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 2025-26

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

Third Year B. Tech. Electrical Engineering Semester-V (with effect from 2025-26) (NEP) (RCP23 Scheme)

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	RCP23LCPC501	Control System	3			25	15	15	15	60	100	3	4
	PC	RCP23LLPC501	Control System Laboratory			2	25				25	50	1	
2	PC	RCP23LCPC502	Electrical Machine-II	3			25	15	15	15	60	100	3	4
	PC	RCP23LLPC502	Electrical Machine-II Laboratory			2	25				25	50	1	
3	PC	RCP23LCPC503	Power System-II	3			25	15	15	15	60	100	3	4
	PC	RCP23LLPC503	Power System-II Laboratory			2	25				25	50	1	
4	PE#	RCP23LCPE501	Electromagnetic Engineering	3			25	15	15	15	60	100	3	4
		RCP23LLPE501	Electromagnetic Engineering Laboratory			2	25				25	50	1	
		RCP23LCPE502	IoT in Electrical Engineering	3			25	15	15	15	60	100	3	
		RCP23LLPE502	IoT in Electrical Engineering Laboratory			2	25				25	50	1	
		RCP23LCPE503	Signals and Systems	3			25	15	15	15	60	100	3	
		RCP23LLPE503	Signals and Systems Laboratory			2	25				25	50	1	
		RCP23LCPE504	Industrial Electrical Engineering	3			25	15	15	15	60	100	3	
		RCP23LLPE504	Industrial Electrical Engineering Laboratory			2	25				25	50	1	
5	MD	RCP23LCMD501	Database Management System	2			25	15	15	15	60	100	2	3
	MD	RCP23LLMD501	Database Management System Laboratory			2	25				25	50	1	
6	SC	RCP23IPSC501	Semester Project-III			2	25				25	50	1	1
7	HS	RCP23ITHSX06	Environmental Science Tutorial		1		25					25	1	1
			Total	**14**	**1**	**12**	**300**			**75**	**450**	**825**		**21**

PC : Programme Core, PE# : Any 1 Programme Elective, MD: Multidisciplinary, SC: Vocational and Skill Enhancement Course, HS: Humanities and Social Science

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

ELECTRICAL ENGINEERING DEPT. RCPIT Office Seal SHIRPUR

Third Year B. Tech. Electrical Engineering Semester-VI (with effect from 2025-26) (NEP) (RCP23 Scheme)

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	RCP23LCPC601	Electrical Machine Design	3			25	15	15	15	60	100	3	4
	PC	RCP23LLPC601	Electrical Machine Design Laboratory			2	25				25	50	1	
2	PC	RCP23LCPC602	Power Electronics	3			25	15	15	15	60	100	3	4
	PC	RCP23LLPC602	Power Electronics Laboratory			2	25				25	50	1	
3	PC	RCP23LCPC603	Power System Operation and Control	3			25	15	15	15	60	100	3	4
	PC	RCP23LLPC603	Power System Operation and Control Laboratory			2	25				25	50	1	
4	PE#	RCP23LCPE601	Digital Signal Processing	3			25	15	15	15	60	100	3	4
		RCP23LLPE601	Digital Signal Processing Laboratory			2	25				25	50	1	
		RCP23LCPE602	Electrical Mobility	3			25	15	15	15	60	100	3	
		RCP23LLPE602	Electrical Mobility Laboratory			2	25				25	50	1	
		RCP23LCPE603	Programmable Logic Control	3			25	15	15	15	60	100	3	
		RCP23LLPE603	Programmable Logic Control Laboratory			2	25				25	50	1	
5	MD	RCP23LCMD601	Machine Learning and Applications	2			25	15	15	15	60	100	2	3
	MD	RCP23LLMD601	Machine Learning and Applications Laboratory			2	25				25	50	1	
6	EL	RCP23IPEL601	Project Stage-I			4	50				50	100	2	2
7	HS	RCP23ICHSX07	Constitution of India	1									Audit	Audit
8	SC	RCP23LLSC601	Full Stack Development-I			2	25				25	50	1	1
			Total	**15**		**16**	**325**			**75**	**500**	**900**		**22**

PC: Programme Core, PE#: Any 1 Programme Elective, MD : Multidisciplinary, EL: Experiential Learning, SC: Vocational and Skill Enhancement Course, HS: Humanities and Social Science

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

ELECTRICAL ENGINEERING DEPTT. C.P.I.T. Office Seal SHIRPUR

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Control System (RCP23LCPC501)		
Control System Laboratory (RCP23LLPC501)		

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	Understand the basic concepts of control system and derive the mathematical model of different type of the 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.	L4	Analyze
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, L4	Apply, Analyze

Control System (RCP23LCPC501)
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 (RCP23LLPC501)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To determine Speed-Torque characteristics of an ac servomotor.
2. To determine an error using Potentiometer.
3. Experimental analysis of D.C. Motor Position control System.
4. 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 systems for step input and obtain performance parameters by using MATLAB
7. To plot root locus diagram of an open loop transfer function and determine range of gain 'k' for stability by using MATLAB.
8. To plot a Bode diagram of an open loop transfer function by using MATLAB.
9. To draw a Nyquist plot of an open loop transfer function and examine the stability of the closed loop system by using MATLAB.
10. Construct a Simulink diagram to calculate the response of the Mass-Spring system.
11. 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.

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: V
Electrical Machines-II (RCP23LCPC502)		
Electrical Machines-II Laboratory (RCP23LLPC502)		

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	To apply basic knowledge of science and engineering to understand electrical machines.	L3	Apply
CO2	To understand construction, concepts, and principles of operation, testing, and application of synchronous machines, induction motors, and special function motors.	L2	Understand
CO3	To understand the behaviour of synchronous machines on infinite bus and analyze data for qualitative and quantitative parameters to determine characteristics of machines by performing practicals.	L2	Understand
CO4	To analyze and perform professional duties in teams for manufacturing, testing, operation, and maintenance with a sense of safety precautions.	L4	Analyze
CO5	To apply knowledge for technological subjects such as utilization of electrical energy, switchgear, and machine design for economical and sustainable development.	L3	Apply

Electrical Machines-II (RCP23LCPC502)
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 08 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 08 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 IM. Special machines: hysteresis motor, repulsion motor, linear induction motor, AC servomotors, AC series motor.

Electrical Machines-II Laboratory (RCP23LLPC502)

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, 3^{rd} Edition, 2016.
2. I. J. Nagrath and D. P. Kothari, "Electrical Machinery", Tata McGraw-Hill Education, 5^{th} 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, 1^{st} Edition, 2014.

Reference Books

1. P. S. Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 7^{th} 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, 1^{st} Edition, 2015.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Power System-II (RCP23LCPC503)		
Power System-II Laboratory (RCP23LLPC503)		

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

Course Objectives

1. To apply the per unit scheme for any power system network and compute the fault levels.
2. To understand basic electricity market principles and power exchange.
3. To study concept of power system stability and its analysis.
4. To analyze the model of control scheme of power system.

Course Outcomes

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

Power System-II (RCP23LCPC503)
Course Contents

Unit-I 07 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, sequence networks of power system, regulating transformers, Per unit impedance diagram of power system , phase shift in star-delta transformer.

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.

Unit-III 09 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, Open conductor faults.

Unit-IV 08 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. Application of numerical methods for solution of non-linear algebraic equations– Gauss Seidel and Newton-Raphson methods for the solu tion of the power flow equations, Comparison of load flow studies, Computational Issues in Large-scale Power Systems.

Unit-V 08 Hrs.

Power System Economics, Stability and Management: Basic Pricing Principles, Generator Cost Curves, Power Exchanges, Spot Pricing, Electricity Market Models, 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-II Laboratory (RCP23LLPC503)

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. Measurement of Direct axis and Quadrature axis reactance of synchronous machine.
3. Formation and calculation of Y BUS .
4. Formation and calculation of Z BUS .
5. Load Flow Analysis using Newton Raphson (NR) Method
6. Load Flow Analysis using Gauss Seidel (GS) Method.
7. Load Flow Analysis using Fast Decoupled (FD) Method.
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.

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

Text Books

1. V. K. Mehta, Rohit Mehta, “Principles of Power System”, S. Chand Publications, Revised Edition, 2022. 2021.
2. C. L. Wadhwa, “Electrical Power System” New Age International Publishers, 2017.
3. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.

Reference Books

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

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Electromagnetic Engineering (RCP23LCPE501)		
Electromagnetic Engineering Laboratory (RCP23LLPE501)		

Prerequisite: Fundamental of Engineering Mathematics and Physics.

Course Objectives

1. To develop a thorough understanding of vector analysis principles and techniques,enabling students to analyze and solve diverse physical problems.
2. To equip students with the knowledge and skills necessary to comprehend and apply fundamental concepts in electrostatics and magneto statics, fostering their ability to analyze electromagnetic phenomena in real-world contexts.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply vector analysis techniques in various coordinate systems including gradient, divergence, and curl operations	L3	Apply
CO2	Utilize Gauss's Divergence theorem and Stoke's theorem to solve vector analysis problems	L3	Apply
CO3	Explain fundamental concepts of electrostatics such as Coulomb's law, Gauss's flux theorem, and Poisson's Equation.	L2	Understand
CO4	Analyze problems related to electrostatic fields in dielectrics in cluding polarization, electric flux density, and capacitance.	L4	Analyze
CO5	Describe principles of magnetic fields, electromagnetic induction, andMaxwell's equations. Apply concepts like Ampere's law and Faraday's law	L4	Analyze

Electromagnetic Engineering (RCP23LCPE501)
Course Contents

Unit-I 08 Hrs.

Vector Analysis: General Treatment on Cartesian, cylindrical, spherical and general curvilinear co-ordinate systems with reference to vectors, operation of gradient, divergence, curl, Laplacian., Gauss's Divergence theorem, Stoke's theorem

Unit-II 08 Hrs.

Electrostatics: Review of electric field quantities and their definitions. Gauss's flux theorem, Poisson's Equation and Laplace Equation, uniqueness theorem, Green's theorem, Coulomb's law, dipole moment. Electrostatic Field in Dielectric: Polarization, electric flux density, boundary conditions, capacitor and capacitance, electrostatic shielding, energy stored in electric fields.

Unit-III 8 Hrs.

Magnetic Fields and Electromagnetic Induction: Statement of economic dispatch problem – cost of generation-Incremental cost curve - co-ordination 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 8 Hrs.

Maxwell's Equations and Electromagnetic Waves: Maxwell's equations, Equation of continuity, Displacement current, Maxwell's equation in point and integral forms ,Time-varying potentials, wave equations, plane waves in Losses Dielectrics, Free space and Good conductors, Poynting vector and Theorem.

Unit-V 8 Hrs.

Transmission Lines: Line equations, input impedance, SWR and power,smith chart,some applications of Transmission lines.

Electromagnetic Engineering Laboratory (RCP23LLPE501)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Plot vector fields in Cartesian, cylindrical, and spherical coordinate systems.
2. Computation of Coulomb's Force.
3. Verification of Gauss's Law.
4. Simulation of electric field distribution between parallel plate capacitors.
5. Simulate electric flux density in dielectric materials and visualize field distributions at dielectric boundaries.
6. Compute and plot the magnetic field generated by a current-carrying wire/loop.
7. Simulate the magnetic field around a conductor and verify Ampere's Law.
8. Simulate voltage induction in a coil due to a changing magnetic field.
9. Skin depth calculation for wave propagation in conductors.
10. Reflection and transmission of plane waves at dielectric interfaces. (Innovative)
11. FDTD (Finite Difference Time Domain) simulation of electromagnetic wave propagation. (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. N. Rao, "Elements of Engineering Electromagnetics", Prentice Hall, 6^{th} Edition, 2004.
2. Matthew N. O. Sadiku,"Element of Electromagnetics", Oxford University Press, 3^{rd} Edition, 2003.

Reference Books

1. William H. Hayt,"Engineering Electromagnetics", Mc-Graw Hill, 11^{th} Edition ,1998
2. R. P. Feynman, R. Leighton and M. Sands, "Feynman Lectures on Physics" Vol.-II Millennium Edition, Pearson, 2012.
3. J. Edminister, "Schaum's Outline Theory and Problems in Electromagnetics", Revised 2^{nd} Edition, 2002. Tata McGraw-Hill, 2010.
4. D. J. Griffiths, "Introduction to Electrodynamics" (4^{th} Edition), PHI Learning, New Delhi, 2015

Program:Electrical Engineering	T. Y. B. Tech.	Semester:V
IoT in Electrical Engineering(RCP23LCPE502)		
IoT in Electrical Engineering Laboratory(RCP23LLPE502)		

Prerequisite: Basic Electrical and Electronics Engineering,Electrical Measurement.

Course Objective

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

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Gain knowledge of sensors and embedded systems.	L2	Understand
CO2	Understand the different IoT processors and controllers.	L2, L3	Understand Apply
CO3	Understand and apply the basic sensor network concepts to IoT.	L2, L3	Understand Apply
CO4	Understand the IoT communication models and protocols.	L2	Understand
CO5	Design and develop small IoT applications to create smart objects.	L4, L5, L6	Analyze Evaluate Create

IoT in Electrical Engineering (RCP23LCPE502)
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: Reading sensor data and sending it to cloud platform, Visualization and analysis of the data on cloud,actuation and control, case study - Home automation, smart grid .

IoT in Electrical Engineering Laboratory (RCP23LLPE502)

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. Write program to monitor temperature and humidity using Arduino.
4. Design of digital dc voltmeter and ammeter.
5. Design of digital ac voltmeter and ammeter.
6. Design of digital frequency meter.
7. Measurement of power and energy.
8. Traffic signal control.
9. Railway gate control by stepper motors.
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 (RCP23LCPE503)		
Signals and Systems Laboratory (RCP23LLPE503)		

Prerequisite: Engineering Physics, Engineering Mathematics for Electrical Engineering.

Course Objective

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

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Classify signals and systems on the basis of their properties and analyse the implications in the context of practical signals and systems.	L1	Understand
CO2	Perform mathematical operations on signals to construct complex signals using basic elementary signals	L3	Apply
CO3	Describe the mathematical principles of continuous time, discrete time systems and applications of signal processing techniques.	L2	Understand
CO4	Calculate the response of linear systems in time domain using various tools such as convolution, Laplace transform, Z transform.	L3	Apply
CO5	Compute Fourier series/ transforms for a set of well defined signals from first principles and apply their appropriate properties for a broader class of signals.	L5	Evaluate

Signals and Systems (RCP23LCPE503)
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 08 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 08 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 Z Transform, 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 (RCP23LLPE503)

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.

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. 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
Industrial Electrical Engineering (RCP23LCPE504)		
Industrial Electrical Engineering Laboratory (RCP23LLPE504)		

Prerequisite: Basics of Electrical Engineering and Electrical Machines.

Course Objective

1. To understand energy conversion process.
2. To impart knowledge of principles of Industrial electrical system components.
3. To explore various characteristic of load and selection of drives.
4. To possess knowledge of advanced and emerging topics in traction mechanism and applications.
5. To learn the various approach for the state space analysis.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the Electrical System Components.	L2	Understand
CO2	Understand the characteristic of load and selection of drives.	L2	Understand
CO3	Analyze various components of industrial electrical systems	L4	Analyze
CO4	Analyze Various Traction Motors.	L4	Analyze
CO5	Evaluate movement and Breaking in Traction system.	L5	Evaluate

Industrial Electrical Engineering (RCP23LCPE504)
Course Contents

Unit-I 07 Hrs.

Electrical System Components: LT system wiring components, selection of cables, wires, switches, distribution box, metering system, protection components, Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB. Electric shock and Electrical safety practices.

Unit-II 07 Hrs.

Electric Drives: Type of drives, Nature of load and duty cycle, Section motors, electrical, mechanical, service capacity and rating and Types of Enclosures. Electrical Characteristic: Starting, Operating and running, speed control and braking characteristics of DC motors, three phase induction motor and single phase induction motor.

Unit-III 08 Hrs.

Industrial Electrical Systems: HT connection, industrial substation, Transformer selection, Industrial loads, motors, Cable and Switchgear selection, Lightning Protection, Earthing design, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components, Air conditioning system.

Unit-IV 09 Hrs.

Traction Motors: Characteristics of traction motors, D.C. series motor, suitability of series motor for traction duty, constructional details of D.C. Traction Motors, suitability of motors for traction duty, series motor, Three phase induction motor, Linear Induction motor, Variable Frequency Drives, Regenerative Drives.

Unit-V 09 Hrs.

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

Industrial Electrical Engineering Laboratory (RCP23LLPE504)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To conduct and study load characteristics of DC shunt motor.
2. To conduct and study speed control of slip ring induction motor by rotor resistance starter.
3. To conduct and study performance characteristics of DC Series motor by load test.
4. To conduct and study insulation test for Transformer oil.
5. To conduct and study Rheostatic braking of DC shunt motor.
6. To conduct and study Plugging braking of DC shunt motor.
7. To study of different types of enclosures.
8. To study an automatic Star delta starter and start three phase induction motor.
9. To understand working of panel board.
10. Modeling and Simulation of starters.
11. Modeling and Simulation of Transformer Connections for Industrial Substation
12. Simulation of Industrial Motors control using VFD

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. 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, 2016.
3. E. Openshaw Taylor, “Utilization of Electric Energy”, Orient Longman, 2006.

Reference Books

1. J. B. Gupta, “ A Course in Electrical Installation Estimating and Costing”, Kataria and Sons, 2013.
2. H. Partab, “Modern Electric Traction”, Dhanpat Rai and Company, 2017.
3. Edward P. Burch, "Electric Traction for Railway Trains”, McGraw Hill Book Company, 2007.
4. J. B. Gupta, “Utilization of Electrical Power and Electic Traction”, Kataria and Sons, 2013.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Database Management System(RCP23LCMD501)		
Database Management System Laboratory(RCP23LLMD501)		

Prerequisite: Structured Programming using C, Object Oriented Programming using Java.

Course Objectives

1. Learn and practice data modeling using the entity relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand about the fundamental concepts of databases, including design, architecture, and data models.	L2	Demonstrate
CO2	Design E-R diagrams, convert to relational schema and use relational algebra queries.	L3, L4	Apply, Analyze
CO3	Construct SQL queries to perform operations on the database.	L3	Analyze
CO4	Understand transaction management technique.	L2	Understand

Database Management System (RCP23LCMD501)
Course Contents

Unit-I 06 Hrs.

Introduction to Databases and Data Models: Introduction, Characteristics of databases, File system vs. database system, Users of the database system, Schema and Instance, Data Independence, level of abstraction, DBMS system architecture, The importance of data models , Types of data models.

Unit-II 08 Hrs.

Relational Data Model: Entity–Relationship Model, Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints: Cardinality and Participation.

Relational Model: Introduction to the Relational Model, relational schema and concept of keys, Mapping the ER Model to the Relational Model Relational Algebra: Unary and Set operations, Relational Algebra Queries.

Unit-III 08 Hrs.

Structured Query Language (SQL) and Normalization: Overview of SQL, Data Definition Commands, Data Manipulation commands, Integrity constraints - key constraints, Domain Constraints, Referential integrity, check constraints, Data Control commands, Transaction Control Commands, Set and String operations, aggregate function - group by, having, Views in SQL, joins, Nested and complex queries, Triggers .

Normalization : Concept of normalization, Function Dependencies, Normal Forms- 1NF, 2NF, 3NF, BCNF.

Unit-IV 06 Hrs.

Transaction Management and Concurrency Control: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.

Database Management System Laboratory (RCP23LLMD501)

List of Laboratory Experiments:

Suggested Experiments: (Any 8)

1. Output all the data entered in the table.
2. Create a table from the given data.
3. Insert Data into the table.
4. Add a column to the table and set default values.
5. Update the data in the given row(s) of the given table.
6. Delete all rows in the table.
7. Create a table with the given constraints.
8. Use a select query to fetch data.
9. Use distinct queries to fetch unique data.
10. Use the where clause to obtain information that meets specific conditions.
11. Use the BETWEEN clause along with WHERE to filter the table based on 2 values.
12. Use the AND clause with WHERE to filter the table based on 2 separate conditions.
13. Use the OR clause is used along with WHERE to filter the table that meets any one of the given multiple conditions.
14. Use the LIKE operator along with WHERE to filter similar values.
15. Use of additional queries - IS NULL, ORDER BY & LIMIT.
16. Renaming of columns during output.
17. Use the MAX() and MIN() functions to retrieve the maximum and minimum values from a column.
18. Combining table - Joins two tables and outputs a single table.
19. Use a left join to output data.
20. Use a cross join to output the data.
21. Use UNION to place a table right on top of another table.
22. Use the WITH query to create temporary tables.
23. Use the EXCEPT query to output the data.
24. Use the INTERSECT query to output the data.

25. Execute a non-correlated subquery independently of the outer query.
26. Design an Entity-Relationship (ER) model for a problem statement.
27. Convert the designed ER model to a Relational Database. Create this database in MySQL / SQL Server (any other suitable software) with required tables. Use DDL commands and Apply the constraints like Primary Key, Foreign key, NOT NULL to the tables.
28. Execute DML commands.
29. Perform aggregate function.
30. Perform SELECT statement for retrieval of data from Database.
31. Perform various JOIN operations on tables.
32. Create views and access data from it using SQL statements.
33. Perform queries for triggers.
34. Perform Nested queries.
35. Identify dependencies in a table and accordingly convert it to 1NF, 2NF, 3NF and BCNF.
36. Mini Project.
    (Minimum eight experiments from the belwo suggested list or any other experiment based on syllabus to be included, which would help the learner to apply the concept learnt.)

Text Books

1. A. Silberschatz, H. Korth, S. Sudarshan, "Database System and Concepts", McGraw Hill, 7^{th} Edition, 2019.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System", Pearson Education, 7^{th} Edition, 2017.

Reference Books

1. Peter Rob, Carlos Coronel,"Database Systems Design, Implementation and Management", Cengage Learning, 8^{th} Edition, 2007.
2. Lynn Beighley, "Head First SQL", O'Reilly Media, 1^{st} Edition, 2007.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", McGraw-Hill, 3^{rd} Edition, 2014.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Semester Project-III (RCP23IPSC501)		

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	To demonstrate various/alternate approaches to complete a project.	L2	Understand
CO2	To demonstrate the ability to work in teams and manage the conduct of the research study	L2	Understand
CO3	To ensure a collaborative project environment by interacting and dividing project work among team members.	L3	Apply
CO4	To present their project work in the form of a technical report/paper and thereby improve the technical communication skill.	L3	Apply
CO5	To conduct a survey of several available literatures in the preferred field of study.	L4	Analyze

Semester Project-III (RCP23IPSC501)
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:

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
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)

Program: Electrical Engineering	T. Y. B. Tech.	Semester: V
Environmental Science Tutorial (RCP23ITHSX06)		

Prerequisite: Interest in Environment and its impact on Human.

Course Objectives

1. To familiarise students with environment related issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. To give overview of Green Technology options.

Course Outcomes

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

Environmental Science Tutorial (RCP23ITHSX06)
Course Contents

Unit-I 01 Hrs.

Air Pollution: Air Quality Index, Case study on Smog

Unit-II 01 Hrs.

Water Pollution: Presentation on Water Pollution (Industrial, Sewage, etc.) explaining any specific case.

Unit-III 01 Hrs.

Noise Pollution: Decibel limits for hospital, library, silence zone, List effects of noise pollution on human health, Measure decibel level in college library, canteen, classroom

Unit-IV 01 Hrs.

Biodiversity loss: Case study on effect of pollution on biodiversity loss.

Unit-V 01 Hrs.

Deforestation: Debate for and against "To promote Economic growth Deforestation is required."

Unit-VI 01 Hrs.

Renewable Energy sources: Presentation on different Renewable Energy Technologies

Unit-VII 01 Hrs.

Climate change: Report on major Impact of Global warming on Environment giving real examples.

Unit-VIII 01 Hrs.

Green Technology: Advantages and Examples of Green Building for Sustainable development, Sustainable Software Design, Data Center Energy Efficiency, Thin-Client and Energy Efficiency.

Text Books

1. R. Rajagopalan, "Environmental Studies From Crisis to Cure".
2. Erach Bharucha, "Textbook of Environmental Studies For Undergraduate Courses".
3. Mohammad Dastbaz, Colin Pattinson, Babak Akhgar, Morgan and Kaufman, Elsevier., "Green Information Technology A Sustainable Approach".

Reference Books

1. Paulina Golinska, Marek Fortsch, Jorge Marx-Gómez, "Information Technologies in Environmental Engineering", New Trends and Challenges, Springer, 2011.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Electrical Machine Design (RCP23LCPC601)		
Electrical Machine Design Laboratory (RCP23LLPC601)		

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	To understand the properties of electrical engineering materials and their role in machine design.	L2	Understand
CO2	To design single phase and three phase transformers based on given specifications.	L6	Create
CO3	To evaluate the performance of transformers considering thermal aspects, cooling, and frequency variations.	L5	Evaluate
CO4	To analyze the performance and design parameters of three phase induction motors.	L4	Analyze
CO5	To apply computer aided design techniques for designing transformers and induction motors.	L3	Apply

Electrical Machine Design (RCP23LCPC601)
Course Contents

Unit-I 08 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 08 Hrs.

Design of Induction Motors: Rating and dimensions of rotating machines – symbols, factors 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 in DC machines, induction motors, synchronous machines, standard frames.

Design of three phase induction motors – output equation, choice of average flux density in air gap, choice of ampere conductors per meter, efficiency and power factor, main dimensions.

Unit-III 08 Hrs.

Design of Transformer: Design of distribution and power transformers – types, classifications, specifications, core construction, transformer winding, design of transformer, output equation of single phase and three phase transformers, design of core, winding, overall dimensions, design of insulation, estimation of leakage reactance for HV and LV winding.

Unit-IV 08 Hrs.

Design Performance of Transformer: No load current of single phase and three phase transformers, 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-V 08 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 (RCP23LLPC601)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To study the design of DC motor starter.
2. To understand the details and assembly process of transformer design.
3. To study the design of simplex lap winding.
4. To study the design of wave winding.
5. To study the design of AC lap winding.
6. To study the design of AC wave winding.
7. To study the design of mush winding.
8. To prepare a report based on an induction motor manufacturing or repairing unit.
9. Do a literature survey about the optimization techniques for design problems.
10. To design and assemble of three phase induction motor in CAD.
11. Report based on transformer manufacturing/repairing unit.
12. Report based on induction motor manufacturing/repairing unit

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, 1^{st} 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, 2^{nd} Edition, 2006.

Reference Books

1. A. K. Sawhney, "Electric Machine Design", Dhanpat Rai and Sons, 10^{th} Edition, 2016.
2. A. E. Clayton, "Performance and Design of DC Machine", ELBS, Isaac Pitman Sons, 3^{rd} 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 Electronics (RCP23LCPC602)		
Power Electronics Laboratory (RCP23LLPC602)		

Prerequisite: Basic Electrical and Electronics Engineering, Circuit Theory.

Course Objectives

1. Enable students to analyze and understand the principles and characteristics of power electronic devices like thyristors, BJTs, MOSFETs, GTOs, IGBTs, and MCTs for effective circuit design.
2. Develop students' skills in designing, simulating, and evaluating rectifiers, choppers, inverters, and AC controllers to solve real world power electronics problems.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the interdisciplinary role and demonstrate the significance of Power Electronics in modern engineering systems.	L2	Understand
CO2	Analyze the working principles, characteristics, and triggering techniques of power electronic devices such as thyristors, BJTs, MOSFETs, GTOs, IGBTs, and MCTs.	L4	Analyze
CO3	Evaluate and design single phase and three phase phase controlled rectifiers (half wave and full wave) for various load conditions and firing schemes.	L5	Evaluate
CO4	Assess the performance of chopper circuits using duty cycle and frequency control methods, and predict their steady state behav ior.	L5	Evaluate
CO5	Synthesize the operation of voltage source inverters and AC volt age controllers (half bridge, full bridge, and PWM),and formulate strategies for harmonic reduction.	L4	Analyze

Power Electronics (RCP23LCPC602)
Course Contents

Unit-I 08 Hrs.

Introduction to Power Electronics: Power Electronics Scope and Applications, Interdisciplinary Nature of Power Electronics, Types of powerelectronics circuits, Thyristor Characteristics, Two transistor analogy, Gate Characteristics, Meth ods 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 08 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 08 Hrs.

Inverters: 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 08 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 (RCP23LLPC602)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Study of SCR gate triggering circuits
2. Study of turn off methods of SCR
3. Analysis of semi converter (with R, R-L load)
4. Analysis of fully controlled converter (with R, R-L load and freewheeling diode)
5. Study of step up and step down chopper.
6. Analysis of single phase half and full wave controlled rectifier.
7. Analysis of of single phase half bridge and full bridge inverter.
8. Simulation of three phase inverter (1200 and 1800 mode)
9. Simulation of AC voltage regulator
10. Simulation of EV converter (Innovative)
11. Simulation of SCR based DC circuit breaker (Innovative)
12. Simulation and 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, 2001.
2. M. D. Singh, K. B. Khanchandani, "Power Electronics", Tata McGraw-Hill, 2001.

Reference Books

1. Rasid, M. H., "Power Electronics Circuits, Devices, and Applications", Prentice-Hall of India, 2nd Edition, 1999.
2. Mohan, Ned, Undeland, Tore M., Robbins, William P., "Power Electronics Converters, Applications, and Design", John Wiley and Sons, 2nd Edition, 1995.
3. Agrawal, J. P., "Power Electronic Systems: Theory and Design", Addison Wesley Longman (Singapore), 2001.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Power System Operation and Control (RCP23LCPC603)		
Power System Operation and Control Laboratory (RCP23LLPC603)		

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	To describe the basic principles of real and reactive power control, load frequency control, and voltage control mechanisms in power systems.	L2	Understand
CO2	To explain the operation of load frequency control for single and two area systems, and the importance of excitation systems and voltage regulation devices in reactive power control.	L2	Understand
CO3	To apply economic load dispatch, unit commitment, and equal area criterion principles through MATLAB programs to solve real time power system operation problems.	L3	Apply
CO4	To analyze the behavior of power systems under static and dynamic conditions using load flow studies, frequency deviation analysis, and stability models including swing equation and AVR simulations.	L4	Analyze
CO5	To evaluate and develop advanced control strategies using computer based tools (SCADA, EMS, MATLAB) to optimize real time operation, economic dispatch, and voltage profile maintenance in modern power systems.	L5	Evaluate

Power System Operation and Control
(RCP23LLPC603)
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 10 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 10 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 04 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 (RCP23LLPC603)

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 the power angle curve of synchronous machine using MATLAB.
10. To study reactive power compensation using any device.
11. Develop and execute dynamic programming method for unit commitment.
12. Simulation of multi area load frequency control using PID controller in MATLAB.

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: VI
Digital Signal Processing (RCP23LCPE601)		
Digital Signal Processing Laboratory (RCP23LLPE601)		

Prerequisite: Signals and System, Engineering Mathematics.

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 the IIR and FIR filters.
4. To understand the use of digital signal processing in electrical engineering.
5. To introduce the students to digital signal processors and its applications.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply the efficient computing algorithms of DFT and FFT in finding the response of the system.	L2	Understand
CO2	Design different types of IIR and FIR filters.	L6	Create
CO3	Evaluate the effects of Poles and Zeros in design of digital filters	L5	Evaluate
CO4	Understand the architecture of DSP Processors.	L2	Understand
CO5	Explain the applications of Digital Signal Processing in Electrical Engineering.	L2	Understand

Digital Signal Processing (RCP23LCPE601)
Course Contents

Unit-I 08 Hrs.

Discrete Fourier Transform and Fast Fourier Transform: Definition and Properties of DFT, IDFT, Circular convolution of sequences using DFT and IDFT. Filtering of long data sequences: Overlap-Save and Overlap-Add Method for computation of DFT. Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT 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 Application 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 (RCP23LLPE601)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Plot of Discrete Time Signals.
2. Frequency response of LTI systems by DTFT .
3. To perform Discrete Fourier Transform .
4. To implement Circular Convolution of two discrete time sequences .
5. To perform Overlap Add method of DFT for long data sequence.
6. To implement the algorithm of DIT-Fast Fourier Transform.
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 by 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, Barrie W. Jervis, "Digital Signal Processing A Practical Approach", Pearson Education, 2^{nd} Edition, 2002.
2. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", McGraw Hill Education Private Limited, 4^{th} Edition, 2013.
3. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press, 2015.
4. Paulo Fernando Ribeiro, Carlos Augusto Duque, Paulo Márcio Ribeiro, Augusto Santiago Cerqueira, "Power Systems Signal Processing for Smart Grids", Wiley, 1^{st} Edition, 2013.

Reference Books

1. Proakis J., Manolakis D., "Digital Signal Processing", Pearson Education, 4th Edition, 2007.
2. Oppenheim A., Schafer R., 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
Electrical Mobility (RCP23LCPE602)		
Electrical Mobility Laboratory (RCP23LLPE602)		

Prerequisite: Electrical Measurement, Signal and System.

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	Describe the different types of energy storage systems and battery charging systems.	L2	Understand
CO2	Classify the different mode of operation for hybrid vehicle.	L3	Apply
CO3	Apply the different Charging standards used for electric vehicles.	L3	Apply
CO4	Differentiate between Vehicle to home and Vehicle to grid concepts.	L3	Apply
CO5	Analyze the concepts of Hybrid and Electric vehicles.	L4	Analyze

Electrical Mobility (RCP23LCPE602)
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 08 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 08 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 (RCP23LLPE602)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Simulation of SPWM technique for electric vehicle converter using MATLAB / SIMULINK.
2. Simulation of three-phase VSI for grid integration in EV using MATLAB / SIMULINK.
3. Design of battery pack in MATLAB Simulink with C Rate Calculation.
4. Design and Simulation of DC Motor for different load conditions in MATLAB / SIMULINK.
5. Design and Simulation of Induction Motor for different load conditions in MATLAB / SIMULINK.
6. BMS Modelling and Simulation.
7. Battery Management System (BMS): Thermal Management Using MATLAB / SIMULINK.
8. Design of PMSM drive in MATLAB.
9. MATLAB / SIMULINK model of BLDC MOTOR for electrical vehicle
10. MATLAB simulation of DC-DC converter efficiency and voltage regulation.
11. Performance Analysis of Lithium-Ion battery for Electric Vehicle Applications.
12. SIMULINK model to calculate vehicles speed from motor torque.

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. 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, 5th 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, 2nd Edition, 2017.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Programmable Logic Control (RCP23LCPE603)		
Programmable Logic Control Laboratory (RCP23LLPE603)		

Prerequisite: Analog and Digital Electronics.

Course Objective

1. Understanding of Programmable Logic Control (PLC) programming, ladder logic.
2. Understand the operation of a PLC.
3. Understand advance programming techniques in PLC.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate knowledge of programmable logic controllers.	L2	Understand
CO2	Develop a program using ladder logic programming software.	L6	Create
CO3	Design PLC based system for process control.	L6	Create
CO4	Understand various timers, counters, fault and interrupt systems.	L2	Understand
CO5	Utilize ladder logic functions and advanced functions for PLC programming	L3	Apply

Programmable Logic Control (RCP23LCPE603)
Course Contents

Unit-I 04 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. Overview of various PLC's by industry.

Unit-II 10 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 flow meters, Velocity and Position Sensors. Output Devices: Relay, Contactor, 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 06 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 10 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 (RCP23LLPE603)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Introduction to ladder programming.
2. Implementation Logic Gates.
3. Implementation of Latching.
4. Implementation of interlocking system.
5. Implementation of on delay timer.
6. Implementation of off delay timer.
7. Implementation of Up-Down counter.
8. Implementation of PLC Arithmetic and Logic Instructions.
9. Implementation of object detection and controlling conveyor motor using ladder programming.
10. Implementation of jump to subroutine and return operations.
11. Implementation of Light ON / OFF control.
12. Implementation of Forward and Reverse direction control of Motors.
13. Implementation of Direct On Line Starter.
14. Implementation of water filling and discharging Process.
15. Logic implementation for traffic control application .
16. Logic implementation for bottle filling application.
17. Design a PLC program to control the liquid level in a tank.
18. Write the PLC programming for continues box filling operation that requires boxes moving on a conveyor to be automatically positioned and filled.

Design based Problems / Open Ended Problem:

- Speed measurement using counter
- DC motor control in both direction
- Level controller of underground and overhand tank.
- Servo motor control
- Automatic Stamping machine
- Automatic Drilling machine
- Automatic painting machine

- Four-way traffic light control
- Control of robotic arm

List of Open Source Software/learning website:
http://www.plcdev.com/book/export/html/9
http://www.plcmanual.com/
http://literature.rockwellautomation.com/
http://www.automation.siemens.com/
http://nptel.ac.in/video.php
http://ial-coep.vlabs.ac.in/List%20of%20experiments.html

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. Frank D. Petruzella, "Programmable Logic Controllers", Mc Graw Hill Education, 4^{th} Edition, 2022.
2. W. Bolton, "Programmable Logic Controllers", Elsevier, 6^{th} Edition, 2015.

Reference Books

1. Terry R. Borden, Richard A. Cox, "Technician's Guide to Programmable Controllers", Cengage Learning, 6^{th} Edition, 2013.
2. Khaled Kamel, Eman Kamel, "Programmable Logic Controllers Industrial Control", Mc Graw Hill Education, 2013.
3. Alan J Crispin, "Programmable Logic Controllers and their Engineering Applications", McGraw-Hill, 2^{nd} Edition, 1996.
4. Parr, "Programmable Controllers: An Engineers Guide", 3^{rd} Edition, Elsevier, Indian Reprint, 2013
5. John R Hackworth and Fredrick D Hackworth Jr., "Programmable Logic Controllers: Programming Methods and Applications", Pearson Education, 2015.
6. Webb J. W. and Ronald A. Reis, "Programmable Controllers: Principle and Applications", Prentice Hall India, 5^{th} Edition, 2009.
7. Stuart A. Boyer, "SCADA Supervisory Control and Data Acquisition", International Society of Automation, 4^{th} Edition, 2016.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Machine Learning and Applications (RCP23LCMD601)		
Machine Learning and Applications Laboratory (RCP23LLMD601)		

Prerequisite: Mathematics for Electrical Engineering, Digital Signal Processing.

Course Objectives

1. Introduce students to the fundamentals of machine learning (ML) techniques.
2. To discuss various mathematical methods and algorithms involved in ML for Signal Processing.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Recall key concepts and fundamentals relevant to machine learning and Applications.	L2	Understand
CO2	Understand the theoretical foundations of linear, non linear models, and the principles behind probabilistic and advanced Machine Learning models.	L2	Understand
CO3	Apply various machine learning and Signal Processing algorithms and techniques, in problem solving.	L3	Application
CO4	Analyze the performance and suitability of different learning techniques for specific applications.	L3	Application

Machine Learning and Applications
(RCP23LCMD601)
Course Contents

Unit-I — 08 Hrs.

Linear Models for Regression: Linear Regression with one variable, Cost function, Gradient descent, Polynomial Curve fitting, least squares, Geometry of least squares, Regularisation.

Unit-II — 08 Hrs.

Linear Models for Classification: Classifying with k-Nearest Neighbors, Decision Trees, Naïve Bayes, Logistic regression, Least Squares for Classification.

Unit-III — 07 Hrs.

Non Linear Models-Neural Networks: Parameter Optimization, Gradient descent Optimization, Evaluation of error-function derivatives, A simple example, Efficiency of backpropagation.

Unit-IV — 07 Hrs.

Probabilistic models and Expectation Maximisation Algorithm: k- means clustering, Gaussian Mixture Model, Maximum likelihood for Gaussian Mixtures, EM for Gaussian Mixtures.

Unit-V — 10 Hrs.

Applications of Machine Learning in Audio Classification, Speech Recognition and Image Processing: Signal Compression with SVD, Dimensionality reduction with PCA, LSTMs and CNNs, Hidden Markov Models, Viterbi Algorithm, Transfer Learning.

Machine Learning and Applications Laboratory (RCP23LLMD601)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Given a dataset, Predicting feature values with Linear Regression.
2. Binary Classification using Logistic Regression.
3. Find the minimum of a polynomial by Steepest Descent Method.
4. Dimensionality reduction by Principal Component Analysis.
5. Classification with Naïve Bayesian algorithm.
6. Image Compression and Reconstruction by SVD Decomposition.
7. Polynomial Regression: To generate a dataset and fit a Polynomial through it.
8. Reducing Overfitting by Ridge and Lasso Regression of A Given Dataset.
9. Backpropagation Implementation in Simple Neural Network with one hidden layer.
10. Implementation of Dropout Using Convolutional Neural Network.
11. Implementation Of Data Augmentation In Python.
12. Reducing Overfitting by Ridge and Lasso Regression of A Given Data.

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 practicals performed during laboratory sessions.

Text Books

1. Tom M. Mitchell, "Machine Learning", McGraw Hill Education, 2017.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 1^{st} Edition, 2006.

Reference Books

1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, 2020.
2. Kevin P. Murphy, "Machine Learning, A Probabilistic Perspective", MIT Press, 2012.

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Project Stage-I (RCP23IPEL601)		

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	Demonstrate project based learning that allows students to transfer existing ideas into new applications.	L2	Understand
CO2	Present the research in the form of technical writing, understand what constitutes to plagiarism and how to use proper referencing styles.	L2	Understand
CO3	Develop an ability to work in teams and manage the conduct of the research study.	L3	Apply
CO4	Integrate different perspectives from relevant disciplines which help them to get internships, jobs and admission for higher studies.	L3	Apply
CO5	Apply engineering knowledge to produce solution of a problem considering cultural, social, environmental, and economic factors using appropriate tool and method.	L4	Analyze

Project Stage-I (RCP23IPEL601)
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: VI
Constitution of India (RCP23ICHSX07)		

Course Objectives

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Have general knowledge and legal literacy and thereby to take up competitive examinations.	L3	Apply
CO2	Understand state and central policies, fundamental duties	L2	Understand
CO3	Understand Electoral Process, special provisions.	L2	Understand
CO4	Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.	L2	Understand
CO5	Understand Engineering ethics and responsibilities of Engineers.	L2	Understand
CO6	Understand Engineering Integrity and Reliability.	L2	Understand

Constitution of India (RCP23ICHSX07)
Course Contents

Unit-I 02 Hrs.

Introduction to the Constitution of India: The Making of the Constitution and Salient features of the Constitution, Preamble to the Indian Constitution, Fundamental Rights and its limitations.

Unit-II 02 Hrs.

Directive Principles of State Policy: Relevance of Directive Principles State Policy, Fundamental Duties. Union Executives – President, Prime Minister, Parliament, Supreme Court of India.

Unit-III 03 Hrs.

State Executives: Governor, Chief Minister, State Legislature, High Court of State.
Electoral Process in India, Amendment Procedures, 42^{nd}, 44^{th}, 74^{th}, 76^{th}, 86^{th} and 91^{st} Amendments.

Unit-IV 02 Hrs.

Special Provisions: For SC and ST, Special Provision for Women, Children and Backward Classes, Emergency Provisions.

Unit-V 02 Hrs.

Human Rights: Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India, Powers and functions of Municipalities, Panchayats and Co–Operative Societies.

Unit-VI 02 Hrs.

Scope and Aims of Engineering Ethics: Responsibility of Engineers Impediments to Responsibility. Risks, Safety and liability of Engineers, Honesty, Integrity and Reliability in Engineering.

Text Books

1. Durga Das Basu, "Introduction to the Constitution on India", (Student Edition) Prentice-Hall EEE, 25^{th} Edition, 2021.
2. Charles E. Haries, Michael S. Pritchard and Michael J. Robins, "Engineering Ethics", Thompson Asia, 2003.

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1. M. V. Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2003.
2. M. Govindarajan, S. Natarajan, V. S. Senthilkumar, "Engineering Ethics", Prentice-Hall of India, 2013.

3. Brij Kishore Sharma, "Introduction to the Constitution of India", 7th Edition, PHI Learning Pvt. Ltd., 2015.

4. Latest Publications of Indian Institute of Human Rights, New Delhi.

Online Resources

1. www.nptel.ac.in
2. www.hnlu.ac.in
3. www.nspe.org
4. www.preservearticles.com

Program: Electrical Engineering	T. Y. B. Tech.	Semester: VI
Full Stack Development-I (RCP23LLSC601)		

Prerequisite

1. Basic understanding of computers and web browsers.
2. Familiarity with basic programming concepts (variables, loops, functions, etc.).
3. Introductory knowledge of HTML and CSS.
4. Basic understanding of JavaScript (optional but beneficial).

Course Objectives

1. To introduce students to the fundamentals of web development using HTML, CSS, and JavaScript.
2. To provide in-depth knowledge of modern JavaScript (ES6+) features used in frontend development.
3. To enable students to build interactive user interfaces using React and its component-based architecture.
4. To develop skills in managing state, handling events, and using React Hooks for building dynamic applications.
5. To empower learners to build and deploy real-world React projects including a personal portfolio.

Course Outcomes

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Design responsive web pages using HTML5, CSS, and modern layout techniques.	L3	Apply
CO2	Apply core JavaScript and ES6+ features to build interactive web functionalities.	L3	Apply
CO3	Develop dynamic user interfaces using React components, props, state, and event handling.	L6	Create
CO4	Manage application state and side effects using React Hooks and advanced patterns.	L4	Analyze
CO5	Build and deploy real-world React projects and a personal portfolio showcasing frontend skills.	L6	Create

Full Stack Development-I (RCP23LLSC601)
Course Contents

Unit-I — 10 Hrs.

React JS for Front-end development:

ES6+ Features

- Let and Const (Replacing var)
- Arrow functions
- Promises(async / await)
- Spread / Rest operators
- Destructuring

Javascript Functions

- Array Map Method
- JavaScript forEach Method
- JavaScript Filter() Method
- JavaScript Reduce Method

React Fundamentals

- About React
- About JSX in React
- Components in React
- Iteration in React
- Conditional Rendering
- Range Utility and styling in React

Working With State in React

- Event Handlers
- The useState Hook
- Forms in React
- Props Vs. State

React Hooks

- About Hooks

- Immutability Revisited and Refs
- Side Effects
- Custom hooks and Data Fetching
- Memoization

Project - Interactive Forms with Dynamic Tabs

- Project - The Job Application Form

Component API Design

- The Spectrum of Components
- Polymorphism and Compound Components
- React Context
- Understanding Modals

Portfolio Project

- Portfolio Website

Project - 2048 Game

- 2048 - Game

Advanced Patterns and Smarter State in React

- React State and Visual Updates
- Smarter Component Design in React
- Managing Complex State with use Reducer
- Advanced UI and Safe State Updates in React

Unit-II 06 Hrs.

HTML / CSS:

Introduction to HTML

- Introduction to HTML tags and structure
- List / Images / Links / Table using HTML
- Semantic HTML
- Quiz: HTML
- Project: HTML

Introduction to CSS

- Ways to style using CSS
- CSS selectors and properties
- CSS layout and positioning - Box model
- Quiz: CSS
- Project: CSS

Unit-III 12 Hrs.

Javascript:

- Introducing output/printing
- Printing on multiple lines
- Print text and numbers using single print

Variables and Datatypes

- Introduction to variables and datatypes
- Quiz on variables
- Boolean data type and negative numbers

Strings

- Introduction to strings
- Quiz on strings

Functions in JavaScript

- Learn about functions
- Use functions in problems

Conditional Statements

- Intro to if / else
- Quiz on conditions
- Combining conditions - And / or

Debug Your Code

- Learn to debug common errors
- Practice debugging

Arrays

- Introduction to arrays

- Quiz on Arrays

Loops

- While loops
- For loops
- Quiz on loops
- Break / continue

ES6+ Features in JavaScript

- Introduction to let and const
- Arrow Functions
- Spread and Rest Operators
- Destructuring in JavaScript

User Inputs

- How to take user input
- Practice problems

Getting Started with Algorithmic Problems

- What are test cases?
- What are custom inputs?
- Review problems

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Creation of HTML Skeleton.
2. Creation of a Paragraph in HTML.
3. Add the elements in HTML - images and videos. Links to external websites, Create lists, Add tables.
4. SUse semantic HTML.
5. Do inline styling in CSS.
6. Create a style sheet in CSS - internal and external.
7. Use class / ID selector in CSS.
8. do font stying in CSS.
9. do layout and positioning in CSS.
10. Printing a number/text in JS.
11. Arithmetic Operations in JS.
12. Inserting text Between Outputs in JS.
13. Create and Declare Variables in JS.
14. Use of String datatype / Float Datatype.
15. Create a boolean variable.
16. Use a function in JS.
17. Call a function within a function.
18. Render Dynamic Data in JSX.
19. Do Inline Styles in JSX.
20. Update the given React component to display dynamic values and additional information inside the in React.
21. Create a basic react component in React.
22. Create flexible and reusable components in React.
23. Create a component with an input field and two buttons in React.
24. Interact with DOM elements and handle side effects in React using useRef and useEffect.
25. Handle Form Submissions with Fetch in React.

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. A. Banks and E. Porcello, "Learning React: Modern Patterns for Developing React Apps", 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2020.

Reference Books

1. S. Stefanov, "React – Up & Running: Building Web Applications", Sebastopol, CA, USA: O'Reilly Media, 2016.
2. A. Accomazzo, N. Murray, A. Lerner, C. Blank, and D. Gallo, "Fullstack React: The Complete Guide to ReactJS and Friends", San Francisco, CA, USA: Fullstack.io, 2017.
3. D. Crockford, "JavaScript: The Good Parts", Sebastopol, CA, USA: O'Reilly Media, 2008.
4. M. Haverbeke, "Eloquent JavaScript: A Modern Introduction to Programming", 3rd ed., San Francisco, CA, USA: No Starch Press, 2018.
5. J. Duckett, "HTML and CSS: Design and Build Websites", Indianapolis, IN, USA: Wiley, 2011.