulation of single step-down chopper.
14. Simulation of single-phase half-bridge and full-bridge inverter.
15. Simulation of three-phase inverter (120° and 180° mode).
16. Simulation of AC voltage regulator.
17. Simulation of EV converter (Innovative).
18. Simulation of SCR-based DC circuit breaker (Innovative).
19. Simulation of multi-level converter (Innovative).

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. Bimbhra, P. S., "Power Electronics", Khanna Publishers, New Delhi, 2001.
2. Singh, M. D., Khanchandani, K. B., "Power Electronics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2001.

Reference Books

1. Rasid, M. H., "Power Electronics Circuits, Devices, and Applications", Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition, 1999.

2. Mohan, Ned, Undeland, Tore M., Robbins, William P., "Power Electronics Converters, Applications, and Design", John Wiley and Sons, Inc., 2nd Edition, 1995. item Agrawal, J. P., "Power Electronic Systems: Theory and Design", Addison Wesley Longman (Singapore) Pte. Ltd., New Delhi, 2001.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Electrical Machine Design (22PCEE6030T)		
Electrical Machine Design Laboratory (22PCEE6030L)		

Prerequisite: Knowledge of Electrical Machine-I, Electrical Machine-II, fundamentals of electrical engineering, and various materials used in electrical machines.

Course Objectives

1. To understand the fundamental aspects and modern trends in electrical machine design.
2. To study the properties of materials used in transformers and rotating machines.
3. To design transformers and induction motors based on standard specifications.
4. To analyze thermal performance and cooling methods of electrical machines.
5. To apply computer aided design techniques in transformer and motor design.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply knowledge of mathematics, science, and engineering for design of electrical machines.	L3	Apply
CO2	Analyze the electrical engineering material characteristics for designing an energy efficient electrical machine.	L4	Analyze
CO3	Analyze the temperature rise in electrical machines and its impact on rating and duty of machines.	L4	Analyze
CO4	Analyze and design electrical machines and components to meet desired needs within realistic constraints such as economic, environmental, social, safety, manufacturability, and sustainability.	L6	Create
CO5	Apply discharge duties in the field of design and manufacturing industries and pursue higher studies in optimal design using the latest software and engineering tools.	L3	Apply

Electrical Machine Design (22PCEE6030T)
Course Contents

Unit-I 10 Hrs.

Fundamental Aspects of Electrical Machine Design: Design of machines: Design factors, limitations in design, modern trends in design of electrical machines, materials used in transformers and rotating machines. Thermal design aspects of electrical machines. Design of starters – shunt motors, series motors, slip ring induction motors.

Unit-II 12 Hrs.

Design of Transformer: Design of distribution and power Transformer,-types, Classifications, specifications, core construction, transformer winding, design of Transformer, output equation of single phase and three phase transformer , design of core, winding, overall dimension ,design of insulation, estimation of leakage reactance for H.V. and L.V. winding.

Unit-III 10 Hrs.

Design Performances of Transformer: No Load Current of –single phase, Three phase, Magnetizing Volt-ampere, change of Parameters with change of frequency, Temperature rise of transformers , design of tank with tubes, transformer oil as a cooling medium, temperature rise in plain walled tanks, ,air blast cooling, forced oil circulation , thermal rating , heating time constant of transformers.

Unit-IV 12 Hrs.

Design of Induction motors:

Rating and dimensions of rotating Machines:symbols, factor affecting size of rotating machines, choice of specific magnetic loading , choice of specific electric loading , variation of output and losses with Linear dimensions , separation of D and L d.c. Machines, Induction Motors, Synchronous Machines, standard Frames.

Design of three phase Induction Motors: design output equation, choice of average flux density in air gap, choice of ampere conductors per meter, efficiency and power factor, main dimensions.

Unit-V 12 Hrs.

Design of Windings for AC and DC Machines: DC machine windings – types of DC windings, choice and design of simplex and duplex lap and wave windings, equalizer connections, dummy coils, concept of multiplex windings, reason for choosing them.

AC machine windings – single and double layer, single phase AC windings with integral and fractional slots, three phase windings.

Electrical Machine Design Laboratory (22PCEE6030L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To study general electrical symbols.
2. To study the design of a DC shunt motor starter.
3. Details and assembly of transformer design.
4. To study the design of simplex lap winding.
5. To study the design of wave winding.
6. To study the design of AC lap winding.
7. To study the design of AC wave winding.
8. To study the design of mush winding.
9. Report based on induction motor manufacturing/repairing unit.
10. Assembly of three-phase induction motor.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. G. Upadhyay, "Design of Electrical Machines", New Age International Publication, 1st Edition, 2018.
2. M. V. Deshpande, "A Course in Electrical Machine Design", Prentice Hall of India, 2011.
3. S. K. Sen, "Principles of Electrical Machine Design with Computer Programs", Oxford and IBH Publishing Company, 2nd Edition, 2006.

Reference Books

1. A. K. Sawhney, "Electric Machine Design", Dhanpat Rai and Sons, 10th Edition, 2016.
2. A. E. Clayton, "Performance and Design of DC Machine", ELBS, Isaac Pitman Sons, 3rd Edition, 2004.
3. S. V. Kulkarni, S. A. Khaparde, "Transformer Engineering: Design and Practice", Marcel Dekker Inc., 2004.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Power System Operation and Control (22PCEE6040T)		
Power System Operation and Control Laboratory (22PCEE6040L)		

Prerequisite: Basic knowledge of Electrical and Electronics Engineering, Electrical Generation Systems, Electrical Transmission and Distribution Systems.

Course Objectives

1. To understand real power control and operation.
2. To know the importance of frequency control.
3. To analyze different methods to control reactive power.
4. To understand unit commitment problem and importance of economic load dispatch.
5. To understand real time control of power systems.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze load frequency control and speed–load characteristics in power systems	L4	Analyze
CO2	Analyze single-area and two-area power system frequency control using tie-line power flow models	L4	Analyze
CO3	Apply reactive power and voltage control methods to improve system stability	L3	Apply
CO4	Analyze the economic dispatch and unit commitment problems for cost-effective power system operation	L4	Analyze
CO5	Explain the role of computer control, SCADA, and EMS in real-time power system operation	L2	Understand

Power System Operation and Control
(22PCEE6040T)
Course Contents

Unit-I 08 Hrs.

Load Frequency Control: Basics of speed governing mechanism and modeling – speed - load characteristics – load sharing between two synchronous machines in parallel. Control area concept. Load Frequency Control of a single area system. Static and dynamic analysis of uncontrolled and controlled cases. Integration of economic dispatch control with LFC. Two area system, modeling, static analysis of uncontrolled case tie line with frequency bias control of two-area system, state variable model.

Unit-II 08 Hrs.

Reactive Power Voltage Control: Basics of reactive power control, Excitation systems – modelling. Static and dynamic analysis: stability compensation generation and absorption of reactive power. Methods of voltage control – tap changing transformer. System level control using generator voltage magnitude setting. Tap setting of OLTC transformer. MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

Unit-III 08 Hrs.

Economic Operation of Power Systems: Statement of economic dispatch problem – cost of generation- Incremental cost curve - coordination equations without loss and with loss, solution by direct method and λ-iteration method.

Economic Aspects of Power Generation: Load curve, load duration and integrated load duration curves – load demand, diversity, capacity, utilization and plant use factors - Numerical Problems.

Unit-IV 09 Hrs.

Unit Commitment: Statement of Unit Commitment problem– constraints, spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints. Solution methods – Priority list methods - forward dynamic programming approach. Numerical problems on priority-list method using full- load average production cost and Forward DP method.

Unit-V 09 Hrs.

Computer Control of Power Systems: Need for computer control of power systems. Concept of energy control centre (or) load dispatch centre and the functions – SCADA and EMS functions.

Power System Operation and Control Laboratory (22PCEE6040L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Write a program for economic dispatch in power systems using MATLAB.
2. Simulation of Automatic Voltage Regulator using MATLAB.
3. Write a program for economic load dispatch using lambda-iteration method.
4. Write a program to compute the voltage and power factor for a given system using MATLAB.
5. Write a program to solve the given Equal Area Criteria problem using MATLAB.
6. Simulation of single-area load frequency control using MATLAB.
7. To demonstrate the excitation system using MATLAB.
8. Write a program to solve swing equation by classical method.
9. Write a program to plot power-angle curve of synchronous machine using MATLAB.
10. To study reactive power compensation using any device.
11. To develop and execute dynamic programming method for unit commitment (Innovative).

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
2. C.L. Wadhwa, "Electrical Power System", New Age International, 2017.
3. Ashfaq Husain, "Electrical Power System", CBS Publishers and Distributors, 5^{th} Edition, 2020.
4. Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", 4^{th} Edition, PHI learning, 2022.
5. V. K. Mehta, Rohit Mehta "Principles of Power System", Revised Edition , S. Chand Publications, 2022.

Reference Books

1. O. I. Elgerd, “Electric Energy Systems Theory” McGraw Hill Education, 1995.
2. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
3. Hadi Sadat, “ Power System Analysis”, Tata McGraw Hill, 3rd Edition, 2016.
4. L. P. Singh, “Advanced Power System Analysis and Dynamics”, New Age International, 6th Edition, 2012.
5. Narain G. Hingorani and Laszlo Gyugyi, “Understanding FACTS” ,IEEE Press, 2000.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Digital Signal Processing (22PEEE6051T)		
Digital Signal Processing Laboratory (22PEEE6051L)		

Prerequisite: Signals and System, Engineering Mathematics, MATLAB fundamentals.

Course Objectives

1. To develop a thorough understanding of DFT and FFT and their applications.
2. To teach the design techniques and performance analysis of digital filters.
3. To design IIR and FIR filters.
4. To understand the use of digital signal processing in electrical engineering.
5. To introduce students to digital signal processors and their applications.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply efficient algorithms such as DFT and FFT to determine system response	L3	Apply
CO2	Design various types of IIR and FIR filters	L6	Create
CO3	Evaluate the effects of poles and zeros in digital filter design	L5	Evaluate
CO4	Describe the architecture of DSP processors	L2	Understand
CO5	Explain applications of Digital Signal Processing in Electrical Engineering	L2	Understand

Digital Signal Processing (22PEEE6051T))
Course Contents

Unit-I 08 Hrs.

Discrete Fourier Transform and Fast Fourier Transform: Definition and properties of DFT, IDFT, circular convolution using DFT and IDFT. Filtering of long data sequences using Overlap-Save and Overlap-Add methods. Fast Fourier Transform (FFT), Radix-2 decimation in time and decimation in frequency algorithms, inverse FFT.

Unit-II 08 Hrs.

IIR Digital Filters: Types of IIR Filters (Low Pass, High Pass, Band Pass, Band Stop), Analog filter approximations: Butterworth, Chebyshev I. Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters (Butterworth and Chebyshev-I) from Analog filters with numerical examples. Effect of Poles and Zeros on the Frequency Response of IIR filters. Position of Poles and Zeros of Low Pass, High Pass, Band Pass, Band Stop, All Pass filters.

Unit-III 08 Hrs.

FIR Digital Filters: Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase (Type 1 to Type 4) FIR Filters. Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Kaiser), Design of FIR filters using Frequency Sampling technique, Comparison of IIR and FIR filters.

Unit-IV 08 Hrs.

Poles, Zeros and Filters: Effects of poles and zeros in the frequency response of IIR filters (LP, HP, BP, BR/Notch, All Pass filters). Placement of zeros and design of filters in Type1 to Type 4 Linear Phase FIR filters. Finite Word Length effects in Digital Filters Quantization, truncation and rounding, Error due to truncation and rounding.

Unit-V 08 Hrs.

Processor and Applications in Electrical Domain: Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating-point DSP processor, Computer architecture for signal processing, Harvard Architecture, Pipelining, multiplier and accumulator (MAC). Applications of Digital Signal Processing in Electrical Engineering domain.

Digital Signal Processing Laboratory (22PEEE6051L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Plot of discrete-time signals.
2. Frequency response of LTI systems using DTFT.
3. To perform Discrete Fourier Transform (DFT).
4. To implement circular convolution of two discrete-time sequences.
5. To perform overlap-add method of DFT for long data sequences.
6. To implement the algorithm of DIT-Fast Fourier Transform (FFT).
7. To plot the FFT of sinusoids with noise.
8. Magnitude and phase response of FIR filter.
9. Design an analog Butterworth filter with given specifications.
10. Design a digital IIR Butterworth filter with given specifications.
11. Design an FIR filter using window method.
12. Removal of Noise by a designed filter.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. Emmanuel C. Ifeachor and Barrie W. Jervis, "Digital Signal Processing: A Practical Approach", Pearson Education, 2nd Edition, 2002.
2. Sanjit K. Mitra, "Digital Signal Processing - A Computer Based Approach", McGraw Hill Education Private Limited, 4th Edition, 2013.
3. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press, 2015.
4. Paulo Fernando Ribeiro, Carlos Augusto Duque, Paulo Marcio Ribeiro, Augusto Santiago Cerqueira, "Power Systems Signal Processing for Smart Grids", Wiley, 1st Edition, 2013.

Reference Books

1. Proakis J. and Manolakis D., “Digital Signal Processing”, Pearson Education, 4th Edition, 2007.
2. Oppenheim A., Schafer R., and Buck J., “Discrete Time Signal Processing”, Pearson Education, 3rd Edition, 2014.
3. B. Venkata Ramani and M. Bhaskar, “Digital Signal Processors: Architecture, Programming and Applications”, Tata McGraw Hill, 2nd Edition, 2004.
4. A. Anand Kumar, “Digital Signal Processing”, PHI Learning Pvt. Ltd., 2nd Edition, 2015.
5. Ramesh P. Babu, “Digital Signal Processing”, SCITECH Publication, 4th Edition, 2015.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Electric Mobility (22PEEE6052T)		

Prerequisite: Basic concept of Batteries, Electrical Motors, Power Electronics.

Course Objective

1. To make students understand the need and importance of Electric and Hybrid Electric vehicles.
2. To differentiate and analyze the various energy storage devices.
3. To impart the knowledge about architecture and performance of Electric and Hybrid Vehicles.
4. To study the different Charging standards used for electric vehicles.
5. To classify the different drives and controls used in electric vehicles.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze the concepts of hybrid and electric vehicles	L4	Analyze
CO2	Describe the different types of energy storage systems and battery charging systems	L2	Understand
CO3	Classify the different modes of operation for hybrid vehicles	L4	Analyze
CO4	Apply the different charging standards used for electric vehicles	L3	Apply
CO5	Differentiate between Vehicle-to-Home and Vehicle-to-Grid concepts	L4	Analyze

Electric Mobility (22PEEE6052T)
Course Contents

Unit-I 08 Hrs.

Introduction to Hybrid and Electric Vehicles: Need and importance of Electric Vehicle and Hybrid Electric Vehicles, Environmental importance of Hybrid and Electric vehicles. Hybrid Electric vehicles: Concept and architecture of HEV drive train (Series, parallel and series-parallel). Micro Hybrid, Mild Hybrid, Full Hybrid, Plug-in Hybrid, Electric vehicles: Components, configuration, performance, tractive effort, Advantages and challenges in EV.

Unit-II 09 Hrs.

Energy Storage Systems and Battery Management Systems: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery specifications, Battery based energy storage and its analysis, Classification of lithium ion batteries, Aluminum Air and Aluminum ion battery. Fuel Cell based energy storage, Super Capacitor based energy storage.

Battery Management Systems: Introduction: Different Charging algorithms and Charging method, Cell Balancing methods. Battery Management System: Functions of BMS, Block diagram of BMS, SoC Estimation methods, Thermal Management of Battery

Unit-III 08 Hrs.

Hybrid Power Train and Mode of Operation: Control Strategies and Design of the Major Components: Series and Parallel Hybrid Electric Drive Train. Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Regenerative braking.

Unit-IV 08 Hrs.

Drives and Charging Infrastructure: Selection of drives for Electric vehicle: PMSM drive and BLDC drive, Sizing of motor, Charging Levels: 01,02 and 03, Charging Standards: CCS, CHAdeMO, SAE J1772, IEC 60309, Bharat DC 001, Bharat AC 001, Electric Vehicle Supply Equipment (EVSE).

Unit-V 09 Hrs.

Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid: Introduction, applications, V2H with demand response, Case Study of V2H.

Vehicle to Grid: Introduction of V2G, V2G infrastructure in the smart grid, Role of aggregator for V2G, Case study of V2G.

Vehicle to Vehicle: Introduction of V2V, Concept and structure

Electrical Mobility Laboratory (22PEEE6052L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Introduction to electric vehicle technology.
2. Introduction to fundamentals and types of batteries.
3. Simulation of SPWM technique for electric vehicle converter using MATLAB/SIMULINK.
4. Simulation of three-phase VSI for grid integration in EV using MATLAB/SIMULINK.
5. Design of battery pack in MATLAB Simulink with C-rate calculation.
6. Design and simulation of DC motor for different load conditions in MATLAB/SIMULINK.
7. Design and simulation of induction motor for different load conditions in MATLAB/SIMULINK.
8. BMS modelling and simulation.
9. Battery Management System (BMS): thermal management using MATLAB/SIMULINK.
10. Design of PMSM drive in MATLAB.
11. MATLAB/SIMULINK model of BLDC motor for electric vehicle.
12. MATLAB simulation of DC-DC converter efficiency and voltage regulation.
13. Performance analysis of lithium-ion battery for electric vehicle applications (Innovative).
14. Simulink model to calculate vehicle speed from motor torque (Innovative).

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. James Larminie and John Lowry, "Electrical Vehicle", John Wiley and Sons, 2nd Edition, 2012.
2. Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles", SAE International Publisher, 2011 .
3. K T Chau, "Energy Systems for Electric and Hybrid Vehicles", The Institution of Engineering and Technology Publication, 2016.
4. D.A.J Rand, R. Woods and R. M. Dell, "Batteries for Electric Vehicles", Research Studies Press Ltd, New York, John Willey and Sons

Reference Books

1. Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and Design", CRC Press, 2009.
2. Junwei Lu and Jahangir Hossain et al (eds), "Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", IET Digital Library, 2015.
3. Tom Denton, "Automobile Electrical and Electronic Systems", SAE International Publications, 5^{th} Edition, 2017.
4. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley and Sons, 2^{nd} Edition, 2017.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Programmable Logic Control (22PEEE6053T)		
Programmable Logic Control Laboratory (22PEEE6053L)		

Prerequisite: Analog and Digital Electronics

Course Objectives

1. Understanding of PLC programming and ladder logic.
2. Understand the operation of a PLC.
3. Understand advanced programming techniques in PLC.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the architecture, components, and operating principles of Programmable Logic Controllers for industrial automation applications	L2	Understand
CO2	Identify and select appropriate input and output devices for PLC-based industrial control systems	L3	Apply
CO3	Develop PLC programs using ladder logic to implement arithmetic, logic, and sequential control operations	L3	Apply
CO4	Analyze the operation of timers, counters, and their combinations for implementing industrial control logic	L4	Analyze
CO5	Implement advanced PLC programming features such as program control instructions, functional blocks, and structured text for automation systems	L3	Apply

Control System (22PCEE6053T)
Course Contents

Unit-I 06 Hrs.

Programmable Logic Controllers Components: Overview of PLC, Parts of a PLC, Principles of Operation, Modifying the Operation, PLC Size and Application, PLC Architecture, Input/Output Unit, I/O modules, Sourcing and Sinking, Central Processing Unit.

Unit-II 08 Hrs.

Input and Output Devices: Mechanical Switches, Proximity Switches, Photoelectric Sensors and Switches, Encoders, Temperature Sensors, Position/Displacement Sensors, Strain Gauges, Pressure Sensors, Ultrasonic Proximity Sensors, Smart Sensors, Turbine -type flowmeters, Velocity and Position Sensors. Output Devices: Relay, Directional Control Valves, Motors, Stepper Motors, Examples of Applications, Conveyor Belt, Robot Control System, Packages on Conveyor Belt Systems.

Unit-III 10 Hrs.

PLC Programming: Types of PLC programming methods, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Logic Functions using ladder diagram, Multiple Outputs, writing a Ladder Logic Program Directly from a Narrative Description, arithmetic and logic function implementation using ladder programming, Programming Examples.

Unit-IV 10 Hrs.

Timers and Counters: Timers: On delay, off delay, and retentive timers, Cascading Timers, Programming Examples Counters: Up, down Cascading Counters, Combining Counter and Timer Functions, Programming Examples.

Unit-V 06 Hrs.

Program Control Instructions: Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Math Instructions, Addition, Subtraction, Multiplication, Division, Functional Block diagram, sequential function charts, Branching and Convergence, instruction list, Structured Text programming examples and case studies, overview of SCADA system.

Programmable Logic Control Laboratory (22PEEE6053L)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Introduction to ladder programming.
2. Implementation of logic gates.
3. Implementation of light ON/OFF control.
4. Object detection and controlling conveyor motor using ladder programming.
5. Implementation of DOL starter.
6. Implementation of ON-delay timer.
7. Implementation of OFF-delay timer.
8. Implementation of up-down counter.
9. Logic implementation for traffic control application.
10. Logic implementation for bottle filling application.
11. Design a PLC program to control the liquid level in a tank.
12. Write PLC programming for continuous box filling operation using a conveyor system.

Design Based Problems / Open Ended Problem:

1. Speed measurement using counter.
2. DC motor control in both directions.
3. Level controller of underground and overhead tank.
4. Servo motor control.
5. Automatic stamping machine.
6. Automatic drilling machine.
7. Automatic painting machine.
8. Four-way traffic light control.
9. Control of robotic arm.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

The Oral/Practical examination will be based on the entire syllabus, including the experiments performed during laboratory sessions.

Text Books

1. Frank D. Petruzella, “Programmable Logic Controllers”, Mc Graw Hill Education, 4th Edition, 2022.
2. W. Bolton, “Programmable Logic Controllers”, Elsevier, 6th Edition, 2015.

Reference Books

1. Terry R. Borden and Richard A. Cox, “Technician’s Guide to Programmable Controllers”, Cengage Learning, 6th Edition, 2013.
2. Khaled Kamel and Eman Kamel, “Programmable Logic Controllers: Industrial Control”, McGraw Hill Education.
3. Alan J. Crispin, *Programmable Logic Controllers and their Engineering Applications*, McGraw-Hill, 2nd Edition, 1996.
4. Parr, “Programmable Controllers: An Engineer’s Guide”, 3rd Edition, Elsevier, Indian Reprint, 2013.
5. John R. Hackworth and Frederick D. Hackworth Jr., “Programmable Logic Controllers: Programming Methods and Applications”, Pearson Education, 2015.
6. Webb J. W., “Programmable Controllers: Principles and Applications”, PHI, New Delhi.
7. Stuart A. Boyer, “SCADA: Supervisory Control and Data Acquisition”, ISA Publication.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Project Stage- I (22PJEE6060L)		

Course Objectives

1. To implement the solution as per the problem statement.
2. To develop the team building, writing, logical reasoning and management skills.
3. To provide the connections between the designs and concepts across different disciplinary boundaries.
4. To encourage students to become independent personnel, critical thinkers and lifelong learners.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze the problem statement and produce solution of the problem considering cultural, social, environmental and economic factors using appropriate tool and method.	L4	Analyze
CO2	Interpret project based learning that allows students to transfer existing ideas into new applications.	L2	Understand
CO3	Apply the ability to work in teams and manage to conduct the project development activity.	L3	Apply
CO4	Use different perspectives from relevant disciplines which help them to get internships, jobs, and admission for higher studies.	L3	Apply
CO5	Explain the project development in the form of technical writing, and interpret what constitutes plagiarism and the use of proper referencing styles.	L2	Understand

Project Stage- I (22PJEE6060L)
Course Contents

Syllabus:

Domain knowledge (any beyond) needed from the following areas for the effective implementation of the project: Electrical Machines, Power System Analysis, Electromagnetic Engineering,Utilization of Electrical Energy, Industrial Automation Control and Digital Signal Processing, Internet of Things, Machine Learning, Python Programming.

The above areas can be updated based on the technological innovations and development needed for specific project.

Guidelines:

The main purpose of this activity is to improve the students' technical skills, communication skills by integrating writing, presentation and teamwork opportunities.

- Each group will be reviewed twice in a semester and marks will be allotted based on the various points mentioned in the evaluation scheme.
- In the first review of this semester, each group is expected to complete 30 percent of project.
- In the second review of this semester, each group is expected to complete 50 percent of project.
- The students may use this opportunity to learn different computational techniques towards development of a product.
- Interaction with alumni mentor will also be appreciated for the improvement of project.

Assessment Criteria:

- At the end of the semester, after confirmation by the project guide, each project group will submit project completion report in prescribed format for assessment to the departmental committee (including project guide).
- Assessment of the project (at the end of the semester) will be done by the departmental committee (including project guide).
- Oral examination should be conducted by Internal and External examiners. Students have to give presentation and demonstration based on their project.

Prescribed Project Report Guidelines:

Size of report shall be of minimum 25 pages. Project Report should include appropriate content for:

- Introduction
- Literature Survey

- Related Theory
- Implementation details
- Project Outcomes
- Conclusion
- References

Assessment criteria for the departmental committee (including project guide) for Continuous Assessment:

Assessment criteria for the departmental committee (including project guide) for End Semester Exam:

Each review consists of 25 marks. Average of the marks scored in both the two reviews will be considered for final grading. The final certification and acceptance of TW ensures the satisfactory performance on the below mentioned aspects.

Each group will be reviewed twice in a semester by faculty guide and faculty coordinator based on the following criteria:

- Project progress
- Documentation/Technical paper writing
- Key findings
- Validation of results
- Product Development

Table 1: Log Book Format

S. N.	Week (Start Date : End Date)	Work Done	Sign of Guide	Sign of Coordinator

Table 2: Continuous Assessment Sheet

S. N.	Exam Seat No	Name of Student	Student Attendance (5)	Log Book Maintain (5)	Literature Review (5)	Depth of Understanding (5)	Report (5)	Total (25)

Table 3: Evaluation Sheet

S. N.	Exam Seat No	Name of Student	Project Selection (5)	Design / Simulation / Logic (5)	PCB / Hardware / Programming (5)	Result Verification (5)	Presentation (5)	Total (25)

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Professional and Business Communication Tutorial(22HMEE6070T)		

Prerequisite: Basic course in Effective Communication Skills.

Course Objectives

1. To inculcate professional and ethical attitude at the workplace.
2. To enhance communication and interpersonal skills.
3. To develop effective presentation skills.
4. To have written skills for technical documentation.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Plan, organize and write technical documents like reports, proposals and research papers in the prescribed format using appropriate language and style with an understanding of ethics in written communication	L2	Understand
CO2	Apply techniques of writing resume, participating in group discussions and facing interviews	L3	Apply
CO3	Develop interpersonal skills in professional and personal situations	L4	Analyze
CO4	Understand the documentation process of meetings and conduct meetings in a professional manner	L2	Understand
CO5	Understand communication across cultures and work ethics	L2	Understand
CO6	Design and deliver effective presentations using PowerPoint	L6	Create

Professional and Business Communication Tutorial (22HMEE6070T) Course Contents

Unit-I 08 Hrs.

Technical Writing: Report Writing: Types of report, parts of formal report, collection of data and survey analysis, pre-writing of report, language and style in reports, formatting of reports, referencing in report.

Proposal Writing: Types of technical proposals, format of proposal, language and style, presentation of proposal.

Technical Paper Writing: Parts of a technical paper, language and formatting, referencing in IEEE format.

Plagiarism: Types of plagiarism, consequences of plagiarism

Unit-II 08 Hrs.

Employment Skills: Group Discussion: Purpose of a GD, types of GD, criteria for evaluating a GD, Dos and Don'ts of a GD, Tips to be successful in GD.

Cover Letter and Resume Writing: Format and content of cover letter, types of resume, structure,content and formatting of resume.

Interview Skills: Types and modes of interview, Preparation for interview, Dos and Don'ts of interview, frequently asked questions during interview.

Unit-III 05 Hrs.

Introduction to Interpersonal Skills: Emotional Intelligence: Definition, difference between IQ and EQ, how to develop EQ .

Leadership: Types of leadership, leadership styles, case studies.

Team Building: Difference between group and team, importance of team work, strategies to be a good team player.

Time Management: Importance of time management, cultural views of time, 80/20 rule, time wasters, setting priorities and goals, .

Conflict Management: Types of conflicts, strategies to manage conflict, case studies.

Unit-IV 04 Hrs.

Meetings and Documentation: Planning and preparation for meetings, strategies for conducting effective meetings, notice, agenda and minutes of a meeting, business meeting etiquettes.

Unit-V 05 Hrs.

Cross-cultural communication, Ethics and Presentation Skills: Communication across cultures, professional and work ethics, responsible use of social media, introduction to Intellectual Property Rights. Presentation strategies, overcoming stage fear, techniques to prepare effective PowerPoint presentation.

Professional and Business Communication Tutorial (22HMEE6070T)

List of Assignments

Suggested Assignments:

1. Business Proposal (PowerPoint presentation).
2. Resume writing.
3. Interpersonal Skills (documentation of activity).
4. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings).
5. Business ethics.
6. Presentation Skills.

Laboratory work will be based on subject specific lab assignment/case study.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work..

Text Books

1. Sharma R.C. and Krishna Mohan, "Business Correspondence and Report Writing", Tata Mc-GrawHill Education, 2017.
2. Ghosh, B. N., "Managing Soft Skills for Personality Development", Tata McGraw Hill. Lehman.

Reference Books

1. Fred Luthans, "Organizational Behavior", McGraw Hill, 7th edition, 2010.
2. Lesiker and Petit, "Report Writing for Business", McGraw Hill, 10th edition, 1997.
3. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw Hill, 2nd edition, 1990.
4. Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 12th edition, 2012.
5. Heta Murphy, "Effective Business Communication", Mc Graw Hill, 7th edition, 1997.