Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure

Final Year B. Tech. (Electrical Engineering)

with effect from Academic Year 2026-27

(RCP23 NEP Scheme)

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

Vision of the Institute

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

Mission of the Institute

To impart high quality Technical Education through:

M1: Innovative and Interactive learning process and high quality, globally recognized instructional programs.

M2: Fostering a collaborative scientific temper among students with ethical responsibility towards the society.

M3: Preparing students from diverse backgrounds to have aptitude for employment, entrepreneur ship and research with a spirit of professionalism.

M4: To contribute to the nation's sustainable development.

Vision of the Electrical Engineering Department

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

Mission of the Electrical Engineering Department

M1: Deliver innovative, interactive learning fostering excellence in Electrical Engineering and emerging technologies.

M2: Cultivate scientific inquiry, ethical responsibility, and interdisciplinary collaboration to ad dress energy, automation, and societal challenges.

M3: Empower diverse students with skills for employment, entrepreneurship, and research, nurturing professionalism and lifelong learning.

Program Educational Objectives

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

PEO1: Graduates will apply electrical engineering knowledge and innovation to solve complex industrial and societal problems.

PEO2: Graduates will demonstrate ethical leadership and collaborate across disciplines to promote sustainable and inclusive development.

PEO3: Graduates will pursue careers in employment, entrepreneurship, or research, embracing professionalism and lifelong learning.

R. C. Patel Institute of Technology, Shirpur Autonomous

Final Year B. Tech Electrical Engineering Semester- VII / VIII (w. e. f. 2026-27)

Sr. No	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	Total Credit
							Continuous Assessment (CA)				ESE			
				L	T	P	TA	TT1	TT2	Average TT1 & TT2				
							A			B	C	A+B+C		
1	PC	RCP23LCPC701	Switchgear and Protection	3	--	--	25	15	15	15	60	100	3	4
		RCP23LLPC701	Switchgear and Protection Laboratory	--	--	2	25	--	--	--	25	50	1	
2	PE#	RCP23LCPE711	Electrical Power System Design	3	--	--	25	15	15	15	60	100	3	4
		RCP23LLPE711	Electrical Power System Design Laboratory	--	--	2	25	--	--	--	25	50	1	
		RCP23LCPE712	High Voltage Engineering	3	--	--	25	15	15	15	60	100	3	
		RCP23LLPE712	High Voltage Engineering Laboratory	--	--	2	25	--	--	--	25	50	1	
		RCP23LCPE713	Computer Aided Power System Analysis	3	--	--	25	15	15	15	60	100	3	
		RCP23LLPE713	Computer Aided Power System Analysis Laboratory	--	--	2	25	--	--	--	25	50	1	
		RCP23LCPE714	Illumination Engineering	3	--	--	25	15	15	15	60	100	3	
		RCP23LLPE714	Illumination Engineering Laboratory	--	--	2	25	--	--	--	25	50	1	
3	PE#	RCP23LCPE721	Electrical Drives and Control	3	--	--	25	15	15	15	60	100	3	4
		RCP23LLPE721	Electrical Drives and Control Laboratory	--	--	2	25	--	--	--	25	50	1	
		RCP23LCPE722	Power System Stability	3	--	--	25	15	15	15	60	100	3	
		RCP23LLPE722	Power System Stability Laboratory	--	--	2	25	--	--	--	25	50	1	
		RCP23LCPE723	Advanced Digital Signal Processing	3	--	--	25	15	15	15	60	100	3	
		RCP23LLPE723	Advanced Digital Signal Processing Laboratory	--	--	2	25	--	--	--	25	50	1	
		RCP23LCPE724	Power System Dynamics (NSM)	3	--	--	25	15	15	15	60	100	3	
		RCP23LLPE724	Power System Dynamics Laboratory (NSM)	--	--	2	25	--	--	--	25	50	1	
4	MD	RCP23LCMD701	Deep Learning	2	--	--	25	15	15	15	60	100	2	3
		RCP23LLMD701	Deep Learning Laboratory	--	--	2	25	--	--	--	25	50	1	
5	EL	RCP23ITELX08	Research Ecosystem	--	2	--	50	--	--	--	--	50	2	2
6	EL	RCP23IPEL701	Project Stage-II	--	--	8	50	--	--	--	50	100	4	4
7	HS	RCP23ICHSX09	Disaster Management and Preparedness	2	--	--	--	--	--	--	--	--	--	Audit
8	SC	RCP23LCSC701	Solar Energy and Electrical System Design	1	--	--	40	--	--	--	--	40	1	1
			Total	14	2	16	340	--	--	60	390	790	22	22

PE# Any One Elective

Prepared By	Checked By	BOS Chairman	Dean Academics	COE	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

Final Year B. Tech Electrical Engineering Semester- VII / VIII (w. e. f. 2026-27)

Sr. No	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme						Credit	Total Credit
							Continuous Assessment				ESE	Total		
				L	T	P	TA	TT1	TT2	Average TT1 &				
							A			B	C	A+B+C		
1	PE#	RCP23LCPE811	HVDC Transmission	3	–	–	25	15	15	15	60	100	3	3
		RCP23LCPE812	EHVAC Transmission	3	–	–	25	15	15	15	60	100	3	
		RCP23LCPE813	Restructured Power System	3	–	–	25	15	15	15	60	100	3	
		RCP23LCPE814	Optimization Techniques	3	–	–	25	15	15	15	60	100	3	
		RCP23LCPE815	DC Microgrid and Control Systems	3	–	–	25	15	15	15	60	100	3	
			NPTEL/SWAYAM Courses*	3	–	–	25	15	15	15	60	100	3	
2	EL	RCP23IPELX10	Internship (OJT) cum Project	–	–	36	200	–	–	–	200	400	18	18
3	SC	RCP23LCSC801	Magnetics for Power Electronic Converters	1	–	–	40				–	40	1	1
			Total	**4**	**--**	**36**	**265**	**--**	**--**	**15**	**260**	**540**	**22**	**22**

1. #: Any One Program Elective, TA: Teacher Assessment; ESE: End Semester Examination
2. Program Elective Courses offered for the students doing Internship (OJT).
3. Program Elective Courses offered by NPTEL /SWAYAM for the students doing internships (OJT).
4. These courses are to be studied in self-study mode using NPTEL/Swayam Platform.
5. Students doing an internship (OJT) shall submit certificate of NPTEL Examination **OR** they have to appear examinations conducted by institute like TT1, TT2 and ESE.
6. Students undergoing internship (OJT) have the option to appear for both NPTEL examination and the End Semester Examination (ESE) conducted by the institute for the respective course. In such cases, the better of the two scores (NPTEL or ESE) shall be considered for final grading.
7. List of NPTEL courses will be decided by concerned BOS at the beginning of the semester VIII.

Prepared By	Checked By	BOS Chairman	Dean Academics	COE	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

Semester- VII

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Switchgear and Protection (RCP23LCPC701)		
Switchgear and Protection Laboratory (RCP23LLPC701)		

Prerequisite: Generation Transmission and Distribution of Electric Power, Power System.

Course Objectives

1. To explores the knowledge of arc interruption.
2. To demonstrate different type of circuit breakers and relay.
3. To understand the characteristic feature and proper selection of protective elements in different protective scheme.
4. To possess knowledge related to different protection for major and individual power system elements.
5. To meet desired needs the recent technology in protection.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply the knowledge of science for understanding arc generation and interruption in medium and high voltage circuits.	L3	Apply
CO2	Illustrate construction, operation, and specifications of different circuit breakers used in power systems.	L3	Apply
CO3	Apply basic relay and their role in protection systems.	L3	Apply
CO4	Apply relay based on modern techniques and their role in protection schemes.	L3	Apply
CO5	Analyze different protection schemes used in power systems.	L4	Analyze

Switchgear and Protection (RCP23LCPC701)
Course Contents

Unit-I **08 Hrs.**

Arc Interruption Theories: Basic requirement of Switching and protection, Arc phenomenon, maintenance of arc Properties of arc, interruption theories Transient recovery Voltage, Transient analysis, RRRV. Switching Transients: Closing of a line, Reclosing of a line, Interruption of small capacitive Currents, Interruption of Inductive load currents, Current chopping.

Unit-II **08 Hrs.**

Circuit Breakers: Construction, Working principle, Application and comparison of different types of circuit Breakers such as Air break, Air blast, Minimum oil circuit breaker, SF6 and Vacuum Circuit breakers, H.V.D.C. Circuit breakers, Circuit breaker ratings.

Unit-III **09 Hrs**

Protective Relay-I: Protection system and its attributes, organization of protection, zones of protection and mal-operation. Desirable qualities of protective relaying, Definitions of terms used in relaying, Construction, working and characteristic features of electromagnetic relay: Over current, instantaneous over-current, definite time over-current, inverse time over-current relay directional over current relay and differential relay

Unit-IV **09 Hrs.**

Protective Relay-II: Principle of operation and characteristics of induction type, Impedance relay, Reactance relay, MHO relay, Buccholz, Negative Phase Sequence, Harmonic restraint relays. Static Over current relay: overview of Static relay, block diagram, operating principle, merits and demerits of static relay. Digital relay: Basic component of digital relay, Microprocessors based relay, block diagram, DMPR relays, DTPR relays, digital temperature protection relays.

Unit-V **08 Hrs.**

Protection Schemes: Different type of protective scheme: Over current protection, Differential protection, earth fault protection, distance protection and carrier aided protection. Protective scheme for generator, transformer, bus bar, transmission line and motor.

Switchgear and Protection Laboratory (RCP23LLPC701)
List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To conduct and study of Arc extinction phenomenon, Application in air circuit breaker.
2. To conduct and plot the characteristic of rewirable fuses and MCB.
3. To conduct and plot operating characteristics of over current relay.
4. To conduct Protection of transformer using differential relay.
5. To conduct and study of Static relay.
6. To conduct and study of microprocessor base relay.
7. To study of protection scheme for alternator.
8. To study of switchgear testing kit.
9. To study Electromechanical Relay.
10. Simulation of protection of transmission line.
11. Simulation of differential protection of transformer.
12. Modeling and Simulation of Over Current Relay.
13. Modeling and Simulation Protection of alternator.
14. Modeling and Simulation of digital relay.

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 per formed during laboratory sessions.

Text Books

1. B. Ravindranath,M. Chander,"Power SystemProtection and Switchgear", New Age International, 2^{nd} Edition, 2018.
2. Sunil S. Rao, "Switchgear Protection and Power Systems", Khanna Publisher, 14^{th} Edition, 1977.
3. Y. G. Paithankar, S. R. Bhide, "Fundmentals of Power System Protection", Prentice Hall of India, 2004.

Reference Books

1. T. S. Madhavarao, "Power System Protection Static Relay", Tata MacGraw Hill, 2^{nd} Edition, 2017.
2. R. P. Maheshwari, Nilesh G. Chothani, "Protection and Switchgear", Oxford Press, 2011.
3. Badri Ram, D. Vishvakarma, "Power System Protection and Switchgear", Tata McGraw Hill, 2^{nd} Edition, 2017.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Electrical Power System Design (RCP23LCPE711)		
Electrical Power System Design Laboratory (RCP23LLPE711)		

Prerequisite: Electrical Energy Generation System, Power System Transmission and Distribution, Power System Analysis.

Course Objectives

1. To explore the design concept of electrical power system.
2. To provide an ideas of electrical and mechanical design concept of transmission line.
3. To give an economical consideration, project execution and site selection concept.
4. To explore the knowledge of power system improvement.
5. To explore the knowledge of power system planning

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply electrical design principles for transmission lines and substations	L3	Apply
CO2	Analyze mechanical design aspects including sag-tension and tower configurations	L4	Analyze
CO3	Apply concepts of substation layouts, bus-bar schemes, and protection coordination	L3	Apply
CO4	Analyze distribution system performance including voltage regulation and load distribution	L4	Analyze
CO5	Analyze power system planning, reliability, and improvement techniques	L4	Analyze

Electrical Power System Design (RCP23LCPE711)
Course Contents

Unit-I **09 Hrs.**

Electrical Design of Transmission Lines : Requirement of transmission systems, selection of voltage level, choice of conductors (including bundled conductors), spacing of conductors, corona and its effects, insulators and their types, surge impedance loading (SIL), electrical design of transmission lines, introduction to line compensation (series and shunt), overview of underground cables.

Unit-II **09 Hrs.**

Mechanical Design, EHV Transmission and Substations : Mechanical design considerations, sag-tension relationships, equal and unequal sag calculations, stringing of transmission lines, types of towers and configurations, extra high voltage (EHV) transmission concepts, insulation coordination, radio interference, substation layouts (AIS and GIS), bus-bar schemes, equipment arrangement, introduction to protection coordination.

Unit-III **08 Hrs**

Distribution System Design and Smart Grids : Development of distribution systems, Types of distribution networks, Primary and secondary distribution design, Voltage drop and regulation, Distribution substations, Protection of distribution systems, Rural and urban electrification, Industrial distribution systems, Introduction to smart grids, SCADA systems, Distributed Generation (DG) integration, EV charging infrastructure (impact on distribution).

Unit-IV **08 Hrs.**

Power System Improvement and Compensation Techniques: Power system performance improvement, loss reduction techniques, voltage regulation improvement, reactive power compensation, capacitor placement, introduction to FACTS devices, demand side management (DSM), power factor improvement, financial considerations of improvement schemes.

Unit-V **08 Hrs.**

Power System Planning, Reliability and Modern Trends : Power system planning methods, load forecasting techniques, Generation, transmission and distribution planning, Reliability concepts and indices (SAIFI, SAIDI), Power system stability basics, Renewable energy integration challenges (grid-level), Variability, intermittency, storage concepts, Grid stability with renewables (frequency, inertia issues), introduction to AI-based forecasting, trends in power system planning in India.

Electrical Power System Design Laboratory (RCP23LLPE711)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Draw and analyze substation layout (AIS/GIS) with justification of equipment placement.
2. Perform sag-tension calculations (equal and unequal sag) and interpret results for different spans.
3. Analyze transmission line design parameters (conductor selection, spacing, voltage level) for given data.
4. Draw and compare tower configurations and conductor arrangements based on application.
5. Analyze distribution system (load estimation, feeder current, voltage drop and regulation).
6. Analyze bus-bar schemes and switching arrangements based on reliability and cost considerations.
7. Study and select underground cable types for different applications with justification.
8. Analyze earthing system design (resistance calculation and safety aspects).
9. Perform basic simulation of voltage profile/load flow using MATLAB/ETAP (demonstration or guided exercise).
10. Analyze reactive power compensation techniques for improving system performance.

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 per formed during laboratory sessions.

Text Books

1. M. V. Deshpande, *Electrical Power System Design*, McGraw Hill.
2. B. R. Gupta, *Power System Analysis and Design*, S. Chand.
3. Hadi Saadat, *Power System Analysis*, McGraw Hill.

Reference Books

1. D. P. Kothari & I. J. Nagrath, *Power System Engineering*, McGraw Hill.
2. A. B. Chattopadhyay & D. P. Kothari, *Advanced Electrical and Power System Design*, New Age International.
3. J. Duncan Glover, *Power System Analysis and Design*, Cengage Learning.
4. Industry references from Power Grid Corporation of India Limited and IEEE PES.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
High Voltage Engineering (RCP23LCPE712)		
High Voltage Engineering Laboratory (RCP23LLPE712)		

Prerequisite: Electrical Material, Power Electronics.

Course Objectives:

1. To compare various breakdown mechanisms in solid, liquid, and gaseous dielectric materials.
2. To apply various methods for the generation and measurement of DC, AC, and impulse voltages and currents.
3. To analyze charge formation and separation phenomena in clouds, causes of over-voltages, and lightning phenomena.
4. To perform testing of various high-voltage equipment as per standard testing procedures.
5. To introduce the design, layout, earthing, shielding, and safety precautions of a High Voltage laboratory

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply basic knowledge of electrical engineering material for understanding breakdown phenomena in solid, liquid, and gases.	L3	Apply
CO2	Analyze the occurrence of overvoltage and provide remedial solutions.	L4	Analyze
CO3	Apply the use of various methods for generation of high AC, DC, and impulse voltage and current.	L3	Apply
CO4	Apply the methods of measurement of high AC, DC, impulse voltage and current, and tests on high voltage equipment and devices.	L3	Apply
CO5	Apply various testing procedures as per IS in laboratory with knowledge of earthing, safety, and shielding of HV laboratory.	L3	Apply

High Voltage Engineering (RCP23LCPE712)
Course Contents

Unit-I **09 Hrs.**

Breakdown In Gases, Liquids and Solids: Review and classification of insulating material, Breakdown in gases, Townsend's law. Breakdown in electronegative gases, streamer mechanism of spark, Paschen's law, corona discharge, electronegative gases. Breakdown in pure and commercial liquids, solid dielectric and composite dielectric, Breakdown in vacuum.

Unit-II **09 Hrs.**

Lightning and Switching Over Voltage Protection: Modes of operation: Steady state, Lightning phenomenon, Different types of lightning strokes and mechanisms of lightning strokes, Charge separation theories, Wilson theory, Simpson theory, Reynolds and Mason theory. Causes of over voltages and its effects on power systems, Over voltage due to switching surges and methods to minimize switching surges. Insulation co-ordination of HV and EHV power system.

Unit-III **08 Hrs**

Generation of High Voltage and Currents: Generation of high ac voltages Cascading of transformers, series and parallel resonance system, Tesla coil. Generation of impulse voltages and current Impulse voltage definition, wave front and wave tail time, Multi stage impulse generator, Modified Marx circuit, Tripping and control of impulse generators, Generation of high impulse current .

Unit-IV **08 Hrs.**

Measurement of High Voltage And Currents: Sphere gap voltmeter, electrostatic voltmeter, generating voltmeter, peak reading voltmeter, resistive and capacitive potential divider, and capacitance voltage transformer, cathode ray oscilloscope for impulse voltage and current measurement, partial discharge Measurements. Measurement of high power frequency a.c using current transformer.

Unit-V **08 Hrs.**

Testing and EHV Line Insulation: Basic technology , testing of insulators bushing , cables , transformer, surge diverters and threshold current , capacitance of long objects, Electromagnetic interference, E.H.V line insulation design based upon transient over voltages.

High Voltage Engineering Laboratory (RCP23LLPE712)
List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To perform breakdown test on transformer oil and obtain constants of breakdown voltage equation and breakdown strength.
2. To obtain breakdown strength of composite insulation system.
3. Measurement of unknown high a.c. voltage using sphere gap.
4. Measurement of insulation resistance of 11KV/110 V.P.T by Megger.
5. Analyzing the uniform and non-uniform field in breakdown strength of air insulation system.
6. To understand basic principle of corona and obtain audible and visible corona inception and extinction voltage under non uniform field.
7. Dry and Wet power frequency withstand test for insulator.
8. To Analyzing the Effect of EHV field on Human, Animals and Plants.
9. Study of impulse generator.
10. Simulation of lightening and switching impulse voltage generator.
11. To Analyzing effect of barrier on breakdown voltage of air/ transformer oil.
12. Parametric analysis of Impulse current generator using virtual Laboratory.

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 per formed during laboratory sessions.

Text Books

1. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd. 3rd Edition, 2012.
2. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publication, 6th Edition, 2013.

Reference Books

1. R. S. Jha, "High Voltage Engineering", Dhanpat Rai Publication, 1977.
2. Rakash Das Begamudre, "Extra High Voltage Transmission", New Age International Publication, Revised Edition, 2011.
3. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, "High Voltage Engineering", Khanna Publishers, New Delhi, 2005.
4. Subir Ray, "An Introduction to High Voltage Engineering" PHI Pvt. Ltd. New Delhi, 2013.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Computer Aided Power System Analysis (RCP23LCPE713)		
Computer Aided Power System Analysis Laboratory (RCP23LLPE713)		

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

Course Objectives

1. To understand use of modern tool for the analysis of the complex electrical power systems with less computational time and more accuracy.
2. To model the issues and analyze methods for the power flow, short circuit, contingency and stability analysis, required to be carried out for the continuous monitoring of power systems.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the network topology for representation of power system components and networks.	L2	Understand
CO2	Construct the bus impedance and admittance matrices using suitable algorithms.	L3	Apply
CO3	Analyze short circuit conditions for proper selection of protection schemes.	L4	Analyze
CO4	Apply load flow studies using Newton-Raphson Method, Gauss-Seidel Method, and Fast Decoupled Load Flow Method.	L3	Apply
CO5	Analyze simultaneous faults using matrix transformation techniques.	L4	Analyze

Computer Aided Power System Analysis (RCP23LCPE713)
Course Contents

Unit-I **09 Hrs.**

Network Topology: Modeling of Power System Components, Basic Concepts, Single Phase, Three Phase Models, Matrix, and Representation of Networks Topology of Electric power system Network Graphs, Incidence matrices, fundamental loop and cutest matrix, primitive impedance and admittance matrix, singular transformation of network matrix. in vacuum.

Unit-II **09 Hrs.**

Incidence Matrix: Formation of bus impedance and admittance matrices by algorithm Modification of bus impedance and admittance matrix to account for change in networks. Derivation of loop impedance matrix. Algorithm for formulation of 3 phase bus impedance matrix.

Unit-III **08 Hrs**

Short Circuit Studies: Three phase network, Symmetrical components. Thevenins theorem and short circuit analysis of multi-mode power system using bus impedance matrix. Short circuit calculations for balanced and unbalanced short circuit bus impedance and loop impedance matrices

Unit-IV **08 Hrs.**

Load Flow Studies: Slack bus, loop buses, voltage control buses, Load flow equations, power flow model using bus admittance matrix, Power flow solution through Gauss-Seidal and N-R methods sensitivity analysis, Second order N-R method, fast decoupled load flow method, Sparsity of matrix.

Unit-V **08 Hrs.**

Fault Analysis: Simultaneous faults, Simultaneous Faults by two port network Theory (Z, Y and H-type Faults), Simultaneous faults by matrix Transformations, Analytical simplifications of series and shunt fault.

Computer Aided Power System Analysis Laboratory (RCP23LLPE713)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Determination of equivalent parameters of transmission line.
2. Program for building of bus impedance matrix by addition of branch.
3. Program for building of bus impedance matrix by addition of link.
4. Program/Simulation for illustration of the Ferranti Effect.
5. Program for the formation of bus admittance matrix by Singular Transformation.
6. Program for evaluation of load flow by Newton Raphson Method.
7. Program/Simulation for Balanced Three phase short circuit.
8. Program/Simulation for Unbalanced short circuits.
9. Program/Simulation for Fault analysis of Power System network of an Electric Utility Company.
10. Study of IEC and ANSI standards for Short circuit analysis.
11. Introduction to PSCAD.
12. Introduction to ETAP.

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 per formed during laboratory sessions.

Text Books

1. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
2. J. J. Gringer and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, Indian Edition, 2017.

Reference Books

1. G. W. Stagg and A. H. Ei-Abiad, "Computer Methods in Power System Analysis", Medtech, International student Edition, 2019.
2. G. L. Kusic, "Computer Aided Power System Analysis", Taylor and Francis, 2nd edition, 2008.
3. A. R. Bergen and Vijay Vittal, "Power Systems Analysis", Pearson Education Asia, 2nd edition, 2001.
4. Hadi Sadat,"Power System Analysis", Tata McGraw Hill, 3rd Edition, 2016.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Illumination Engineering (RCP23LCPE714)		
Illumination Engineering Laboratory (RCP23LLPE714)		

Prerequisite: Knowledge basic sciences, mathematics and subjects of Electrical Engineering.

Course Objectives:

1. To get the detailed information about modern lamps and their accessories.
2. To get detailed insight of indoor and outdoor illumination system components, its controls and design aspects.
3. To know the requirements of energy efficient lighting.
4. To introduce the modern trends in the lighting.
5. To get the detailed information about modern lamps and their accessories

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the fundamentals of lighting systems and factors affecting the design of lighting schemes.	L2	Understand
CO2	Explain the criteria for selection of lamps, measurement of light, and laws of illumination for indoor and outdoor lighting systems.	L2	Understand
CO3	Analyze the different types of indoor lighting schemes and select suitable luminaires to meet specified requirements.	L4	Analyze
CO4	Analyze photometric performance and perform calculations for selection of light sources and luminaires in outdoor lighting applications.	L4	Analyze
CO5	Explain modern trends and advancements in lighting technologies.	L2	Understand

Unit-I **08 Hrs.**

Introduction of Light: Introduction of Light: Radiation, colour and eye vision. Types of illumination, Day lighting, Supplementary artificial lighting and total lighting, Quality of good lighting, Factors affecting the lighting shadow, glare, reflection, Colour rendering and stroboscopic effect, Methods of artificial lighting, Lighting systems direct, indirect, semi direct, semi indirect, Lighting scheme, General and localized.

Unit-II **09 Hrs.**

Light Sources: Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low and high mercury and Sodium vapour lamps, Low Vapour Pressure discharge lamps Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL) High Vapour Pressure dis charge lamps Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, Induction lamps.

Unit-III **09 Hrs**

Design of Interior Lighting: Definitions of maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilization and factors affecting it, Illumination required for various work planes, Space to mounting height ratio, Types of fixtures and relative terms used for interior illumination, Calculation of wattage of each lamp and no of lamps needed, Layout of lamp luminaries, Calculation of space to mounting height ratio, Indian standard recommendation and standard practices for illumination levels in various areas, Special feature for entrance, staircase, Corridor lighting and industrial building.

Unit-IV **09 Hrs.**

Design of Outdoor Lighting: Street Lighting : Types of street and their level of illumination required, Terms related to street and street lighting, Types of fixtures used & their suitable application, Various arrangements in street lighting, Requirements of good street lighting, Selection of lamp and luminaries, Calculation of illumination level available on road .Flood Lighting Types of fixtures and their suitable applications, Selection of lamp, projector, Calculation of their wattage, number & their arrangement, Calculation of space to mounting height ratio.

Unit-V **07 Hrs.**

Modern trends in illumination: LED luminary designs Intelligent LED fixtures Natural light con ducting Organic lighting system LASERS, characteristics, features and applications, non-lighting lamps Optical fiber, its construction as a light guide, features and applications.

Illumination Engineering Laboratory (RCP23LLPE714)
List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To Study the status monitoring of light.
2. To study fault monitoring in Lighting Power Systems.
3. To study electrical load monitoring in Lighting Power Systems.
4. To calculate the life of Lighting Lamp.
5. To study the energy management in illumination.
6. To study the Energy efficient illuminating system components.
7. To measure Illumination by lux meter.
8. To prepare a report of different luminaries available in the market and collect the technical data.
9. To study the different lighting accessories required for varies types of lamps.
10. Design an Illumination scheme for a garden of medium size.
11. Design an Illumination scheme for a conference room of medium size.
12. Design an Illumination scheme for a workshop for fine work of medium size.
13. Design an Illumination scheme for a medium size Hotel / Hospital /Shopping complex.

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 per formed during laboratory sessions.

Text Books

1. Gupta J. B., "Utilization of Electric Power and Electric Traction", S. K. Kataria and Sons, 2^{nd} Edition, 2012.
2. Uppal S. L, "Electrical Power", Khanna Book Publication, 132^{th} Edition, 1988.
3. Partab H. P., "Art and Science of Utilization of Electrical Engineering", Dhanpat Rai Publications, Revised Edition, 2017.

Reference Books

1. Jack L. Lindsey, "Applied Illumination Engineering", Fairmont Pr, 2^{nd} Edition, 1996.
2. JohnMatthews, "Introduction to the Design and Analysis of Building Electrical Systems", Springer, 1993.
3. M. A. Cayless, "Lamps and Lighting", Routledge, 4^{th} Edition, 2012.
4. O. E. Taylor, "Utilization of Electrical Energy", Longman, 1971.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Electrical Drives and Control (RCP23LCPE721)		
Electrical Drives and Control Laboratory (RCP23LLPE721)		

Prerequisite: Electrical Machines, Power Electronics and Control System.

Course Objectives:

1. To describe the structure of Electric Drive systems and their role in various applications.
2. To understand the basic principles of control aspects in drives using controlled converters.
3. To review the basic concepts of operation and modern control aspects of dc and ac motors.
4. To select suitable electric drive for various applications in industrial field.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the fundamental concepts and structure of electric drives.	L2	Understand
CO2	Demonstrate basic speed control methods of DC and AC motors through simulation and lab experiments.	L3	Apply
CO3	Analyze the performance of converter fed DC and AC drives in different operating modes.	L4	Analyze
CO4	Analyze the closed loop control techniques used in electric drives.	L4	Analyze
CO5	Analyze the electrical drives for specific industrial applications using modern tools.	L4	Analyze

Electrical Drives and Control (RCP23LCPE721)
Course Contents

Unit-I **06 Hrs.**

Introduction to Electrical Drives: Advantages of Electrical Drives, Parts of Electrical drive, Choice of Electric drives Dynamics of Electrical drives: fundamental torque equations, multi-quadrant operation, nature and classification of load torques, steady state stability, concept of load equalization in drives.

Unit-II **08 Hrs.**

Control of Electrical Drives: Modes of operation: Steady state, Acceleration, Deceleration, Drive classification Closed loop control of drives: Current limit control, torque control, speed control, position control and control of multi-motor drives, speed sensing, and current sensing. Classes of motor duty, criteria for selection of motor.

Unit-III **10 Hrs**

DC Motor Drives: Single phase drives: Single phase half wave, half controlled, Full controlled and Dual converter drives. Three phase drives: Three phase half wave, half controlled, Full controlled and Dual converter drives. Chopper drives: Principle of Rheostatic and regenerative braking control, combined control, two and four quadrant DC-DC converter fed drives. Introduction to closed loop control of DC drives.

Unit-IV **10 Hrs.**

AC Motor Drives: Induction motor drives: Speed control methods on stator and rotor sides of induction motor drives. Closed loop control of Induction motors. Multi-quadrant operation of induction motor drives fed from Voltage Source Inverters. Static slip power recovery control.

Synchronous Motor Drives: Static variable frequency control for Synchronous motors. Load commutated inverter fed Synchronous motor drive, Introduction to closed loop control of Load commutated inverter fed Synchronous motor drive

Unit-V **08 Hrs.**

Drives for Specific Applications: Construction and operation, motor torque equation converter circuits, closed loop motor operation, solar and battery power drive. Textile Mill, Steel Rolling Mill, Cement Mill, and Sugar Mill: Various stages and drive requirements control of ac motors for controlling torque. Introduction to Electric Drive Vehicle.

Electrical Drives and Control Laboratory (RCP23LLPE721)
List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To perform a speed control of D. C. Motor using Single phase fully and half controlled converter.
2. To study the operation of D. C. Drive in four quadrant mode.
3. To observe load voltage and load current waveform of shaded pole induction using A. C Voltage regulator.
4. To observe the speed control of three phase induction motor in vector control mode.
5. To study the working operation of dual converter with PMDC Motor.
6. To perform the MATLAB / SIMULINK model of closed loop speed control of dc motor using PID Controller.
7. To perform the MATLAB / SIMULINK model of Voltage Source Inverter fed Induction Motor Drive.
8. To perform the Step-up Chopper fed DC Drive using MATLAB / SIMULINK.
9. Design and Simulation of Three Phase Induction Motor at different load conditions
10. MATLAB / SIMULINK Model of Three Phase Permanent Magnet Synchronous Motor Drive
11. MATLAB /
    SIMULINK Model of Speed control of BLDC Motor using PID Controller
12. MATLAB / SIMULINK Model of Switched Reluctance Motor

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

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

Text Books

1. G. K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publishing House, 2^{nd} Edition, 2010.
2. B. R. Gupta, V. Singhal, “Fundamentals of Electric Drives and Control”, S. K. Kataria and Sons, Reprint 2013 Edition, 2013.

Reference Books

1. Krishnan, “Electric Motor Drives: Modeling Analysis and Control”, Pearson Education, 1^{st} Edition, 2015.
2. Vedam Subramanyam, “Electrical Drives”, McGraw Hill Education, 2^{nd} Edition, 2017.
3. B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson India Education, 1^{st} Edition, 2022.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Power System Stability (RCP23LCPE722)		
Power System Stability Laboratory (RCP23LLPE722)		

Prerequisite: Knowledge of Power System and Electrical Machines.

Course Objectives

1. To understand the fundamental concepts of power system stability, reliability, and security under steady-state and dynamic operating conditions.
2. To classify different types of power system stability based on the nature of disturbances and evaluation time, and analyze their impact on system performance.
3. To develop the ability to assess the stability of power systems using appropriate analytical methods and mathematical models for small-signal and transient stability studies.
4. To explore various methods and control techniques for enhancing power system stability and preventing instability in modern large-scale interconnected power systems.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the fundamental concepts of power system stability, reliability, and the application of electrical engineering principles in stability analysis.	L2	Understand
CO2	Analyze different types of power system stability based on the nature of disturbances, time frame of evaluation, and energy exchange characteristics.	L4	Analyze
CO3	Analyze the dynamic performance and stability characteristics of synchronous generators under small-signal and large disturbances.	L4	Analyze
CO4	Apply appropriate analytical methods and stability enhancement techniques to assess and improve the stability of interconnected power systems.	L3	Apply
CO5	Evaluate the stability performance of modern interconnected power systems using suitable engineering tools and recommend appropriate solutions for practical power system applications.	L5	Evaluate

Power System Stability (RCP23LCPE722)
Course Contents

Unit-I **09 Hrs.**

Introduction to stability: Rotor, voltage and frequency stability steady state transient & dynamic stability limits, Park's transformation equations, Analysis of transient and sub-transient state operation of salient and non-salient pole machines, phasor diagrams, voltage behind the transient and sub-transient impedances, time constants. Determination of parameters and time constants.

Unit-II **09 Hrs.**

Steady State Stability: SSSL of short transmission lines, Analytical and graphical methods of solutions, lossy lines effect of inertia conservative criterion, synchronizing co efficient multi machine system.

Unit-III **08 Hrs**

Factors Affecting Steady State Stability: Effect of saturation, saturated reactance, equivalent reactance, graphical method to find equivalent effect of short circuit ration effect of governor action, effect of automatic voltage regulator.

Unit-IV **08 Hrs.**

Transient State Stability: Review of transient stability, swing equation, assumption for swing equation and classical model , shortcoming of classical model, equal area criterion, critical cleaning angle and critical clearing time, point by point solution for transient stability.

Unit-V **08 Hrs.**

Factors Affecting Transient State Stability: Effects of types of fault, effect of grounding, effect of high speed reclosing Pre-calculated swing curves and their use, effects of fault clearing time, effects of excitation and governing action, Methods of improving stability, multi-machine problem .

Power System Stability Laboratory (RCP23LLPE722)
Laboratory Experiments

Suggested Experiments: (Any 8)

1. Determination of Parameters and time constants of synchronous machines.
2. Synchronous machine of infinite bus: Effect of Excitation
3. Effect of saturation and & determination of equivalent reactance of synchronous machines.
4. Retardation test on synchronous machines to find moment of inertia of rotating part and angular momentum.
5. To obtain power angle characteristics of lossy & lossless lines.
6. To study transient stability by point by point method.
7. To determine the steady state stability limit of short transmission line.
8. To determine SSSL of long transmission line.
9. Study of clerk's diagram.
10. Study of different types of automatic voltage regulator.

Minimum eight experiments from the above suggested list or any other experiment based on syllabus to be included, which would help the learner to apply the concept learnt.

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

Reference Books

1. Aderson and Ford, "Power System Operation and Control", IEEE
2. E .W. Kimbark , "Power Systems Stability", Vol- I & II , Wiley India Pvt Ltd
3. S. B.Cray , " Power System Stability" , John Wiley
4. Nagrath & Kothari , " Modern Power System Analysi",TMH
5. P. S Bimbhra, "Generalized Electrical Machinery", Khanna Publishers
6. Peter W. Sauer and M A Pai, "Power System Dynamics and Stability", Pearson Education.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Advanced Digital Signal Processing (RCP23LCPE723)		
Advanced Digital Signal Processing Laboratory (RCP23LLPE723)		

Prerequisite: Digital Signal Processing

Course Objectives:

1. To introduce the fundamentals of multirate digital signal processing and sampling rate conversion techniques used in modern signal processing systems.
2. To develop understanding of adaptive systems and adaptive filtering algorithms for solving real-time signal processing problems.
3. To familiarize students with linear prediction methods, optimum linear filters, and lattice filter structures for signal modeling and estimation.
4. To impart knowledge of wavelet transforms and multiresolution analysis for advanced applications such as denoising, compression, and time-frequency analysis.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the concepts of multirate digital signal processing including decimation, interpolation, and sampling rate conversion techniques used in speech and signal processing applications..	L2	Understand
CO2	Analyze adaptive systems and implement adaptive filtering algorithms such as LMS and RLS for applications including system identification, channel equalization, echo cancellation, and noise cancellation.	L4	Analyze
CO3	Apply linear prediction and optimum linear filtering techniques for signal modeling, prediction, and filter realization using lattice and Wiener filter structures.	L3	Apply
CO4	Apply wavelet transform techniques and multiresolution analysis for signal denoising, compression, speckle removal, and time-frequency analysis applications.	L3	Apply

Advanced Digital Signal Processing (RCP23LCPE723)
Course Contents

Unit-I **08 Hrs.**

Multirate DSP: Introduction and concept of Multirate Processing, Block Diagram of Decimator and Interpolator, Decimation and Interpolation by Integer Numbers, Spectra after decimation and Interpolation, Sampling Rate conversion by a Rational Factor I/D. Application: Subband coding of Speech Signals.

Unit-II **06 Hrs.**

Introduction to Adaptive systems: Introduction, Characteristics, Examples of Adaptive systems, Adaptive linear combiner-Description, Weight vectors, desired response and error, performance function, Gradient and minimum mean square error, Decorrelation of errors and Input Components.

Unit-III **08 Hrs**

Adaptive Algorithms and Applications: Adaptive Direct Form FIR Filters based on steepest descent method, Widrow Hoff LMS Adaptive algorithm, RLS algorithms. Applications: System Identification, Adaptive channel equalization, Adaptive echo cancellation, Adaptive noise cancellation.

Unit-IV **12 Hrs.**

Linear Prediction and Optimum Linear Filters: Forward and Backward Linear Prediction, Solution of Normal Equation (Levinson-Durbin and Schur Algorithm), AR Lattice and ARMA Lattice Ladder Filters, Weiner Filters for Filtering and Prediction.

Unit-V **08 Hrs.**

Wavelet Theory: Fourier Transform and its Limitations, Short Time Fourier Transform, Introduction to time frequency analysis, Continuous Wavelet Transform, Discrete Time Wavelet Transform, Multi-resolution analysis, Haar Wavelet, Daubechies Wavelet, Filter bank theory. Application of wavelet theory to signal denoising, speckle removal, and signal compression.

Advanced Digital Signal Processing Laboratory (RCP23LLPE723)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. To perform up sampling & down sampling by integer factors.
2. Convert a signal's sampling rate by a non-integer ratio (e.g.3/2).
3. Two-Channel Sub-band Coding of a Speech/Audio Signal
4. To perform Adaptive channel equalization,
5. To perform Adaptive echo cancellation
6. Unknown Channel Identification using LMS Algorithm
7. To Perform Noise Cancellation Using LMS Algorithm
8. Denoising a signal using Wavelet Transform
9. STFT vs. FT for Non-Stationary Signals(Speech Signals)
10. Speckle removal by Wavelet Transform
11. Signal compression by Wavelet Transform
12. Noise removal from ECG signal Using Digital Filter

Minimum eight experiments from the above suggested list or any other experiment based on syllabus to be included, which would help the learner to apply the concept learnt.

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

Text Books

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing", PHI, 2014.
2. Bernard Widrow and Samuel D.Strearns, "Adaptive Signal Processing", Pearson Edu Asia 2002.
3. Raghuveer. M. Rao and Ajit S.Bopardikar, "Wavelet Transforms -Introduction to theory and applications, Pearson Education, Asia, 2000.

Reference Books

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing- A Practical Approach," Pearson Education, 2nd Edition, 2002
2. Simon Haykin, "Adaptive Filter Theory," Pearson Education, 5th Edition, 2014.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VIII
Power System Dynamics (RCP23LCPE724)		
Power System Dynamics Laboratory (RCP23LLPE724)		

Pre-requisite: Fundamental of Electrical Energy Generation System, Power System Transmission and Distribution.

Course Objectives:

1. To understand the fundamental dynamic behavior of power systems to perform basic stability issues.
2. To acquire fundamental knowledge about modelling of synchronous machines.
3. To recognize the dynamic performance of power systems.
4. To familiarize with the power system stability and controls.
5. To realize about the impact of dynamics in power system.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Choose the fundamental dynamic behavior and controls of power systems to perform basic stability analysis.	L3	Apply
CO2	Comprehend concepts in modeling and simulating the dynamic phenomena of power systems Interpret results of system stability studies.	L3	Apply
CO3	Analyze theory and practice of modeling main power system components, such as synchronous machines, excitation systems and governors.	L4	Analyze
CO4	Analyze controlling of power system stability	L4	Analyze
CO5	Realize impact of dynamics on power system.	L3	Apply

Power System Dynamics (RCP23LCPE724)
Course Contents

Unit-I **8 Hrs.**

Basic Concepts: Power system stability states of operation and system security, system dynamics, problems system model analysis of steady State stability and transient stability, simplified representation of Excitation control.

Unit-II **8 Hrs.**

Modeling of Synchronous Machine: Synchronous machine, park's Transformation analysis of steady state performance, per unit quantities, Equivalent circuits of synchronous machine, determination of parameters of equivalent circuits

Unit-III **8 Hrs**

Excitation and Prime Mover Controllers: Excitation system, Excitation system modeling, excitation systems Standard block Diagram, system representation by state equations, Prime Mover Control Sys-tem.

Unit-IV **9 Hrs.**

Transmission Lines, SVC and Loads: Introduction to Transmission Lines, D-Q Transformation using Variables, Transmission Line Equations in Variables, Loads on Transmission Lines.

Unit-V **9 Hrs.**

Dynamics of a Synchronous Generator: System Model, Synchronous Machine Model, Application of Model, Calculation of Initial Conditions, System Simulation, Consideration of other Machine Models.

Power System Dynamics Laboratory (RCP23LLPE724)
List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Study and simulation of steady-state stability limit of a Single Machine Infinite Bus (SMIB) system using the Power-Angle Curve.
2. Simulation of transient stability of an SMIB system under three-phase fault conditions and determination of critical clearing angle and critical clearing time.
3. Modeling of a synchronous generator using Park's (d-q) Transformation and verification of machine equations in MATLAB/Simulink.
4. Determination of synchronous machine parameters and development of the equivalent circuit in per-unit system.
5. Modeling and simulation of IEEE Type-1 Excitation System and analysis of voltage regulation performance.
6. Modeling and simulation of Prime Mover and Turbine Governor Control System for frequency regulation.
7. Modeling of transmission lines using d-q variables and analysis of transmission line dynamics under different loading conditions.
8. Simulation and performance analysis of Static VAR Compensator (SVC) for voltage stability improvement in a transmission system.
9. Dynamic simulation of a synchronous generator connected to an infinite bus with excitation and governor controllers, and analysis of rotor angle, speed, terminal voltage, and electrical power responses.
10. Comparative study of power system stability with and without excitation control (AVR), governor control, and SVC under fault and load disturbance conditions.

Minimum eight experiments from the above suggested list or any other experiment based on syllabus to be included, which would help the learner to apply the concept learnt.

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

Reference Books

1. K. R. Padiyar,"Power System Dynamics, Stability and Control", BS Publications, 2nd Edition, 2008.
2. P. Kundur, "Power System Stability and Control", McGraw Hill 1995.
3. P. M. Anderson and A. A. Fouad, "Power System Control and Stability", Wiley India, 2nd Edition, 2008.
4. I.J. Nagrath, D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill, 1994.

Chakrabarti, M. L. Soni , P.V.Gupta, U. S. Bhatnagar, "Power System Engineering", Dhanpat Rai and Co., 2009.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VIII
Deep Learning (RCP23LCMD701)		
Deep Learning Laboratory (RCP23LLMD701)		

Pre-requisite: Linear Algebra, Calculus, Probability, Statistics and Machine Learning Basics.

Course Objectives:

1. To introduce students with the fundamental concepts of artificial neural network and different learning algorithms: supervised and unsupervised neural networks.
2. To expose Deep Network based methods to solve real world complex problems.
3. Develop in-depth understanding of the Transfer Learning, its key components, challenges and Applications.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze different neural network architectures and their learning algorithms.	L4	Analyze
CO2	Build solution using appropriate neural network and deep network models.	L6	Create
CO3	Analyze optimization strategies and regularization methods to enhance deep learning model training.	L4	Analyze
CO4	Evaluate and implement transfer learning techniques across various applications.	L5	Evaluate

Deep Learning (RCP23LCMD701)

Course Contents

Unit-I **7 Hrs.**

Introduction to Artificial Neural Learning:

Fundamental concepts of biological Neural Networks, NN Architectures, Important terminologies of ANN: Activation functions: (Sigmoid, Tanh, and ReLU, Leaky ReLU, GELU, Swish, ELU), weights, bias, threshold, learning rate, McCulloch Pitts Neuron: Theory and Architecture; Linear separability; Hebb Network: Theory and Algorithm.

Unit-II **7 Hrs.**

Supervised Learning Networks:

Perceptron: Representational power of Perceptron, The Perceptron Training Rule, Delta Rule; Multilayer Networks: Representational Power of Feedforward Networks; Backpropagation Algorithm: Convergence and local minima, Hypothesis space search and Inductive Bias, Generalization, Vanishing & Exploding Gradients.

Unit-III **7 Hrs**

Optimization for Training Deep Models:

Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies. Optimizers: Gradient Descent, Stochastic Gradient Descent, SGD with Momentum, SGD with Momentum, RMSProp, Adam.

Regularization for Deep Learning:

Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stooping, Sparse Representation, Dropout and Batch Normalization.

Unit-IV **7 Hrs.**

Convolutional Networks:

The Convolution Operation, sparse interactions, parameter sharing, Dataset Augmentation, Pooling, Variations of Heatmaps. Variants of Basic Convolution Function, Efficient Convolution Algorithms (AlexNet, LeNet-5, VGG, InceptionNet, ResNet, MobileNet (for lightweight models)), Attention Mechanisms in CNNs (Squeeze-and-Excitation (SE) Networks, CBAM).

Unit-V **7 Hrs.**

Unsupervised Learning Networks:

Kohonen Self-Organizing Feature Maps – architecture, training algorithm, Kohonen Self-Organizing Motor Map.

Autoencoders:

Sparse Autoencoder, Undercomplete Autoencoders, Regularized Autoencoders, Denoising

Autoencoders, Applications of Autoencoders. Variational Autoencoders (VAEs), Linear Factor Methods such as Probabilistic PCA and Factor Analysis, Independent Component Analysis, Deep Embedded Clustering (DEC)

Self-Supervised Learning:

Contrastive learning (SimCLR, CURL), Instance Discrimination Method.

Unit-VI **7 Hrs**

Transfer Learning:

Fundamental of Transfer Learning, Freezing, Fine-tuning. Transfer Learning Strategies: Inductive Transfer. Types of Deep Transfer Learning: Domain Adaptation, Domain Confusion, One-shot Learning, Zero-shot Learning. Types of Transferable Components: Instance transfer, Feature-representation transfer, Parameter transfer. Transfer Learning Challenges: Negative Transfer, Transfer Bounds. Model: CLIP, SAM (Segment Anything Model). Applications: Transfer learning for NLP/ Audio/ Speech/ Computer Vision

Deep Learning Laboratory (RCP23LLMD701)

List of Laboratory Experiments

Suggested Experiments: (Any 8)

1. Implement Boolean gates using perceptron.
2. Implement backpropagation algorithm from scratch.
3. Monitoring and evaluating deep learning models using Tensorflow and Keras.
4. Evaluate and analyze Prediction performance using appropriate optimizers for deep learning models.
5. Building CNN models for image categorization. (medical image analysis)
6. Implement Graph Convolutional Networks (GCN) for Node Classification and Link Prediction
7. Implement contrastive learning on unlabeled data
8. Anomaly detection using Self-Organizing Network.
9. Compare the performance of PCA and Autoencoders on a given dataset.
10. Transfer Learning with Pre-trained CNN model as a Feature Extractor for Image Classification with a Data Availability Constraint
11. Zero-shot Image Classification using CLIP & Few-shot Learning with DINO

Minimum eight experiments from the above suggested list or any other experiment based on syllabus to be included, which would help the learner to apply the concept learnt.

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

Text Books:

1. Christopher M. Bishop, Hugh Bishop, “Deep Learning Foundations and concept”, Springer Cham, 1st Edition, 2023.
2. S. N. Sivanandam and S. N. Deepa, “Introduction to Soft Computing”, Wiley India Publications, 3rd Edition, 2018.
3. Ian Goodfellow and Yoshua Bengio and Aaron Courville, “Deep Learning”, An MIT Press, 2016.
4. Simon Haykin, “Neural Networks and Learning Machines”, Pearson Prentice Hall, 3rd Edition, 2010.

Reference Books:

1. François Chollet, "Deep Learning with Python", Manning Publication, 2nd edition, 2021.
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Publication, 2017.
3. Andrew W. Trask, Grokking, "Deep Learning", Manning Publication, 2019.
4. John D. Kelleher, "Deep Learning", MIT Press Essential Knowledge series, 2019.

Web Links:

1. Learning Rule: http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/explist.php
2. ANN Virtual Lab: http://cse22-iiith.vlabs.ac.in/List%20of%20experiments.html
3. Deep Learning: https://vlab.spit.ac.in/ai/#/experiments
4. NPTEL Course: Deep Learning Part 1:
   https://onlinecourses.nptel.ac.in/noc19_cs85/preview

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Research Ecosystem (RCP23ITELX08)		

Prerequisite:

1. Basic understanding of Engineering concepts and problem-solving techniques.
2. Fundamental knowledge of project-based learning, data analysis, and domain-specific tools.
3. Basic exposure to project development, technical report writing, and emerging technologies.

Course Objectives:

1. To understand and identify complex engineering, societal, and industrial problems suitable for research through structured analysis of literature, patents, and real-world needs.
2. To learn and apply advanced research methodologies–including experimental, simulation-based, and data-driven approaches–for designing and validating engineering solutions.
3. To gain proficiency in selecting and using appropriate tools, software, and platforms (AI/ML, simulation, CAD, IoT, etc.) for experiment design, data acquisition, and performance evaluation.
4. To transform research insights into innovative prototypes, products, or startup concepts by engaging with innovation ecosystems, TRLs, and funding mechanisms.
5. To analyze socio-technical systems, ethics, and sustainability implications of engineering solutions, ensuring responsible and impactful outcomes.
3. To integrate systems thinking, multidisciplinary perspectives, policy awareness, future technology trends, and technical documentation skills to develop comprehensive research proposals and outputs (papers, patents, reports).

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze complex engineering and societal problems through literature and patent analysis to identify research gaps.	L4	Analyze
CO2	Apply advanced research methods and tools to acquire data and assess solution performance.	L3	Apply
CO3	Apply innovation frameworks and Technology Readiness Levels (TRL) for prototype and startup development.	L3	Apply
CO4	Analyze ethical, socio-technical, and sustainability issues related to engineering solutions.	L4	Analyze
CO5	Analyze multidisciplinary knowledge for engineering research proposal preparation.	L4	Analyze

Research Ecosystem (RCP23ITELX08)
Course Contents

Unit-I **06 Hrs.**

Research Gap Identification & Advanced Problem Formulation

- Identifying high-impact problems from:
  - Industry and Society
  - Emerging technologies (AI, IoT, Blockchain, EV, etc.)
- Research gap identification techniques:
  - Systematic Literature Review (SLR)
  - Patent analysis Defining objectives, scope, constraints, and feasibility of the identified problem
- Writing problem statement for:
  - • Research paper
  - • Product/Startup idea

Activities:

- Convert Industry/ Societal problem into research problem.
- Analyze research articles and extract research gaps.

Unit-II **06 Hrs.**

Experimental Design, Tools & Validation Techniques

- Advanced research methodologies:
  - Experimental, simulation, data-driven, design thinking
- Tool selection:
  - Computational tools and software, simulation and analysis platforms, system prototyping and testing platforms
- Data acquisition:
  - Data collection interfaces, Principles of data cleaning and organization (primary / secondary data)
- Validation techniques:
  - • Accuracy and performance metrics
  - • Benchmarking with existing solutions
- Result interpretation & visualization

Activities:

- Selection of Research Design for final year project.
- • Apply evaluation metrics (e.g., ML model accuracy, system efficiency).

Unit-III **06 Hrs**

Research to Innovation, Product & Startup Ecosystem

- Research → Prototype → Product → Startup lifecycle
- Intellectual Property Rights (IPR), patents, copyrights

- Technology readiness levels (TRL)
- Case studies:
    - AI startups, EV ecosystem, Smart Cities
- Industry-academia collaboration models
- Funding opportunities (grants, incubation, government schemes -
- Anusandhan National Research Foundation (ANRF))

Activities:

- Convert project into startup idea or product pitch.
- Analyze failure of a technology/product.

Unit-IV **06 Hrs.**

Socio-Technical Systems, Ethics & Sustainability

- Socio-technical systems: Interaction of people, technology and environment
- Ethical issues:
    - Plagiarism, AI bias, data privacy
- Sustainability in Engineering:
    - Green practices, resource optimization and lifecycle considerations
- Impact assessment:
    - Social, economic, environmental
    - Policies and governance (data protection laws, standards and compliance requirements)

Activities:

- Case study: Facial recognition ethics / smart surveillance.
- Impact analysis of student's own project.

Unit-V **06 Hrs.**

Integrated Research, Policy and Future Engineering Challenges

- Systems thinking and holistic analysis
- Multidisciplinary problem solving:
    - Healthcare tech, climate tech, smart mobility
- Writing research proposals:
    - Problem → Methodology → Expected outcomes
- Future trends:
    - AI ethics, Quantum computing, Industry 5.0 / 6.0
- Scaling solutions from lab to society

Activities:

- Capstone Task:
    - Identify real-world problem.
    - Apply research methodology.
    - Propose:
        - ❖ Technical solution
        - ❖ Societal impact
        - ❖ Possible commercialization

Continuous Assessment (CA) Guidelines:

The CA shall consist of continuous assessment based on tutorials activities and a final group presentation.

a) Part A (25 Marks):

Each student shall complete a minimum of five tutorials based on the syllabus topics during the semester. The tutorials may include activities such as research gap identification, literature survey, case study analysis, tool-based experimentation, impact analysis, technical report writing, and innovation-oriented problem solving.

b) Part B (25 Marks):

Students shall work in groups and select a project/research topic based on emerging engineering, industrial, or societal challenges. The group presentation shall include:

a. Identification of a real-world problem
b. Application of appropriate research methodology
c. Proposed technical solution
d. Analysis of societal impact
e. Possible commercialization/startup opportunities

Reference Books:

1. Kothari, C. R., Research Methodology: Methods and Techniques, New Age International Publishers, New Delhi, 2023.
2. Booth, W. C., Colomb, G. G., Williams, J. M., Bizup, J., & FitzGerald, W. T., The Craft of Research, University of Chicago Press, Chicago, 2024.
3. Montgomery, D. C., Design and Analysis of Experiments, Wiley, New York, 2020.
4. Singh, Pooja, Katiyar, Aman, Rawat, Shalini, Dhuri, Archana, Research Methodology and IPR, RK Publications, India, 2025.
5. Blok, Vincent (Ed.), Putting Responsible Research and Innovation into Practice: A Multi-Stakeholder Approach, Springer Cham, Switzerland, 2022.

Web References:

1.• Research Methodology: Quantitative Methods and Computer Application
(https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_ma02)

2.• Research Methodology and IPR
(https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed28)

3.• Research and Publication Ethics
(https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ge46)

4.• Research Ethics and Plagiarism
(https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ge26)

5.• Quantitative and Mixed Methods Research for Management

(https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg21)

6.• Doing Qualitative Research

(https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ge61)

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Project Stage-II (RCP23IPEL701)		

Prerequisite:

Course Objectives:

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

Course Outcomes:

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

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Project Stage-II (RCP23IPEL701)
Course Contents

Syllabus:

The primary objective is to meet the milestones formed in the overall project plan decided in Project Stage-I. The idea presented in Project Stage-I should be implemented in Project Stage-II with results, conclusion and future work.

Guidelines:

- Each student group is required to maintain a separate log book for documenting various activities of the project (Refer Table 1).
- 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 50% of project stage-II.
- In the second review of this semester, each group is expected to complete 100% of project stage-II.

Assessment Criteria:

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

Prescribed Project Stage-II Report Guidelines:

The size of the report shall be of minimum 45 pages (excluding the cover and front pages). The Project Stage-II report should include appropriate content for:

- Abstract
- Introduction
  - Background
  - Motivation
  - Problem Statement
  - Objectives
  - Scope

- Literature Survey
  - Review of Existing System(s)
  - Limitations of Existing System(s)
- Proposed System
  - Analysis/Framework/ Algorithm
  - Details of H/W and S/W required
  - Design details
  - Methodology (your approach to solve problem)
- Coding / Implementation
- Testing
- Conclusion
- References

Assessment criteria for Continuous Assessment:

Guide will monitor weekly progress and marks allocation will be as per Table 2.

Assessment criteria for End Semester Exam:

Departmental committee will evaluate project as per Table 3.

Table 1: Log Book Format

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

Table 2: Continuous Assessment Sheet

S.N	PRN	Name of Student	Student Attendance [10 Marks]	Logbook Maintain [10 Marks]	Implementation [10 Marks]	Testing [10 Marks]	Report [10 Marks]	Total Marks [50]

Table 3: Evaluation Sheet

S.N	Exam Seat No	Name of Student	Project Selection [10 Marks]	Design / Simulation / Logic [10 Marks]	PCB / Hardware / Programming [10 Marks	Result Verification [10 Marks]	Presentation [10 Marks]	Total Marks [50]

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Disaster Management and Preparedness (RCP23ICHSX09)		

Course Objectives:

1. To provide basic understanding hazards, disaster and various types and categories of disaster occurring around the world.
2. To identify extent and damaging capacity of a disaster.
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand roles and responsibilities of individual and various organization during and after disaster.
5. To appreciate the significance of GIS, GPS in the field of disaster management.
6. To understand the emergency government response structures before, during and after disaster.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply disaster management principles & guidelines.	L3	Apply
CO2	Conduct risk assessments.	L4	Analyze
CO3	Develop community awareness & participation.	L6	Create
CO4	Utilize Science & Technology tools (GIS, GPS).	L3	Apply
CO5	Prepare disaster management plans.	L6	Create

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Disaster Management and Preparedness (RCP23ICHSX09)
Course Contents

Unit-I **06 Hrs.**

Understanding Disasters & Hazards:

- **Definition and types of disasters:** Natural, Man-made and hybrid disasters,
- **Study of Natural disasters:** Flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion etc.
- **Study of Human/Technology Induced Disasters:** Chemical, Industrial and Nuclear disasters, internally displaced persons, road and train accidents Fire Hazards, terrorism, militancy,
- Hazard & Vulnerability profiles of India (seismic zones, flood-prone areas).
- India's vulnerability to disasters, and the impact of disasters on National development.

Unit-II **06 Hrs.**

Disaster Risk Reduction (DRR) & Mitigation:

- **Disaster Management Cycle:** Prevention, Mitigation, Preparedness, Response, Recovery. Need for disaster prevention and mitigation, mitigation guiding principles, challenging areas, structural and non-structural measures for disaster risk reduction.
- Risk Assessment & Vulnerability Analysis.
- **Science & Technology:** Use of information management, Geo informatics like RS, GIS, GPS and remote sensing mitigation measure..

Unit-III **04 Hrs**

Disaster Preparedness & Response:

- Preparedness Planning, Early Warning Systems (EWS), & Communication.
- Emergency Response: Search & Rescue, Logistics, Medical Aid.
- Psychological Response & Management (Trauma, Stress).
- Role of IT, Media, Govt., NGOs, & Community. .

Unit-IV **04 Hrs.**

Recovery, Rehabilitation & Reconstruction:

- Post-disaster damage assessment.
- Rehabilitation, Reconstruction, & Livelihood Restoration.
- Sanitation, Hygiene, & Waste Management. .

Unit-V **04 Hrs.**

Policy, Governance & Capacity Building:

- National Disaster Management Authority (NDMA) & Legislation.
- Institutional Mechanisms & Community Mobilization.
- Non-Structural Mitigation: Community based disaster preparedness, capacity development and training, awareness and education, contingency plans..

Unit-VI **04 Hrs**

Case studies on disaster (National /International):

- Case study discussion of National Disasters: Tsunami (2004), Bhopal gas tragedy, Kerala and Uttarakhand flood disaster, 26th July 2005 Mumbai flood
- Case study discussion of International Disasters: Hiroshima – Nagasaki (Japan),
- Cyclone Phailin (2013), Fukushima, Daiichi nuclear disaster (2011), Chernobyl meltdown

Reference Books and Reports:

1. Disaster Management, by Harsh K. Gupta, Universities Press Publications (2003).
2. Disaster Management: An Appraisal of Institutional Mechanisms in India, by O. S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. Introduction to International Disaster Management, by Damon Copolla, Butterworth Heinemann Elsevier Publications (2015).
4. Disaster Management Handbook, by Jack Pinkowski, CRC Press, Taylor and Francis group (2008).
5. Disaster management & rehabilitation, by Rajdeep Dasgupta, Mittal Publications, New Delhi (2007).
6. Natural Hazards and Disaster Management, Vulnerability and Mitigation, by R B Singh, Rawat Publications (2006).
7. Concepts and Techniques of GIS, by C. P. Lo Albert, K.W. Yonng, Prentice Hall (India) Publications (2006).
8. Risk management of natural disasters, by Claudia G. Flores Gonzales, KIT Scientific Publishing (2010).
9. Disaster Management – a disaster manger's handbook, by W. Nick Carter, Asian Development Bank (2008).
10. Disaster Management in India, by R. K. Srivastava, Ministry of Home Affairs, GoI, New Delhi (2011)
11. The Chernobyl Disaster: Legacy and Impact on the Future of Nuclear Energy, by Wil Mara, Marshall Cavendish Corporation, New York, 2011.

12. The Fukushima 2011 Disaster, by Ronald Eisler, Taylor & Francis, Florida, 2013.

(Learners are expected to refer reports published at national and international level and updated information available on authentic web sites.)

Program: Electrical Engineering	Final Year B. Tech.	Semester: VII
Solar Energy and Electrical System Design (RCP23LCSC701)		

Coursera Course 01: Solar Energy and Electrical System Design

Link: https://www.coursera.org/programs/nmims-university-faculty-development-program-kjd4b/learn/solar-energy-and-electrical-system-design?authProvider=nmims&source=search

Number of hours: 17 Hrs, Intermediate level

About the Course:

This course supplies learners with the insights necessary for properly planning, and therefore successfully installing, a photovoltaic (PV) system per design specifications. It directs learners through the important steps of initial site inspection and evaluating appropriate locations for PV systems, and features unique elements of residential, small, industrial and utility-scale solar applications. The course probes key design concerns – including load, efficiency, and mechanical and electrical design – as well as aesthetics and tools for planning. Learners experiment with calculations needed to design a PV system, exercising newly gained knowledge about site selection, layout, code compliance, system components, and wire sizing.

This course is targeted for engineers who have interest in entering the solar power sectors. It is also appropriate for HVAC installers, architects and building code inspectors. Learners should have a basic grasp of electrical engineering, physics and mathematical concepts. Those who are unfamiliar with how PV works, the elements of a PV system, and/or solar power ROI should take the first course of the specialization, Solar Energy Systems Overview.

Material includes online lectures, videos, demos, hands-on exercises, project work, readings and discussions. This is the second course in the Solar PV for Engineers, Architects and Code Inspectors specialization.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the principles of photovoltaic (PV) system planning, site assessment, and selection of suitable locations for residential, commercial, industrial, and utility-scale solar installations.	L2	Understand
CO2	Analyze solar energy requirements, load profiles, system efficiency, and environmental factors to determine appropriate PV system configurations.	L4	Analyze
CO3	Design photovoltaic systems by selecting suitable system components, performing electrical and mechanical design calculations, wire sizing, and layout planning in accordance with applicable codes and standards.	L3	Understand
CO4	Evaluate PV system designs considering aesthetics, code compliance, installation constraints, safety requirements, and overall system performance.	L5	Apply
CO5	Develop a complete photovoltaic system design project by integrating site analysis, component selection, design calculations, and documentation to meet specified performance requirements.	L6	Apply

Solar Energy and Electrical System Design (RCP23LCSC701)

Course Contents

Detailed Syllabus:

Unit-I **04**

PV Design Basics

Learners will explore site inspection considerations, shade calculations, roof assessments, solar panel location and spacing, floodplains, power line and battery locations, circuit boxes, pros and cons of rooftop and ground-mounted systems, and considerations related to commercial and utility scale solar applications.

Unit-II **03**

PV Design Considerations:

Students will learn about system loads and efficiency, wind and weight loading, how to calculate the proper size for lag bolts, measuring excess capacity, and considerations related to ballast systems.

Unit-III **04**

Electrical System Design:

Students will learn about system sizing considerations and calculations.

Unit-IV **03**

Recommendation Options:

Students will learn about aesthetics considerations and tools for PV planning

Unit-V **03**

System Design Project: Theory to Practice:

Students will apply their learning to perform system design calculations.

Evaluation Scheme:

Continuous Assessment (CA):

- Course Completion Certification: 15 marks
- Faculty-curated Test: 15 marks
- Assignments / Case Study: 10 marks

Semester- VIII

Program: Electrical Engineering	**Final Year B. Tech.**	**Semester: VIII**
HVDC Transmission (RCP23LCPE811)		

Prerequisite: Power System, Power Electronics.

Course Objectives

1. Impart knowledge related to the concept, planning of DC power transmission and comparison with AC Power transmission.
2. To analyze High Voltage Direct Current (HVDC) converters.
3. To study about the HVDC system control.
4. To possess knowledge related voltage stability in DC system.
5. To meet desired needs the recent technology in in DC system.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply basic transmission concepts to compare the advantages of DC transmission over AC transmission.	L3	Apply
CO2	Analyze the operation of Line Commutated Converters and Voltage Source Converters.	L4	Analyze
CO3	Analyze different the control strategies used in HVDC trans mission system.	L4	Analyze
CO4	Analyze power system stability using an HVDC system	L4	Analyze
CO5	Evaluate the multi terminal HVDC transmission system	L5	Evaluate

HVDC Transmission (RCP23LCPE811)
Course Contents

Unit-I **9 Hrs.**

DC Transmission Technology: Comparison of AC and DC Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVDC Systems. Components of HVDC system. Line Commutated Converter and Voltage Source Converter based systems.

Unit-II **8 Hrs.**

HVDC Converter: Choice of converter configuration, analysis of Gratz circuit with and without over lap, working of converter as rectifier and inverter, equivalent circuit for HVDC link

Unit-III **8 Hrs**

HVDC System Control: HVDC System Control: Principles of DC link control, converter control characteristics, firing angle control, current and extinction angle control, Starting and stopping of HVDC link.

Unit-IV **9 Hrs.**

Converter Faults and Protection: short circuit in bridge, Over current and over voltage protection, Detection of line faults, Principle of DC circuit interruption, DC breakers, Types and characteristics of DC breakers, effects of proximity of AC and DC transmission lines.

Unit-V **8 Hrs.**

MTDC Links: Multi Terminal and Multi In feed Systems. Series and Parallel MTDC systems using LCCs. MTDC systems using VSCs. Modern Trends in HVDC Technology. Introduction to Modular Multi level Converters.

Text Books

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 33rd Edition, 2017.
2. S. Rao„ "EHVAC and HVDC Transmission Engineering and Practice", Khanna Publications, 33rd Edition, 1993

Reference Books

1. T J. Arrillaga, "High Voltage Direct Current Transmission", Institution of Electrical Engineers, 23nd Edition, 2008.
2. E. W. Kimbark, "Direct Current Transmission", Wiley Interscience, 1971.
3. Kimbark, "HVDC Transmission", John Willey and Sons.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VIII
EHVAC Transmission (RCP23LCPE812)		

Prerequisite: Electrical Machine, Power System, High voltage Engineering

Course Objectives

1. To Understand the Urgency of Energy Needs in Developing Countries: Explore the critical nature of energy requirements in developing countries and the impact of these needs on national policies.
2. Analyze Geographical Disparities in Power Generation: Examine the factors contributing to the placement of power stations far from load centers.
3. Examine the Requirement for High Voltage Transmission: Investigate the necessity for very high voltages in the transmission of electric power over extended distances.
4. Evaluate the Evolution of DC Transmission Technology: Explore the historical development of DC transmission since 1950. Assess the rapid strides made in this technology and its role in facilitating extra-long distance power transmission. Understand how DC transmission complements or supplements existing Extra High Voltage Alternating Current (EHVAC) transmission systems.
5. Appraise the Role of Transmission Technologies in Global Energy Relations: Analyze how national policies related to energy, particularly in developing countries, influence relationships with other nations.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the need and significance of EHVAC transmission systems in power networks.	L2	Understand
CO2	Analyze line parameters and ground effects in EHVAC transmission systems.	L4	Analyze
CO3	Analyze the environmental impact of high voltage trans mission systems.	L4	Analyze
CO4	Apply appropriate techniques related to EHVAC transmission in electrical engineering applications.	L3	Apply
CO5	Explain the phenomenon of corona and its effects on EHV transmission systems.	L2	Understand

EHVAC Transmission (RCP23LCPE812)
Course Contents

Unit-I **9 Hrs.**

Introduction to Transmission Line Trends: Basic aspects of AC Power Transmission, Need for HV transmission lines, Role of EHV AC Transmission, Power handling capacity and line loss, Examples on giant power pools and number of lines, Cost of Transmission Lines and equipment, Mechanical considerations in line performance types of vibrations and oscillations.

Unit-II **8 Hrs.**

Calculation of Line and Ground Parameters: Resistance of conductors, Temperature rise of conductors and current carrying capacity, Properties of bundled conductors, Inductance of EHV line configurations, line capacitance calculations, sequence inductance and capacitances.

Unit-III **8 Hrs**

Voltage Gradient of Conductors: Electrostatic, Field of a point charge and its properties, Field of sphere gap, Field of line charges and their properties, charge potential relations for multi conductor lines, Maximum charge condition on a three phase line. Surface voltage gradient on conductors single conductor, two conductors bundle, Maximum surface voltage gradient, Mangled formula, design of cylindrical cages for corona gradients.

Unit-IV **9 Hrs.**

Electrostatic and Magnetic Fields of EHV Lines: Electric shock and threshold currents, Effects of high electrostatic fields on humans, animals and plants, Calculation of electrostatic field of single circuit of three phase line, Profile of electrostatic field of line at ground level. Electrostatic field of a double circuit 3 phase AC line, Insulated ground wire and induced voltage in insulated ground wires. Magnetic field calculation of horizontal configuration of single circuit of three phase lines, Effects of power frequency magnetic fields on human health.

Unit-V **8 Hrs.**

Corona and its Effects: Corona formation, visual critical voltage, corona power loss, corona loss formulae, charge voltage diagram, increase in effective radius of conductor and coupling factors, attenuation of travelling waves due to corona loss. Audible noise – generation and characteristics, limits for audible noise, measurement and meters microphones, weighting networks.

Text Books

1. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", New Age Interna tional Publishers, 33rd Edition, 2007.

Reference Books

1. A. Chakrabarti, D. P. Kothari, A. K. Mukhopadhyay, "Performance Operation and Control of EHV Power Transmission Systems", Wheeler Publishing, 1999.

2. S. Rao, "EHV-AC, HVDC Transmission and Distribution Engineering", Khanna Publishers, 33rd Edition, 2017.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VIII
Restructured Power System (RCP23LCPE813)		

Prerequisite: Electrical Energy generation System, Transmission and Distribution of Electrical Power and Power system Analysis.

Course Objectives

1. To familiarize the students with concepts and need for deregulated power systems.
2. To impart the knowledge of power market development in India and across the world.
3. To understand the key factors in equipment specification and system design.
4. To Explain Transmission Congestion Management, Financial Transmission Rights, Pricing of transmission network usage.
5. To understand different Ancillary Services and reforms in Indian power sector.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the need, objectives, and driving factors for power system restructuring worldwide.	L2	Understand
CO2	Explain the roles and responsibilities of various entities in the electricity market.	L2	Understand
CO3	Analyze key issues in electricity markets such as congestion management, transmission pricing, and ancillary services.	L4	Analyze
CO4	Apply concepts of electricity markets to interpret power market scenarios in India.	L3	Apply
CO5	Analyze locational marginal pricing (LMP) and financial transmission rights (FTR) in power markets.	L4	Analyze

Restructured Power System (RCP23LCPE813)
Course Contents

Unit-I **9 Hrs.**

Introduction to Restructuring of Power Industry: Mesh and Supermesh analysis, Node and Supernode analysis, Deregulation of power industry, unbundling of electric utilities, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models, Market Mechanism.

Unit-II **8 Hrs.**

Power System Operation in Competitive Environment: Role of the independent system operator, Operational planning activities of ISO: ISO in Pool markets, ISO in Bilateral markets, Operational planning activities of a GENCO: GENCOs in Pool and Bilateral markets, market participation issues, competitive bidding.

Unit-III **8 Hrs**

Transmission Congestion Management: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods, Calculation of ATC, Non market methods Market methods Nodal pricing Inter zonal and Intra zonal congestion management Price area congestion management Capacity alleviation method.

Unit-IV **9 Hrs.**

Ancillary Service Management and Pricing of Transmission Network: Introduction of ancillary services, Types of Ancillary services classification of Ancillary services, Load generation balancing related services, Voltage control and reactive power support devices, Black start capability service, ancillary service, Co-optimization of energy and reserve services, International comparison, Transmission pricing, Principles, Classification, Role in transmission pricing methods, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and demerits of different paradigm.

Unit-V **9 Hrs.**

Power Market Development in India: Institutional structure in Indian Power sector, generation, trans mission and distribution utilities.SO and LDCs. PFC, REC, ERCs, traders, Power Exchanges and their roles. Availability based tariff, Open access, Industry structure and regulatory framework, market development, RE Policies, RPO, Tariff policies. Policy changes, regulatory changes, Critical issues / challenges before the Indian power sector and Power Trading.

Reference Books

1. Kirschen and Goran Strbac,"Fundamentals of Power System Economics Daniel", John Wiley and Sons Ltd, 2004.
2. Loi Lei Lai, "Power System Restructuring and Deregulation", Wiley India, 2018.
3. Kankar Bhattacharya, Jaap E. Daalder ,Math Bollen, "Operation of Restructured Power Systems", Springer Publication, 2001.
4. Mohammad Shahidehpour and Muwaffaq Alomoush, "Restructured Electrical Power Systems: Operation, Trading and Volatility" , CRC Press; 1^{st} Edition, 2017

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Program: Electrical Engineering	Final Year B. Tech.	Semester: VIII
Optimization Techniques (RCP23LCPE814)		

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

Course Objectives

1. To give students the basic knowledge and tools to recognize, classify and solve different questions related to optimization problems as they appear in engineering.

2. Topics to be covered include basics of convex analysis, least squares, linear and quadratic programs, semi definite programming, optimality conditions, duality theory, and interior point methods.

3. Applications to a variety of electrical engineering problems will be presented.

4. The emphasis will be on training students to translate question in optimization to the correct mathematical formalization and to apply the correct techniques to solve such questions.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Formulate engineering problems as optimization problems for effective analysis and solution.	L3	Apply
CO2	Apply fundamental optimization theories to solve problems related to power systems.	L3	Apply
CO3	Analyze various optimization tools and techniques used to solve engineering problems.	L4	Analyze
CO4	Analyze and apply different optimization techniques in electrical engineering applications.	L4	Analyze
CO5	Formulate engineering problems into appropriate mathematical optimization models and apply suitable solution techniques.	L4	Analyze

Optimization Techniques (RCP23LCPE814)
Course Contents

Unit-I **9 Hrs.**

Introduction to Optimization: Introduction, Historical Development, Engineering Applications of Optimization, Statement of Optimization Problem.

Unit-II **8 Hrs.**

Linear Programming: Simplex Method, Revised Simplex Method, Duality, and Sensitivity Analysis.

Unit-III **8 Hrs.**

Non Linear Programming: One Dimensional Minimization, Elimination Methods. Fibonacci Method, Golden Section Method, Interpolation Methods, Quadratic and Cubic Interpolation Methods

Unit-IV **9 Hrs.**

Unconstrained Optimization Methods: Univariate and Pattern Search Methods, Rosen brocks Method of Rotating Coordinates, Simplex Method. Descent Methods, Steepest Descent Method, Conjugate Gradient Method (Fletcher Reeves Method), Davidon Fletcher Powell Method.

Unit-V **8 Hrs.**

Constrained Optimization: Complex Method, Cutting Plane Method, and Method of Feasible Directions, Integer Programming, Quadratic Programming, and Introduction to Genetic Algorithm.

Text Books

1. S. S.Rao "Engineering Optimization: Theory andApplications", NewAge International Publishers, Revised 3^{rd} Edition, 2005.
2. Chander Mohan, Kusum Deep, "Optimization Techniques", New Age International Publishers, 2^{nd} Edition, 2023.

Reference Books

1. H. A. Taha, "Operation Research", Pearson Education, 9^{th} Edition, 2014.
2. R. L. Fox, "Optimization Methods for Engineering Design", Addison Wesley, 1971.
3. D. E. Goldberg, "Genetic Algorithms in Search, Optimisation, and Machine Learning", Addison Wesley, 1989.
4. Himmelblau, D.M. "Applied Nonlinear Programming", McGraw Hill, 1972.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VIII
DC Microgrid and Control System (RCP23LCPE815)		

Prerequisite: Fundamental of Power electronics, Power system and Control system

Course Objectives:

1. To understand the fundamental concepts of microgrid and its components, types of microgrids, advantages of microgrid compared to the central conventional grid.

2. To understand general concepts and application, control strategies and principle of operation of DC microgrid.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the concepts of microgrids.	L2	Understand
CO2	Develop PV model for power systems and standard grid tied inverter.	L6	Create
CO3	Analyze the significance of energy management in micro grid system.	L4	Analyze
CO4	Analyze control strategies for DC microgrids.	L4	Analyze
CO5	Analyze stability issues in microgrid.	L4	Analyze

DC Microgrid and Control System (RCP23LCPE815)
Course Contents

Unit-I **9 Hrs.**

Introduction to Microgrid: Overview of microgrids, concept of microgrid, Microgrid and distributed generation, Microgrid vs Conventional Power System, AC and DC Microgrid with Distributed Energy Resources.

Unit-II **8 Hrs.**

Power Electronics for Micro grid: Power Electronics for Micro grid, Power Electronic Converters in Micro grid Applications, Power Electronic Converters in Micro grid Applications (Power Electronic for Interfacing), Converter Modulation Techniques, Modeling of converters in micro grid power system (AC /DC and DC/AC Converters Modeling), DC/DC Converter Modeling and Control, Modeling of Renewable Energy Resources (Modeling of Wind Energy System, Photovoltaic System), Modeling of Energy Storage System.

Unit-III **8 Hrs**

Microgrid Dynamics: Microgrid Dynamics and Modeling, Operation Modes and Standards, Microgrid Control Architectures, Intelligent Microgrid Operation and Control, Energy Management in Microgrid System.

Unit-IV **9 Hrs.**

DC Microgrid Control System: DC Microgrid System Architecture and AC Interface, DC Microgrid Dynamics and Modelling, Control of DC Microgrid System, Applications of DC Microgrids.

Unit-V **9 Hrs.**

Stability in Microgrid: Stability in Microgrid, Stability Analysis of DC Microgrid, DC Microgrid sta bilization strategies (passive damping method, Impedance/Admittance stability criteria), DC microgrid stabilization using nonlinear Techniques.

Text Books

1. Fusheng Li, Ruisheng Li, Fengquan Zhou, Microgrid Technology and Engineering Application, Elsevier, 1st Edition, 2015.
2. Hassan Bevrani, BrunoFrançois, Toshifumi Ise,Microgrid Dynamics and Control JohnWiley Sons, 1st Edition, 2017.

Reference Books

1. S. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks", Institution of Engi neering and Technology, 2nd Edition, 2009.

Program: Electrical Engineering	Final Year B. Tech.	Semester: VIII
Internship (OJT) cum Project (RCP23IPELX10)		

Prerequisite:

1. Fundamental knowledge of engineering concepts and programming
2. Basic understanding of professional ethics and communication skills
3. Exposure to laboratory courses and mini-projects
4. Teamwork and problem-solving skills

Course Objectives:

1. To provide practical exposure to industrial and professional environments.
2. To bridge the gap between academic learning and industry practices.
3. To develop technical, communication, teamwork, and managerial skills.
4. To enable application of engineering knowledge for solving real-world problems.
5. To familiarize students with modern tools, technologies, and professional ethics.
6. To prepare students for industry-oriented careers through project implementation and professional experience.

Course Outcomes: On completion of the course, learner will be able to:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply engineering knowledge and technical skills in industrial environments.	L3	Apply
CO2	Analyze and solve practical engineering problems using appropriate tools and techniques.	L4	Analyze
CO3	Demonstrate professional ethics, teamwork, communication, and organizational skills	L3	Apply
CO4	Utilize modern engineering tools and technologies for assigned tasks and projects.	L3	Apply
CO5	Prepare technical reports, presentations, and project documentation effectively.	L6	Create
CO6	Adapt to professional work culture and demonstrate readiness for professional careers.	L3	Apply

Internship (OJT) cum Project (RCP23IPELX10)
Course Contents

Overview of the OJT Process

The On-Job Training (OJT) program begins with an introduction to workplace ethics, safety practices, organizational culture, and professional conduct to prepare students for industrial environments. Students are then exposed to industrial processes, workflow practices, tools, and modern technologies relevant to their domain of study.

During the technical training phase, students work on assigned industrial tasks and projects under the guidance of faculty mentors and industry supervisors. The program emphasizes the application of engineering concepts, teamwork, communication skills, and problem-solving abilities in real-world professional settings.

The later stages of the OJT focus on project implementation, report writing, technical documentation, and presentation preparation. Students are required to maintain logbooks and progress records throughout the training period. At the end of the semester, students present their project work through demonstrations and viva-voce examinations, followed by comprehensive evaluation and feedback.

Internship (OJT) Schedule, Duration and Credits

The Internship / On-Job Training (OJT) cum Project is an integral part of the Final Year B.Tech. program and carries a total of 18 academic credits toward completion of the degree requirements.

Each credit corresponds to 40 hours of work, resulting in approximately 550–600 hours of industrial training and project work over one semester.

The full-time OJT program is conducted during the designated semester as per the academic schedule. The duration of the OJT is one complete semester in the final year. Faculty mentors are assigned for mentoring, monitoring, and evaluating students throughout the OJT period.

Approximately 50% of the students undergo OJT during Semester VII while the remaining students continue academic activities in the institute. In Semester VIII, the arrangement is interchanged to ensure equal academic and industrial exposure for all students.

To avoid academic scheduling conflicts and ensure fair evaluation, oral, practical, and End Semester Examinations for both Semester VII and Semester VIII will be conducted at the end of Semester VIII. Students are issued a combined mark sheet covering both semesters.

Types of External OJT Opportunities

Sr. No	Type of OJT	Examples / Description
1	Industry OJT	Industrial internships with or without stipend.
2	Government / PSU OJT	BARC, SAMEER, Railways, ISRO, etc.
3	Research OJT	IITs, NITs, IISc, IIMs, and other research institutes.
4	Institute-Based OJT	OJT at institutes approved by DJSCE and departments.
5	Other Approved OJT	Any approved industrial/research work relevant to the domain.

OJT / Internship Sources

To facilitate OJT and internship opportunities, AICTE has signed Memorandums of Understanding (MoUs) with various industries, government organizations, and training institutions. These collaborations provide students with industrial exposure, skill development opportunities, research internships, and professional training through multiple recognized platforms and organizations.

Students may also approach organizations such as the Board of Apprenticeship Training (BOAT) and Board of Practical Training (BOPT) for additional training opportunities.

Major OJT / Internship Sources

Sr. No.	Organization / Platform	Nature of Opportunity
1	Internshala	Internship and industry training opportunities
2	NETiit (Taiwan)	International internship opportunities
3	HireMee	Skill-based internships and employability support
4	IGNCA	Research and cultural project opportunities
5	CCEI, Republic of Korea	International innovation and creative economy internships
6	IIWM, Bangalore	Waste management and sustainability projects
7	Engineering Council of India (ECI)	Engineering and professional development activities
8	Fourth Ambit	Industry training and technical internships
9	LinkedIn	Professional networking and internship opportunities
10	Telecom Sector Skill Council (TSSC)	Telecom and communication technology training
11	SCHOLARSMERIT	Internship and skill enhancement programs
12	Studenting Era	Student internship and academic support activities

13	MSME	Industry exposure and entrepreneurship opportunities
14	BOAT	Apprenticeship and industrial training programs
15	BOPT	Practical and apprenticeship-based training opportunities

Evaluation Metrics

Sr. No.	Evaluation Component	Marks
1	Internal Review 1	100
2	Final Internal Review	100
3	End Semester Evaluation (OJT Viva / Presentation)	200
Total		**400**

Evaluation Parameters

The student shall be evaluated based on the following parameters:

- Understanding of assigned work.
- Progress and task completion.
- Technical skill development.
- Learning ability and initiative.
- Professional behaviour and discipline.
- Communication and presentation skills.
- Problem solving and contribution.
- Quality of work and innovation.
- Logbook maintenance and report documentation.
- Application of engineering knowledge.

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Necessary Documents

Students are required to submit and maintain the following documents during the OJT period:

1. No Objection Certificate (NOC)
2. Undertaking for opting OJT
3. OJT Joining Form
4. Parent/Guardian Undertaking Form
5. Contact Details and OJT Objectives Form
6. Student Logbook / Daily Activity Record
7. Internal Review Evaluation Sheets
8. External Supervisor Evaluation Form
9. Internal Supervisor Feedback Form
10. Student Feedback Form
11. SDG Mapping Form
12. Final OJT Report
13. Project Report and Presentation
14. OJT Completion Certificate

Scheme of Examination

Component	Marks
Continuous Internal Assessment	200
End Semester OJT Evaluation (Report & Presentation)	200
Total	**400**

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Program: Electrical Engineering	**Final Year B. Tech.**	**Semester: VII**
Magnetics for Power Electronic Converters (RCP23LCSC801)		

Coursera Course 01: Magnetics for Power Electronic Converters

Link: https://www.coursera.org/programs/nmims-university-faculty-development-program-kjd4b/learn/magnetics-for-power-electronic-converters-v2?authProvider=nmims&source=search

Number of hours: 16 Hrs, Intermediate level

About the Course:

This course provides a comprehensive understanding of the analysis, modeling, and design of magnetic components used in modern power electronic converters. Magnetic components such as inductors, transformers, and coupled inductors are fundamental building blocks of switching power supplies, renewable energy systems, electric vehicle chargers, UPS systems, and industrial power converters. The course begins with the fundamentals of magnetic circuits, magnetic materials, inductance, and transformer principles, enabling learners to understand the interaction between magnetic devices and power electronic converters. Emphasis is placed on developing mathematical models for inductors and transformers that accurately predict converter performance under practical operating conditions.

The course further focuses on advanced magnetic component design techniques, including the analysis of AC copper losses caused by skin effect and proximity effect, which become significant at high switching frequencies. Learners gain hands-on knowledge of designing inductors using the Geometric Constant (Kg) method and designing high-frequency transformers while optimizing core and copper losses. The course equips students with the ability to select suitable magnetic materials, estimate losses, optimize efficiency, and design reliable magnetic components for high-frequency switching converters. By the end of the course, students will be capable of analyzing, designing, and optimizing magnetic devices that satisfy electrical, thermal, and efficiency requirements in practical power electronic applications.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the principles of magnetic circuits, magnetic materials, inductors, and transformers used in switching power converters.	L2	Understand
CO2	Analyze magnetic circuits and evaluate the performance of inductors and transformers using appropriate mathematical models.	L4	Analyze
CO3	Calculate AC copper losses due to skin effect and proximity effect in high-frequency magnetic windings.	L3	Apply
CO4	Design inductors and coupled magnetic components using the Geometric Constant (Kg) method for specified converter requirements.	L6	Create
CO5	Design and optimize high-frequency transformers by minimizing core and copper losses while meeting efficiency and thermal constraints.	L6	Create

Magnetics for Power Electronic Converters (RCP23LCSC801)

Course Contents

Detailed Syllabus:

Unit-I **05**

Basic Magnetics

Magnetics are an integral part of every switching converter. Often, the design of the magnetic devices cannot be isolated from the converter design. The power electronics engineer must not only model and design the converter, but must model and design the magnetics as well. Modeling and design of magnetics for switching converters is the topic of this course. In this module, basic magnetics theory is reviewed, including magnetic circuits, inductor modeling, and transformer modeling. This provides the technical tools needed in the remainder of the course to understand operation of magnetic devices, model their losses, and design magnetic devices for switching converters.

Unit-II **04**

AC Copper Losses

Eddy currents also cause power losses in winding conductors. This can lead to copper losses significantly in excess of the value predicted by the dc winding resistance. The specific conductor eddy current mechanisms are called the "skin effect" and the "proximity effect". These effects are most pronounced in high-current conductors of multilayer windings, particularly in high-frequency converters. This module explains these physical mechanisms and provides practical methods to compute these losses.

Unit-III **04**

Inductor Design

The goal of this chapter is to design inductors for switching converters. Specifically, magnetic elements such as filter inductors are designed using the Geometric Constant (Kg) method. The maximum flux density Bmax is specified in advance, and the element is designed to attain a given copper loss. Both single-winding inductors and multiple-winding elements such as coupled inductors and flyback transformers are considered.

Unit-IV **03**

Transformer design

In a substantial class of magnetic applications, the operating flux density is limited by core loss rather than saturation. For example, in a conventional high-frequency transformer, usually it is necessary to limit the core loss by operating at a reduced value of the peak ac flux density. Hence, design of core-loss-limited magnetic devices is characterized by finding the ac flux density that minimizes total core plus copper loss. This module considers the design of transformers and ac inductors for switching converters, including minimization of total loss. Design examples include the isolation transformers of a full bridge two-output converter and of an isolated Cuk converter.

Evaluation Scheme:

Continuous Assessment (CA):

- Course Completion Certification: 15 marks
- Faculty-curated Test: 15 marks
- Assignments / Case Study: 10 marks

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