Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering
SoE & Syllabus 2018
3rd to 8th Semester
Electrical Engineering

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

SoE No. EL-202.1

B.TECH SCHEME OF EXAMINATION 2020-21

(Revised Scheme of Examination w.e.f. 2022-23 onward)

Electrical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
TOTAL FIRST & SECOND SEM										47				
Third Semester														
1	3	BS	GE2201	Engineering Mathematics III	T	3	0	0	3	3	30	20	50	3 Hours
2	3	PC	EL2201	Analog Electronics	T	3	0	0	3	3	30	20	50	3 Hours
3	3	PC	EL2202	Lab. : Electronics Engineering Workshop	P	0	0	2	2	1		60	40	
4	3	PC	EL2203	Electrical Machines	T	4	0	0	4	4	30	20	50	3 Hours
5	3	PC	EL2204	Lab.:Electrical Machines	P	0	0	2	2	1		60	40	
6	3	PC	EL2205	Network Analysis	T	3	0	0	3	3	30	20	50	3 Hours
7	3	PC	EL2206	Lab.:Computer Programming	P	0	0	2	2	1		60	40	
8	3	PC	EL2207	Electrical Measurement & Instrumentation	T	3	0	0	3	3	30	20	50	3 Hours
9	3	PC	EL2208	Lab.:Electrical Measurement & Instrumentation	P	0	0	2	2	1		60	40	
				TOTAL		**16**	**0**	**8**	**24**	**20**				
Fourth Semster														
1	4	BS	GE2204	Advance Mathematical Techniques	T	3	0	0	3	3	30	20	50	3 Hours
2	4	PC	EL2251	Electrical Machines in Power System	T	3	0	0	3	3	30	20	50	3 Hours
3	4	PC	EL2252	Lab.:Electrical Machines in Power System	P	0	0	2	2	1		60	40	
4	4	PC	EL2253	Electrical Energy Generation System	T	3	0	0	3	3	30	20	50	3 Hours
5	4	PC	EL2254	Lab.:Renewable Energy System	P	0	0	2	2	1		60	40	
6	4	PC	EL2255	Electric & Magnetic Fields	T	3	0	0	3	3	30	20	50	3 Hours
7	4	PC	EL2256	Lab.:Electrical Engineering Workshop	P	0	0	2	2	1		60	40	
8	4	PC	EL2257	Microprocessor	T	3	0	0	3	3	30	20	50	3 Hours
9	4	PC	EL2258	Lab.:Microprocessor	P	0	0	2	2	1		60	40	
10	4	PC	EL2259	Signals & Systems	T	4	0	0	4	4	30	20	50	3 Hours
				TOTAL		**19**	**0**	**8**	**27**	**23**				
List of Audit Courses														
1	3	HS	GE2121	Env Studies for 3 Sem. EL,ET,CT	A	3	0	0	3	0				
2	3	HS	AU2123	YCCE Communication Aptitude Preparation (YCAP3)	A	3	0	0	3	0				
3	4	HS	AU2125	YCCE Communication Aptitude Preparation (YCAP4.2) for EL,EE,ET	A	3	0	0	3	0				

MSEs* = Two MSEs of 15 Marks each will conducted and marks of these 2 MSEs will be considered for Continuous Assessment

TA ** = for Theory : 5 marks on lecture quizzes, 11 marks on TA2+TA4 activitied decided by course teacher, 4 marks on class attendance

TA = for Practical : MSPA will be 15 marks each**

		June 2022	1.05
Chairperson	Dean (Acad. Matters)	Date of Release	Version

Applicable for AY 2022-23 Onwards

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Electrical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Fifth Semester														
1	5	HS	GE2312	Fundamental of Economics	**T**	3	0	0	3	3	30	20	50	3 Hours
2	5	PC	EL2301	Power Electronics	**T**	3	0	0	3	3	30	20	50	3 Hours
3	5	PC	EL2302	Lab.:Power Electronics	**P**	0	0	2	2	1		60	40	
4	5	PC	EL2303	Fundamentals of Power System	**T**	3	0	0	3	3	30	20	50	3 Hours
5	5	PC	EL2304	Electrical Drives	**T**	3	0	0	3	3	30	20	50	3 Hours
6	5	PC	EL2305	Lab.:Electrical Drives	**P**	0	0	2	2	1		60	40	
7		OE		Open Elective - I *	**T**	3	0	0	3	3	30	20	50	3 Hours
8	5	OE		Open Elective - II *	**T**	3	0	0	3	3	30	20	50	3 Hours
				TOTAL		**18**	**0**	**4**	**22**	**20**				
Audit Courses														
1	5	HS	AU2127	YCCE Communication Aptitude Preparation (YCAP5.2) for EL,EE,ET	**A**	3	0	0	3	0				

Open Electives -I

1	5	OE	EL2311	OEI:Renewable Energy Generation System
2	5	OE	EL2312	OEI:Electrical Machines and their Applications
3	5	OE	EL2313	OEI:Testing and Maintenance of Electrical Machines
4	5	OE	EL2314	OEI: Solar power plant design and Installation

Open Electives -II

4	5	OE	EL2321	OEII:Electrical Energy Audit and Safety
5	5	OE	EL2322	OEII:Utilization of Electrical Energy
6	5	OE	EL2323	OEII:Power System Engineering

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TA = for Practical : MSPA will be 15 marks each**

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SoE No. EL-202.1

B.TECH SCHEME OF EXAMINATION 2020-21

(Revised Scheme of Examination w.e.f. 2022-23 onward)

Electrical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Sixth Semester														
1	6	HS	GE2311	Fundamental of Management	**T**	3	0	0	3	3	30	20	50	3 Hours
2	6	PC	EL2351	Control System	**T**	3	0	0	3	3	30	20	50	3 Hours
3	6	PC	EL2352	Lab.:Control System	**P**	0	0	2	2	1		60	40	
4	6	PC	EL2353	Power System Analysis	**T**	3	0	0	3	3	30	20	50	3 Hours
5	6	PE		**Professional Elective I**	**T**	3	0	0	3	3	30	20	50	3 Hours
6	6	PE	EL2354	**Lab.**:Simulation of Power Electronics & Power System	**P**	0	0	2	2	1		60	40	
7	6	OE		**Open Elective III ***	**T**	3	0	0	3	3	30	20	50	3 Hours
8	6	OE		**Open Elective IV ***	**T**	3	0	0	3	3	30	20	50	3 Hours
9	6	PC	EL2355	Lab.:Substation Design	**P**	0	0	2	2	1		60	40	
10	5/6	STR	EL2360	**Industry Visit and its report**	**P**	0	0	0	0	1		60	40	
					TOTAL	**18**	**0**	**6**	**24**	**22**				

Professional Electives -I

1	6	PE	EL2361	**PEI:**Advanced Power Electronics
2	6	PE	EL2362	**PEI**:Electrical Distribution in Power System
3	6	PE	EL2363	**PEI:**Illumination Engineering (MOOC)
4	6	PE	EL2364	**PEI:**Electric Vehicles
5	6	PE	EL2365	**PEI**:Electric Power Utilization
6	6	PE	EL2366	**PEI:** Grid Integration of Renewable Energy
7	6	PE	EL2367	**PEI:** Switched Mode Power Supply
8	6	PE	EL2368	**PEI:** Programming in C for beginners

Open Electives -III

9	6	OE	EL2371	**OEIII**:Renewable Energy Generation System
10	6	OE	EL2372	**OEIII**:Electrical Machines and their Applications
11	6	OE	EL2373	**OEIII**:Testing and Maintenance of Electrical Machines
12	6	OE	EL2374	**OEIII**:Solar power plant design and Installation

Open Electives -IV

13	6	OE	EL2381	**OEIV:**Electrical Energy Audit and Safety
14	6	OE	EL2382	**OEIV**:Utilization of Electrical Energy
15	6	OE	EL2383	**OEIV**:Power System Engineering
16	6	OE	EL2384	**OEIV**: Electrical Wiring: Estimation and Costing

Audit Courses											
1	6	HS	AU2128	YCCE Communication Aptitude Preparation (YCAP6.1) for CV,EL	**A**	3	0	0	3	0	

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TA = for Practical : MSPA will be 15 marks each**

		June 2022	**1.05**
Chairperson	**Dean (Acad. Matters)**	**Date of Release**	**Version**

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B.TECH SCHEME OF EXAMINATION 2020-21

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Electrical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Seventh Semester														
1	7	PC	EL2401	Switchgear & Protection	**T**	3	0	0	3	3	30	20	50	3 Hours
2	7	PC	EL2402	Lab.:Switchgear & Protection	**P**	0	0	2	2	1		60	40	
3	7	PC	EL2403	High Voltage Engineering	T	3	0	0	3	3	30	20	50	3 Hours
4	7	PC	EL2404	Lab.:High Voltage Engineering	**P**	0	0	2	2	1		60	40	
5	7	PE		**Professional Elective II**	**T**	3	0	0	3	3	30	20	50	3 Hours
6	7	PE		**Professional Elective III**	**T**	3	0	0	3	3	30	20	50	3 Hours
7	7	PE		**Professional Elective IV**	**T**	3	0	0	3	3	30	20	50	3 Hours
8	7	STR	EL2409	Mini Project	**P**	0	0	4	4	2		60	40	
9	7	STR	EL2410	Campus Recrutment Training (CRT)	**P**	0	0	0	0	2		100		
					TOTAL	**15**	**0**	**8**	**23**	**21**				

Professional Electives -II

1	7	PE	EL2411	**PEII:** Fundamentals of Power Quality
2	7	PE	EL2412	**PEII:**Electrical Installation Design
3	7	PE	EL2413	**PEII:**Electrical Machine Design
4	7	PE	EL2421	**PEII:** Power System Operation and Control
5	7	PE	EL2422	**PEII:** Sensors and Actuators

Professional Electives -III

5	7	PE	EL2422	**PEIII**:FACTS Devices
6	7	PE	EL2423	**PEIII**: Electrical Energy Management and Audit
7	7	PE	EL2424	**PEIII:**Advanced Control System
8	7	PE	EL2425	**PEIII:**Artificial Intelligence Based System

Professional Electives -IV

9	7	PE	EL2431	**PEIV:**Advanced Electrical Drives
10	7	PE	EL2432	**PEIV**:Fundamentals of Smart Grid
11	7	PE	EL2433	**PEIV**:Computer Methods in Power System
12	7	PE	EL2434	**PEIV**:EHVAC-HVDC Transmission

Coursera Electives				
1	6	PE	EL2366	**PEI**:Energy Production, Distribution and Safety
1	7	PE	EL2435	**PEIV**: Power Electronics Specialization

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		June 2022	**1.04**
Chairperson	**Dean (Acad. Matters)**	**Date of Release**	**Version**

Applicable for AY 2020-21 Onwards

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SoE No. EL-202.1

B.TECH SCHEME OF EXAMINATION 2020-21

(Revised Scheme of Examination w.e.f. 2022-23 onward)

Electrical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Eigth Semester														
1	8	STR	EL2451	Major Project	**P**	0	0	12	12	9		60	40	
2	8	STR	EL2452	Extra curricular Activity Evaluation	**P**	0	0	0	0	1		100		
				TOTAL		**0**	**0**	**12**	**12**	**10**				
				GRAND TOTAL		**86**	**0**	**46**	**132**	**163**				

MSEs* = Two MSEs of 15 Marks each will conducted and marks of these 2 MSEs will be considered for Continuous Assessment

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TA = for Practical : MSPA will be 15 marks each**

		June 2022	**1.05**	**Applicable for AY 2022-23 Onwards**
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Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Technology

SoE & Syllabus 2020

3rd Semester

Electrical Engineering

28 June 2019

III Semester

GE2201 - Engineering Mathematics III

Objectives	Outcomes
1. Able to find numerical solution of various mathematical equations 2. Give knowledge of Laplace transform, Z transform, Fourier transform 3. Define the periodic functions in the form of Fourier series 4. Solve partial differential equations	The student will be able to: 1. Estimate the Calculus of Numerical Function. 2. Determine transforms and inverse transforms of various functions of variables and use it to solve Mathematical equations. 3. Discuss the nature of periodic function and express it in terms of series. 4. Use appropriate method/s to solve partial differential equations.

Unit I: Finite Differences

Difference table; Operators E and Δ, Central differences, Factorials notation, Numerical differentiation and integration, Difference equations with constant coefficients. **(6 hours)**

Unit II: Laplace Transform

Laplace Transforms: Laplace transforms and their simple properties, Unit step function, inverse of Laplace transform, convolution theorem, Applications of Laplace transform to solve ordinary differential equations .**(7 hours)**

Unit III: Z-transform

Z-Transform definition and properties (with proof), inversion by partial fraction decomposition and residue theorem, Applications of Z-transform to solve difference equations with constant co-efficient. **(6 hours)**

Unit IV: Fourier Series

Periodic Functions and their Fourier series expansion, Fourier Series for even and odd function, Change of interval, half range expansions **(7 hours)**

Unit V: Partial Differential Equation

Partial Differential Equations of first order first degree i.e. Lagrange's form, linear homogeneous equations of higher order with constant coefficient. Application of variable separable method to solve first and second order partial differential equations. **(7 hours)**

Unit VI : Fourier Transform : Definition: Fourier Integral Theorem, Fourier sine and cosine integrals, Finite Fourier sine & cosine Transform Parseval's Identity, convolution Theorem**.** **(6 hours)**

Text Books:

SNo	Title	Edition	Authors	Publisher
1	Advance Engineering Mathematics	9th Edition (September 2009)	Kreyszig.	Wiley
2	Higher Engineering Mathematics	40th edition, (2010)	B.S. Grewal	Khanna Publishers (2006)
3	Advanced Engineering Mathematics	8th revised edition, 2007	H.K. Dass	Publisher: S.Chand and Company Limited

Reference Books:

SNo	Title	Edition	Authors	Publisher
1	Mathematics for Engineers	19th edition, (2007)	Chandrika Prasad.	John Wiley & Sons
2	Advanced Mathematics for Engineers	4th edition, (2006)	Chandrika Prasad	John Wiley & Sons
3	Applied Mathematics for Engineers	3rd edition, (1970)	L.A. Pipes and Harville	McGraw Hill
4	A text Book of Applied Mathematics	3rd edition, (2000)	P.N. and J.N. Wartikar	Pune Vidyarthi Griha Prakashan
5	A text book of Engineering Mathematics	Reprint 2008	N.P. Bali and Manish Goyal	Laxmi Prakashan

III Semester
EL2201 - Analog Electronics

Course Objective	Course Outcomes
After taking this course, the student should be able to analyze, simulate, and design single and multistage amplifiers. Design of single, multistage, and op-amp amplifier are covered in detail including analysis of biasing techniques, frequency response compensation, feedback, stability, noise and nonlinearity	The student will be able: 1. To identify the basic structure, characteristics and various operating modes of BJT 2. To Explain and Describe the various small signal parameters and its applications 3. To demonstrate the knowledge to develop various power amplifier and oscillator circuit. 4. To analyse and evaluate the basic concept of Op-Amp circuit and its various applications.

UNIT-1: Bipolar Junction Transistors (BJT)
BJT, Theory of operation, characteristics, Biasing arrangements (CB, CE, CC modes), operating modes , Stability factor, Transistor as a switch.

UNIT-2: Small Signal Analysis
Small signal analysis of CE, CB, CCmodes and their comparison, AC equivalent circuit, transistor equivalent circuit-CE, Hybrid equivalent model, Analysis of a transistor using h-parameter, emitter follower, RC coupled amplifier, low frequency response of an RC coupled stage

UNIT-3 :Power & Feedback Amplifier
Introduction to Power Transistors, Power amplifiers- classification as A,B, AB, C, Push pull amplifiers, Cross over distortion, Positive and Negative amplifiers- classification, feedback amplifiers, advantages and applications.

UNIT-4:Oscillator Circuits
Basic principle of sinusoidal oscillator, R-C Phase Shift and Wein Bridge oscillators, Tuned oscillators- Collpits and Hartley; Crystal oscillator

UNIT-5 : Operational Amplifier (OA)
Simple linear circuit: Inverting, non-inverting , buffer amplifier, summer integrator , differentiator, log, antilog, Multiplier, instrumentation amplifier, grounding and shielding problem in instrumentation amplifier. Precision rectifier, RMS to DC conversion, constant current and voltage sources, Sinusoidal oscillator with frequency and amplitude stabilization elementary , idea of active filter with Butterworth second order filter design procedure.

UNIT-6: Applications of Operational Amplifier
Applications of Operational amplifier for clipping, clamping, comparator circuit with non-linear components, Multiplexers, Demultiplexer, Astable, Mononstable, Bistable multivibrator circuits using OpAmp, sample/ hold circuits,D/A and A/D conversion circuits.

III Semester
EL2201 - Analog Electronics

Text Books:

SNo.	Title	Authors	Publisher
1	Electronic Principles,	A.P. Malvino,	Tata Mcgraw Hill Publications
2	Electronics : Analog & Digital	I. J. Nagrath	PHI Publication
3	Linear Application Handbook	National Semiconductors	
4	Operational Amplifiers	Dailey	Tata McGraw Hill
5	Introduction to Operational Amp	Wait	Tata McGraw Hill
6	Designing with Op- Amps	France	Tata McGraw Hill

Reference Books:

SNo.	Title	Authors	Publisher
1	Electronic devices and circuits	Jacob Millman, and C.C. Halkias	TMH Publications
2	Introduction to Semiconductor	M. S. Tyagi	John Wiley & Sons Inc
3	Materials and Devices		
4	Solid State Electronic Devices	Ben G. Streetman,	PHI, 5th Ed, 2001

III Semester
EL2202 - Lab. : Electronics Engineering workshop w

Course Objective	Course Outcomes
To expose printed circuit board (PCB) design, fixing of components on PCB, testing of components and circuits	1. This course gives the basic introduction of electronic hardware systems. 2. It provides hands-on training with familiarization, identification, testing, assembling, dismantling of various components. 3. Student can identify the active and passive electronic components 4. Testing of electronics components like Resistor, Capacitor, Diode, Transistor, UJT and JFET using multimeter. 5. PCB fabrication and repairing such systems by making use of the various tools and instruments available in the Electronics Workshop.

Mapped program outcomes							

Practical based on following topics :-

Minimum eight practical based on following are to be set up :-

Expt. No.	Experiments based on
01	Design and fabrication of PCB
02	Design of voltage regulators
03	Design of different timers using operational amplifiers.
04	Study and testing of diodes
05	Study and testing of transistors
06	Study and testing of MOSFET, IGBT
07	Study and testing of Thyristor, power diodes
08	Study and testing of power transistors
09	Study and testing of operational amplifiers, LEDs.ICs etc

III Semester
EL2203 - Electrical Machines w

Course Objective	Course Outcomes
The course objective is to impart knowledge of • The basic principle of transfer of electrical power, operation, construction of 3-phase transformers, their classification, connections and phasor diagrams. • The basic principle, construction, operation, Performance characteristics, steady state analysis and applications of electrical motors andinduction generator.	Students will be able to 1. Demonstrate the knowledge of Operation of single phase and auto-transformer. Develop, analyse and evaluate vector diagrams and performance indices of single phase transformer. 2. Explain Construction, vector grouping, testing and examine the need of parallel operation of three phase transformers 3. Explain and examine principle, construction, types, operation, speed control, characteristic and applications of DC machines and evaluate performance parameters of d.c.machines 4. .Explain and examine principle, construction, operation, starting, speed control ,applications and evaluate the performance indices of induction motors.
Mapped program outcomes:1,2,3	

UNIT 1: ELECTRO MAGNETISM: (6)
Magnetic Field, Magnetic Flux, Magnetic Flux Density, Permeability, Relation between magnetic flux density and field intensity, magnetic field due to current carrying conductor and a coil, Right hand grip rule, Force on a current carrying conductor placed in a magnetic field, Flemings Left hand Rule, Magnetomotive Force, Magnetic Field Strength, Reluctance, Magnetization curves of magnetic materials, Magnetic hysteresis and hysteresis loss, Eddy current and loss, leakage flux and fringing, Faraday's laws of electromagnetic induction, Lenz's Law, Flemings's Right hand rule, Types of induced EMF.

UNIT-2: SINGLE PHASE TRANSFORMER (10)
Phasor diagram of transformer on no load and on load, Load Test, Open circuit and short circuit test on 1 phase transformer, equivalent circuit of transformer, Efficiency and condition for maximum efficiency, Regulation and Efficiency using O.C. & S.C. data, Autotransformer operation, kVA rating of autotransformer.

UNIT-3: THREE PHASE TRANSFORMER (08)
Types of 3 phase transformers, Construction, Labelling of terminals, Vector Groups, Polarity marking & Test, Transformer connections and their comparative features, Open Delta Connection, parallel operation of single and three phase transformers, All day efficiency

UNIT-4 D.C. GENERATOR: (08)
Construction, Magnetic structure, Field and Armature systems, Field and Armature windings (Both Lap and Wave Types),EMF Equation, Characteristics and applications of different types of D.C. Generators, Building of Emf in D.C. Shunt generator, Armature reaction, commutation, straight line commutation, inter-poles, compensating winding.

III Semester
EL2203 - Electrical Machines w

UNIT 5: D.C. MOTOR: **(08)**

Principle, Torque Equation, Characteristics and applications of various types of D.C. Motors, Starting of D.C. Motors, Speed control of Series and Shunt motors, Power flow in DC machines, Losses and Efficiency in D.C. machines,

UNIT 6 :THREE PHASE INDUCTION MOTOR **(10)**

Equivalent circuit, No load and blocked rotor tests and determination of parameters of equivalent circuit, Losses and efficiency. Starting, Speed control, Crawling and cogging, Double cage induction motor: principle, construction, torque slip characteristics. Induction Generator: principle, isolated operation, double fed induction generator, applications

Text Books:

SNo	Title	Edition	Authors	Publisher
1	Electrical Machines	2nd -1993	Dr. P. K. Mukherjee and S. Chakravarti	Dhanpat Rai Publications (P) Ltd
2	Electrical Machines	3rd -2010	I.J.Nagrath and Dr. D.P.Kothari	Tata McGraw Hill
3	Electric Machines		Ashfaq Husain	Dhanpat Rai Publications (P) Ltd.

Reference Books:

SNo	Title	Edition	Authors	Publisher
1	D.C. Machines		Langsdorf	
2	Electrical Machines and Transformers		Nasser Syed	
3	Laboratory manual for Electrical machines		Dr. D.P. Kothari and Prof. Umre	.S. S.CHAND

III Semester
EL2204 - Lab.: Electrical Machines w

Course Objective	Course Outcomes
	The student will be able to understand the 1. Circuit connections, selections of measuring instruments and their position in the circuit to determine the circuit quantities 2. Evaluation of performance indices, equivalent circuit parameters and variation of the performance on loading of single phase and three phase transformance, induction motors and DC shunt motors 3. Magnetizing characteristics of the DC Generator, Critical Field resistance and speed of the machine 4. Various methods of speed control of DC shunt motor and three phase wound rotor induction motor

Mapped program outcomes	a	b	c	f	g	h	j

Minimum Eight Practical are to be performed out of the following :-

Expt. No.	Experiments based on
01	To perform load test on 1-phase transformer to determine its efficiency and voltage regulation.
02	To perform Open Circuit and Short Circuit tests on a 1-phase transformer to evaluate efficiency and voltage regulation.
03	To perform back to back test on two identical 1-phase transformers.
04	To study conversion of a 2-winding transformer into an autotransformer.
05	To study phasing out and polarity marking of a 3-phase transformer.
06	To study voltage and current relations in a 3-phase, Delta-Star connected transformer.
07	To perform Open Circuit and Short Circuit test on a 3-phase transformer.
08	To plot magnetization characteristic of a DC generator.
09	To study speed control of a DC shunt motor by varying – (a) field excitation and (b) armature voltage
10	To perform load test on a DC shunt motor.
11	To study measurement of slip of a 3-phase induction motor by different method.
12	To study control of a 3-phase slip-ring induction motor by – (a) variation of a rotor resistance and (b) varying supply voltage
13	To perform load test on a 3-phase induction motor by indirect loading.
14	To perform load test on a 3-phase induction motor by direct loading.
15	To perform No-Load and Blocked rotor tests on a 3-phase induction motor.
16	To perform No-Load and Blocked rotor tests on a 1-phase induction motor.
17	To study Induction generator operation.

III Semester
EL2205 - Network Analysis

Course Objective	Course Outcomes
The basic objective of this course is to introduce students to the fundamental theory and mathematics for the analysis of electrical circuits. Through the material presented in this course, students will learn: • The fundamental principles of electrical circuit analysis and to be able to extend these principles into a way of thinking for problem solving in mathematics, science, and engineering • To become adept at using various methods of circuit analysis, including simplified methods such as series-parallel reductions, voltage and current dividers, and the mesh - node method. • To appreciate the consequences of linearity, in particular the principle of superposition and Thevenin - Norton equivalent circuits. • To analyze analog circuits that include energy storage elements. • To utilize Laplace transforms for circuit analysis. • To analyze four terminal networks using two-port parameters.	Upon successful completion of this course, students should be able to: 1) Define basic concepts related to the course of network analysis. 2) 2) Select best possible method of circuit analysis for a given situation. 3) Apply a variety of circuit analysis methods including theorems and Laplace transform. 4) Design circuits for a given voltage, power, as well as for critical frequencies and two port parameters

Mapped program outcomes							

UNIT 6 :THREE PHASE INDUCTION MOTOR (10)

Equivalent circuit, No load and blocked rotor tests and determination of parameters of equivalent circuit, Losses and efficiency. Starting, Speed control, Crawling and cogging, Double cage induction motor: principle, construction, torque slip characteristics. Induction Generator: principle, isolated operation, double fed induction generator, applications

UNIT-1: NODAL ANALYSIS OF ELECTRIC CIRCUITS

Basics of electric circuits, circuit elements and their voltage – current relationship, classification of circuit elements, sources - their types and characteristics, concept of equivalent sources, source transformation, concept of supernode and V – shift, nodal analysis of circuits containing resistors, inductors, capacitors, transformers, and both independent and dependent sources to determine current, voltage, power, and energy.

UNIT-2: : MESH ANALYSIS OF ELECTRIC CIRCUITS

Concept of supermesh and I – shift, mutual inductance, coefficient of coupling, dot convention, dot marking in coupled coils, mesh analysis of circuits containing resistors, inductors, capacitors, transformers, and both independent and dependent sources to determine current, voltage, power, and energy.

UNIT-3 :NETWORK THEOREM

Superposition Theorem, Thevenin"s Theorem, Norton"s Theorem, Maximum Power Transfer Theorem.

III Semester
EL2205 - Network Analysis

UNIT-4: INITIAL AND FINAL CONDITIONS, IMPEDANCE FUNCTIONS AND CIRCUIT ANALYSIS WITH LAPLACE TRANSFORM

Concept of initial and final conditions, behavior of resistor, inductor and capacitor at t = 0- and at t = 0+, procedure for evaluating initial and final conditions, analytical treatment.

Review of Laplace Transform, concept of complex frequency, transform impedance and admittance, s – domain impedance and admittance models for resistor, inductor and capacitor, series and parallel combinations of elements. Transformed network on loop and mesh basis, mesh and node equations for transformed networks, time response of electrical network with and without initial conditions by Laplace transform.

UNIT-5:TRANSFORMS OF OTHER SIGNAL WAVEFORMS, NETWORK FUNCTIONS, POLES AND ZEROS OF NETWORK FUNCTIONS

Unit step, ramp and impulse functions with and without time delay, their Laplace transform, waveform synthesis and its application to electrical networks.

Terminal pairs or ports, network functions for one port and two port networks, definition and physical interpretation of poles and zeros, pole-zero plot for network functions, restrictions on pole and zero locations for driving point and transfer functions, time domain behavior from the pole – zero plot, network synthesis using pole – zero plot.

UNIT-6: TWO PORT PARAMETERS

Standard reference directions for the voltages and currents of a two – port network, defining equations for open circuit impedance, short circuit admittance, transmission, inverse transmission, hybrid and inverse hybrid parameters, relationships between parameter sets, conditions for reciprocity and electrical symmetry in terms of two – port parameters, interconnections of two - port networks.

Text Books:

SNo	Title	Edition	Authors	Publisher
1	Network Analysis	3rd Edition	M. E. Van Valkenburg	PHI Learning Private Limited
2	Engineering Circuit Analysis	8th Edition	William H. Hayt, Jack E. Kemmerly, Steven M. Durbin	McGraw – Hill
3	Linear Circuit Analysis	2nd Edition	Decarlo, Lin	Oxford Univ. Press

Reference Books:

SNo	Title	Edition	Authors	Publisher
1	Schaum"s 3000 Solved Problems In Electric Circuits Book 1 & 2	1st Edition	Syed A. Nasar	McGraw - Hill
2	Schaum"s Outline Series: Theory and Problems of Electric Circuits	5th Edition	Joseph A. Edminister	McGraw - Hill
3	Basic Circuit Theory	3rd Edition	Lawrence P. Huelsman	PHI Learning Private Limited

III Semester
EL2206 - Lab.: Computer Programming

Course Objective	Course Outcomes
To make the student familiar with the application of MATLAB using programming and simulink.	1) The inbuilt functions, keywords, concepts of drawing and using the various toolbars in SCILAB programming. 2) To design the matrix operation and mesh analysis which generally using in mathematical operation. 3) The various conditions like for loop, while loop and if else loop which are used in decision making statement. 4) The RL series circuit which is the basic concept in basic engineering. 5) The differential equations used in mathematical operation. 6) The design of 2-D and 3-D plots.

Mapped program outcomes								

Minimum Eight Practical are to be performed from the following :-

Expt. No.	List of Experiments
01	Program to demonstrate the script file and elementary matrix manipulations
02	Program to demonstrate indexing of matrices.
03	Program to create function and calling functions
04	Program to solve linear differential equations
05	Write a function that returns the two roots of a quadratic equation, given the three arguments a, b and c. Test the function from the command line
06	Write a function that returns the mean and standard deviation of a vector of numbers (input vector). While Matlab supplies the mean() and std() functions, try just using the sum() and length() functions.
07	Write a function that reverses the order of letters in a string, and returns the new string.
08	Use the eval() Matlab function to evaluate strings such as: exp1 = „5*6 + 7"; Note this, and feval(), is very useful for dynamic programming
09	Use a cell array to store a list of expressions, stored as strings. Then use eval() and a for loop to iterate over the expressions and evaluate them.
10	Create the vector 0:pi/20:2*pi and use it to sample the sin() function. Plot the results and edit the figure window to put labels on the figure. Save the figure (.fig) and export a .jpg file.
11	Use the meshgrid() function to sample a 2 dimensional input space between 0 and 2p, then use the data to sample the function $\sin(x_1)*\cos(x_2)$. Plot the results using the mesh() function.
12	Create a GUI that prompts the user for a number and then displays double that number next to the entered value.
13	Start Simulink and using a sin() **source** and a **scope sink**, view the signal over 10 seconds.
14	Change the frequency of the sin() source and again compare the results. Next change the simulation length.
15	Build the first order system H(s) = 1/(1+3s) in the model and pass a sin() signal through the system. Make sure you run the simulation for a long enough time for the transients to die down and the system to settle. Replace the first order system with the second order system, what is the difference when the system settles down H(s) = 1/(1+2s+s^2).
16	We need to simulate the resonant circuit and display the current waveform as we change the frequency dynamically

III Semester
EL2207 - Electrical Measurement & Instrumentation

Course Objective	Course Outcomes
Students will be able to understand the operation of different electrical instrument used for measurement of electrical and non-electrical parameters and measurement of resistance, inductance or capacitance using various bridges. CT and PT applications	Upon successful completion of this course, Students should be able to: 1) Explain the working of Electrical instruments and compute the value of Resistances, inductance and capacitance by using bridges. 2) Evaluate electrical power and energy in single phase and three phase circuits. 3) Explain and illustrate the concept of instrumentation system with different Transducers and Sensors. 4) Explain the construction, working principle and applications of Transducers. 5) Evaluate Power calculations and applications of Transducers.

UNIT - I: MEASURING INSTRUMENTS

Electrical Measurement :

Classification of Instruments , Deflection and null type instruments ,forces acting in Indicating instruments , PMMC and MI type instruments (Construction and working principle)

Measurement of Resistance :

Classification of Resistance, Wheatstone bridge , Kelvin's Double Bridge , Loss of charge method.

Megger (Construction and Operating principle, Measurement of Earth Resistance.

UNIT – II: POTENTIOMETERS AND AC BRIDGES

D.C. Potentiometer:

Basic Potentiometer circuit, Lab.Type Potentiometer voltage ratio box.

A.C. Potentiometer:--

Standardization of AC Potentiometer, Drysdale Polar potentiometer, Gall-Tinsley (Co-ordinate type) Potentiometer.

AC Bridges:

General equation of AC bridge balance, measurement of Inductance by Maxwell Inductance-capacitance Bridge, detectors used in AC Bridges, Measurement of Capacitance By High voltage Schering bridge , Measurement of Relative Permittivity by Schering bridge, Measurement of frequency By Wien's Bridge.

UNIT – III: MEASUREMENT OF POWER AND ENERGY

Wattmeter :

Electrodynamometer type wattmeter (construction and operation) , LPF Wattmeter, Measurement of power using instrument transformer, Blondal's Theorem , Measurement of three phase power By single wattmeter , Two wattmeter , and three wattmeter method , measurement of Reactive power for Balanced load using single wattmeter method.

Energy Measurement :

Induction type Energy meter (construction and operating principle)Errors and their compensation , Two element energy meter , maximum demand energy meter , phantom Loading (Merz – price).

Power factor Meter : Three phase Electrodynamometer type power factor meter.

III Semester
EL2207 - Electrical Measurement & Instrumentation

UNIT – IV: INSTRUMENT TRANSFORMERS

Instrument Transformer :

Use of instrument transformer , ratios in instrument transformer , burden , characteristics of CT , Effect of secondary open in CT.

Potential transformer : Difference between CT and PT , Errors in PT , Reduction of errors in PT , characteristics of PT

UNIT – V: DIGITAL INSTRUMENTS AND TRANSDUCERS

Digital Voltmeters, Digital Ammeters:

Ramp type digital Voltmeter and Ammeter, Integrating type digital voltmeter and ammeter.

Digital Frequency Meter: Basic circuit, Time base , start and stop Gate circuit for measurement of frequency. Electrical resonance type frequency meter , Weston frequency meter

Transducers: Introduction , Types (Piezoelectric Transducer , Active , Passive transducers)

UNIT – VI: ANALOG TRANSDUCERS

Transducers :

Transducers required for the measurement of (Non electrical quantities)

Linear displacement ,(LVDT), Strain , (Strain gauge, Un bounded metal Strain gauge, semi conductor Strain gauge),Pressure , (Bourden Tube,Bellows, Pirani Gauge),Torque ,

Linear velocity, Angular Velocity, Temperature,(Thermocouples ,First and Second Law of Thermocouple, Thermistors , Bimetallic Thermocouples), Flow (Electromagnetic Flow meter), Acceleration : LVDT Accelerometer.

Digital Encoding transducers – Contacting or Brush type, Shaft encoder.

Text Books:

SNo	Title	Edition	Authors	Publisher
1	Electrical Measurement And Instrumentation	Eighteenth Revised and Enlarged Edition , 2007)	A.K.Sawhney	
2	Electrical Measurement :		J. Singh	
3	Electrical Measurement and Measuring Instrument.			Tata McGraw Hills

Reference Books:

SNo	Title	Edition	Authors	Publisher
1	Electrical And Electronics Measurement	19th Edition	A.K.Sawhney	

III Semester
EL2208 - Lab :Electrical Measurement & Instrumentation

Course Objective	Course Outcomes
	The student will be able to understand 1) Measure resistance, capacitance, and inductance using AC and DC bridges 2) Calibrate single phase energy meter 3) Determined the characteristics of RTD,themistor,pressure and transducer 4) Measure the active and reactive power using different types of method

Mapped program outcomes	a	b	c	f	g	h	j

Minimum Eight Practical are to be performed out of the following :-

Expt. No.	Experiments based on
01	To measure high resistance using loss of charge method.
02	To measure low resistance using Kelvins" double bridge.
03	To measure inductance using Maxwell"s inductance capacitance bridge.
04	To measure inductance using Anderson"s bridge.
05	To measure three phase power using two wattmeter method
06	To measure electrical energy using electromechanical energy meter.
07	Determination of self inductance using Owen"s bridge.
08	Testing of single phase induction type energy meter.
09	Measurement of reactive power in balanced three phase ac circuit using single wattmeter.
10	Study of Pressure gauge.
11	Study of Strain gauge.
12	To measure Torque using sensors.
13	To study first order response of filters- (i) High pass filters (ii) Low pass filters (iii) Notch filter.
14	Study of an instrumentation amplifier.
15	Study of Cathode Ray Oscilloscope.
16	Draw the characteristics of LVDT.
17	Measurement of distance by ultrasonic transducers.
18	Draw the characteristics of RTD, Thermo couple and Thermistor.

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Technology

SoE & Syllabus 2020

4th Semester

Electrical Engineering

28 June 2019

IV Semester
GE2204 - Advanced Mathematical Techniques

Objective	Outcomes Students will be able to
• To introduce various Numerical Methods to solve algebraic and differential equations • To understand the concept of Probability distribution • To introduce the concept of Fuzzy Set theory and functions • To make aware of different optimization techniques	• Utilize numerical techniques to obtain approximate solutions of mathematical equations • Measure the Statistical parameters for random variables • Explain the basic concept of fuzzy sets, Relations and fuzzy logic. • Design and determine the solution of linear programming problems

Unit I:
Numerical Methods for Algebraic And Transcendental Equations: Errors in numerical calculation, Errors in series approximation, Rounding of error solutions of algebraic and transcendental equations, Iteration method, Bisection method, False position method, Newton Raphson method and their convergence
Numerical Methods System of Algebraic Equations: Solution of System of linear equations, Gauss- Seidel method, Crouts method**.** **(7 hours)**

Unit II:
Numerical Methods for Differential Equations: Numerical solution of ordinary differential equation by Taylor's series method, Picard's method, Runge's second and third order method, Runge-Kutta 4^{th} order method, Euler's method, Euler's modified method, Milne's Predictor and Corrector method. **(6 hours)**

Unit III:
Random Variables and Probability Distribution: Discrete and continuous random variables, probability density function of one and two variables, Probability distribution function of one and two variables, Joint distributions and conditional distributions. **(6 hours)**

UNIT IV:
Mathematical Expectation: Definition of mathematical expectation, functions of one and two random variables, The variance and standard deviations, moment generating function other measures of central tendency and dispersion, Skewness and Kurtosis. **(7 hours)**

UNIT V:
Fuzzy Sets And Fuzzy Logic: Fuzzy sets and systems, crisp sets, overview of fuzzy logic and classical logic, fuzzy compliment, fuzzy union, fuzzy intersection and combinations of these fuzzy sets operations crisp and fuzzy relations. **(7 hours)**

Unit VI:
OPTIMIZATION TECHNIQUES: Definition of basic concepts of LPP, Formulation of LPP and its Solution by graphical, simplex methods and Big M method. **(6 hours)**

IV Semester
GE2204 - Advanced Mathematical Techniques

Text Books:

SN	Title	Edition	Authors	Publisher
1	Computer based Numerical and Statistical Techniques	Paperback Firstedition 2003	M. Goyal	Laxmi Publication
2	Numerical Methods	Fourth Edition (2004)	S.S. Sastri	PHI Publishers
3	Fuzzy Engineering	Softcover edition (2005)	Bari Kosko	Prentice Hall PTR
4	Optimization Techniques	Year-2009.First Edition	C.Mohan and Kasum Deep	New Age International Publication

Reference Books:

SN	Title	Edition	Authors	Publisher
1	Advanced Engineering Mathematics	4th edition 2006	H.K.Dass	S. Chand Group
2	Advanced Engineering Mathematics	9th Edition-2007	Kreyszig	JOHN WILEY & SONS
3	Mathematics for Engineers	19th edition 2007	Chandrika Prasad.	JOHN WILEY & SONS
4	Advanced Mathematics for Engineers	4th edition 2006	Chandrika Prasad	JOHN WILEY & SONS
5	Higher Engineering Mathematics	40 edition 2010	B S Grewal	Khanna Publishers
6	A text book of Engineering Mathematics	Reprint 2008	N.P. Bali and Manish Goyal	LaxmiPrakashan

IV Semester
EL2251 - Electrical Machines in Power System

Course Objective	Course Outcomes
To make student aware about • The basic principle, construction, operation, performance characteristics and steady state and transient analysis of synchronous machines. • The principle, construction, operation, control and applications of special electric motors.	The student will be able to understand : 1) Explain constructional features, develop phasor diagram and winding layout, examine steady state performance of synchronous machines and determine induced emf and voltage regulation of synchronous alternator 2) Illustrate the need and method of parallel operation of alternators, analyse and evaluate the behaviour of synchronous machine connected to infinite bus. 3) Interpret behaviour & determine time constant and equivalent circuit parameters under transient conditions of synchronous machines 4) Explain the principle, construction and operation of special machines and identify their applications

UNIT-1: Three Phase Synchronous Generator **(07)**

Introduction, Constructional features of cylindrical and salient pole rotor machines, Full pitch coil, short pitched coil, Coil span factor, concentrated winding, distributed winding, distribution factor, introduction to armature winding and field winding, MMF of armature winding, induced EMF with and without harmonics.

UNIT-2: Steady State Operation of Three phase synchronous generators **(07)**

Effect of loading on terminal voltage, Armature reaction, Effect of load power factor on armature reaction, concept of synchronous reactance, Phasor diagram on load, regulation by Direct loading, Emf method, Load characteristics, External Characteristic, Zero power factor characteristics (ZPFC), construction of Potier triangle.

UNIT-3: Parallel Operation **(06)**

Conditions of synchronization of generator with another generator and or Infinite busbars, Parallel operation, Load sharing between parallel connected generators. Effect of variable excitation and power input on generator operation.

UNIT-4: Synchronous Motor **(06)**

Principle of operation, Methods of starting, phasor diagram, expression for torque, Excitation Emf, load/torque angle, Effect of variable excitation and load on motor operation, V and inverted V curves, Concept of synchronous condenser,
Introduction to Reluctance and Hysteresis motor

UNIT 5: Synchronous Machine Connected to Infinite Bus **(08)**

Power Angle Characteristic of Synchronous machines with and without armature resistance. Expression for electrical and electromechanical power developed, losses and efficiency in synchronous machines.

UNIT-6: Transient Behaviour **(06)**

Short circuit ratio, unbalanced Loading, Sequence Component, Sudden 3-phase short circuit, Constant flux linkage theorem, Transient and sub–transient reactances, Time constants and equivalent circuit diagram, role of damper winding in both generator and motor operation. Experimental determination of steady state & transient parameters

IV Semester
EL2251 - Electrical Machines in Power System

Text Books:

SN	Title	Edition	Authors	Publisher
1	Electrical Machines	2nd -1993	Dr. P. K. Mukherjee and S. Chakravarti	Dhanpat Rai Publications (P) Ltd
2	Electrical Machines	3rd -2010	I.J.Nagrath and Dr. D.P.Kothari	Tata McGraw Hill
3	Alternating Current Machines	1st -1983	M.G. Say	CBS Publishers
4	Electrical Machinery	7TH -2008	P.S.Bhimbra	
5	Electrical Machinery	1ST-1985	A.E.Fitzgerald, C.Kingsley, S.D.Umens	Mc Graw Hill
6	Electric Machines	2nd -2008	Ashfaq Husain	Dhanpat Rai Publications (P) Ltd.

IV Semester
EL2252 - Lab. Electrical Machines in Power System

Course Objective	Course Outcomes
To make student aware about The basic principle, construction, operation, performance characteristics and steady state and transient analysis of synchronous machines. The principle, construction, operation, control and applications of special electric motors	The student will be able to understand : 1) Explain constructional features, develop phasor diagram and winding layout, examine steady state performance of synchronous machines and determine induced emf and voltage regulation of synchronous alternator 2) Illustrate the need and method of parallel operation of alternators, analyse and evaluate the behaviour of synchronous machine connected to infinite bus. 3) Interpret behaviour & determine time constant and equivalent circuit parameters under transient conditions of synchronous machines. 4) Explain the principle, construction and operation of special machines and identify their applications

Mapped program outcomes	1	2	3				

Minimum Eight Practical are to be performed out of the following :-

Expt. No.	Experiments based on
01	To determine voltage regulation of an alternator by direct loading.
02	To determine voltage regulation of an alternator by synchronous impedance method.
03	To plot external characteristics of synchronous generator at different power factor loads.
04	To perform slip test on a 3-phase synchronous machine.
05	To study synchronization of a 3-phase alternator with infinite bus-bars.
06	To determine sub-transient reactances of synchronous machine.
07	To determine negative sequence reactance of a 3-phase synchronous machine.
08	To determine zero sequence reactance of a 3-phase synchronous machine.
09	To observe armature voltage and current waveforms of a 3-phase alternator during slip-test on C.R.O.
10	To plot V and inverted V curves of a 3-phase synchronous motor.

IV Semester
EL2253 - Electrical Energy Generation System

Course Objective	Course Outcomes

Unit I: Introduction to generation systems **(7)**

Importance of Electrical Energy, Generation of Electrical Energy, Relationships among Energy units, Calorific value of fuels.

Sources of Electrical energy- Coal, oil and natural gas, hydro, solar, wind and nuclear energy.

Different factors associated with a generating station : connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity and utilization factor, load curve and load duration curveload survey, base load and peak load station, advantages of interconnection.

Tariff-: Definition, Objective, Characteristics of tariff, Types of Tariff (Numerical), economical choice of tariff.

Unit II: Solar Energy **(7)**

Solar radiation & its Measurement: - Solar constant, Solar radiation at earth's surface, Solar radiation geometry, Solar radiation on tilted surfaces, Solar radiation measurement, Solar Energy Collectors: - Physical principles of the conversion of solar radiation into heat, flat plate collectors. Applications of Solar energy: Solar Dryer, Solar Still, Solar cooker

Solar Photovoltaic Cell: Principle of solar photovoltaic energy conversion, Equivalent circuit of solar cell,

Unit III: Wind Energy **(7)**

Principle of wind energy conversion, Power in the wind, Cut In, Cut Off Wind Speed ,Site selection considerations, Basic components of wind energy conversion systems(WECS),Classification of WEC systems, Advantages and Limitations of WECS,,Types of wind Machines(HAWT and VAWT), Application of wind energy.

Unit IV: Hydro Power Station **(6 or7)**

Schematic arrangement of Hydroelectric Power Station, Constituents of Hydroelectric power plant, Advantages and Limitations of Hydro-electric Plants ,Hydrology, stream flow, flow duration curve, power duration curve, mass curve, reservoir capacity, Water Power equation (Numerical), type of hydro power plants and their field of use, pumped storage plant and their utility, surge tanks. General study of Hydro Turbine, Introduction to Small hydro plants.

Unit V: Thermal Power Station **(7)**

Introduction, Site selection, size and number of units, general layout, major equipment, auxiliaries, electric supply to auxiliary, cost of generation ,effect of different factors on costs.

General study of steam Turbine.

Condenser: Different types of condensers. Construction and Working principle of Condenser

Unit VI: Nuclear Power Plant and Biomass Energy **(7)**

A)Site selection for nuclear power plant, introduction to nuclear physics, chain reaction, Working Principle of nuclear Power Plant, Components of a nuclear reactor, types of nuclear reactor, material for moderator and control rods, control of nuclear reactors, , economics of nuclear power generation.

B)Biogas production from waste biomass, classification of biogas plants, operational parameters, availability of raw material and gas yield.

IV Semester
EL2253 - Electrical Energy Generation System

Course Objective	Course Outcomes

Text Books:

SN	Title	Edition	Authors	Publisher
1	A Textbook on Power System Engineering	2nd edition 2014	M.L.Soni,P.V.Gupta,U.S.Bhatnagar	Dhanpat Rai and Co.
2	Principles of Power System	2nd edition 2008	V.K.Mehta, Rohit Mehta	S.Chand
3	Generation of Electrical Energy	5th edition 2007	B.R.Gupta	S.Chand
4	Non-Conventional Energy Sources	5th edition 2011	G. D. Rai	Khanna

Text Books:

SN	Title	Edition	Authors	Publisher
1	Power System Analysis	1st edition 2007	T.K. Nagsarkar, M.S. Sukhija	Oxford
2	Electrical Power System	5th edition 2007	Ashfaque Hussain	CBS
3	Non-Conventional Energy Resources	2nd edition 2010	B. H. Khan	Tata McGraw-Hill

IV Semester
EL2254 - Lab. Renewable Energy Sources

Course Objective	Course Outcomes
To make student aware about The basic principle, construction, operation, performance characteristics and steady state and transient analysis of synchronous machines. The principle, construction, operation, control and applications of special electric motors	The student will be able to understand : 1) Explain constructional features, develop phasor diagram and winding layout, examine steady state performance of synchronous machines and determine induced emf and voltage regulation of synchronous alternator 2) Illustrate the need and method of parallel operation of alternators, analyse and evaluate the behaviour of synchronous machine connected to infinite bus. 3) Interpret behaviour & determine time constant and equivalent circuit parameters under transient conditions of synchronous machines. 4) Explain the principle, construction and operation of special machines and identify their applications

Minimum Eight practical are to be performed based on the following :-

Expt. No.	Experiments based on
01	To plot V-I characteristics of a single PV module.
02	To plot V-I characteristics of a series connected PV modules.
03	To plot V-I characteristics of a parallel connected PV modules
04	To study the effect of tilt angle on power output of module.
05	To study the effect of shadow on power output of solar PV module.
06	To study the solar based battery charger
07	To study the wind based battery charger
08	To study the hybrid wind and solar based charger
09	To study the biogas generation plant model set up at YCCE Campus
10	To study the box type solar cooker
11	To study solar water heater in natural convection and force convection mode
12	Study of Hydroelectric Power Plant
13	To design home solar PV system.
14	To study Parabolic Solar Cooker

IV Semester
EL2255 - Electric and Magnetic Fields

Course Objective	Course Outcomes
To educate the student in static electric and magnetic fields. To make them aware about various laws of electromagnetic & electrostatic fields.	The student will be able to : 1. Remember, Understand and Analyze the properties of electrostatic field. 2. Apply electrostatics on different mediums and analyze the boundary characteristics. 3. Remember and Understand and Apply the properties of electromagnetic field. 4. Understand the electromagnetic waves and analyze them over different medium.

UNIT-1:Vector Analysis
Scalars and vectors, vector algebra, the Cartesian coordinate system , the scalar and vector field, the dot product, the cross product, Cylindrical coordinate system, Spherical coordinate system.

UNIT-2:Coulomb's Law and Electric Field Intensity: Electric Flux Density, Gauss's Law, and Divergence
Coulomb"s Law, electric field intensity, types of charge distributions, electric field due to line charge density, surface charge density, and volume charge density, streamlines and sketches of fields. Concept of electric flux, electric flux density, Gauss"s Law, application of Gauss"s Law to symmetrical charge distributions, application of Gauss"s law to differential volume element, divergence, Maxwell"s first equation in electrostatics, the vector operator □and the Divergence theorem.

UNIT-3Energy and Potential: Conductors, Dielectrics, and Capacitance
Energy expended in moving a point charge in an electric field, potential difference and potential, the potential field of a point charge, line charge density and surface charge density, the potential field of a system of charges, potential gradient, the dipole, energy density in the electrostatic field, Current and current density, continuity of current, metallic conductors, conductor properties and boundary conditions, the method of images, semiconductors, the nature of dielectric materials, boundary conditions for perfect dielectric materials, capacitance, several capacitance examples.

UNIT-4:Poisson's and Laplace's Equations
Poisson"s and Laplace"s equations, Uniqueness theorem, examples of the solution of Laplace"s equation (involving one variable only).

UNIT-5 Steady Magnetic Field: Magnetic Forces, Materials, and Inductance
Biot – Savart law, magnetic field due to infinitely long current filament, finite length current filament, Ampere"s circuital law, magnetic field due to coaxial cable, uniform sheet of surface current, solenoid, toroid, curl and its physical interpretation, Stoke"s theorem, magnetic flux and magnetic flux density, scalar and vector magnetic potentials, Force on a moving charge, force on a differential current element, force between differential current elements, force and torque on a closed circuit, nature of magnetic materials, magnetization and permeability, magnetic boundary conditions, potential energy and forces on magnetic materials, inductance and mutual inductance.

IV Semester
EL2255 - Electric and Magnetic Fields

Course Objective	Course Outcomes
To educate the student in static electric and magnetic fields. To make them aware about various laws of electromagnetic & electrostatic fields.	The student will be able to : 1. Remember, Understand and Analyze the properties of electrostatic field. 2. Apply electrostatics on different mediums and analyze the boundary characteristics. 3. Remember and Understand and Apply the properties of electromagnetic field. 4. Understand the electromagnetic waves and analyze them over different medium.

UNIT-6: Time-Varying Fields and Maxwell's Equations, Uniform Plane Wave

Faraday"s Law, derivation of Maxwell"s equations in point form and integral form, displacement current and its physical interpretation, concept of retarded potentials, Maxwell"s equations in phasor form, wave equations, uniform plane waves, solution of wave equation in free space, perfect dielectric, lossy dielectrics and good conductor, skin effect and skin depth, Poynting vector.

Text Books:

SN	Title	Edition	Authors	Publisher
1	Engineering Electromagnetics	7th Edition	W.H. Hayt J. A. Buck	McGraw Hill Publication.
2	Schaum"s Outline Series Theory and Problems of Electromagnetics	2nd Edition	Joseph A. Edminister	Schaum"s outline Series of Engineering
3	Principles of Electromagnetics	4th-2007	Matthew N.O.Sadiku	Oxford University Press

Reference books:

SN	Title	Edition	Authors	Publisher
1	Applied Electromagnetic	1978	Plonus M. A.	MGH
2	Electromagnetics	1998	Kraus J. D.	MGH
3	Fundamentals of Electromagnetics with MATLAB	2nd Edition	Karl E. Lonngren, Sava V. Savov, Randy J. Jost	Scitech Publishing Inc.

IV Semester
EL2256- Lab.: Electrical Engineering Workshp

Course Objective	Course Outcomes
This practical will allow to handle different electrical daily use equipment used by electrical engineer. Concept of illumination from design point is also studied. House wiring concept will also be understood by student.	The student will be able to 1. Describe the basic concept of various electrical components. 2. Demonstrate, formulate and solve the basic maintenance and troubleshooting of household equipments, energy saving etc. 3. Outline the fundamentals of major electrical devices and actual operation of devices like induction motor.

Mapped Program Outcomes	1	2	3	4	5	6	12

Practical based on following topics :-

Expt. No.	Experiments based on
01	a. To set up a staircase wiring using given lamp, controlledby switches. b. To set godown wiring using given lamp, controlled by switches.
02	Determination of polarity marking of single phase transformer.
03	To make connections of a fluorescent lamp wiring and to study accessories of the same.
04	To implement residential house wiring using switches, fuse, indicator, lamp and energy meter.
05	Study of 11 KV sub-station at YCCE.
06	Testing of DC Compound Motor
07	To study internal and external parts of ceiling fan.
08	To measure earth resistance by Earth Tester.
09	Study of Power Cables.
10	Study of line insulators.

IV Semester
EL2257- Microprocessors

Course Objective	Course Outcomes
1) To learn the microprocessor applications in electrical engineering 2) To understand principle of microprocessor chip working. 3) To study Interfacing with memory and other peripherals	The students will be able to: CO1: List, select and explain types of memory devices and architecture of 8085 microprocessor CO2: Recall, experiment with and make use of assembly language instructions of 8085. CO3: Demonstrate and test microprocessors and its interfacing devices. CO4: Illustrate and make use of DMA controller and timer.

Mapped Program Outcomes	1	2	3	12

UNIT-1: **Memory devices**
Memory devices, RAM, ROM, Introduction to Intel"s 8085 Architecture, Flag register, Instruction set, Addressing modes, assemblers, hand coding (7 Hours)

UNIT-2: Programming Instructions
Branching instruction, Simple programmes, stack, PUSH, POP Instructions, CALL/RETURN instruction & Subroutines- simple & nested programmes, Programmes using Subroutines. (8 Hours)

UNIT-3: Timing Diagrams
Timing Diagrams, Timing Diagram of instruction. Delay programmes, Serial data transfer, Interrupts - concept and structure in 8085 Interrupt service routine, advanced instructions & Programming of 8085A. (7 Hours)

UNIT-4: Interfacing of Microprocessor
Complete signal description of 8085, interfacing memory devices interfacing I/O devices. Methods of data transfer-serial, parallel synchronous and asynchronous. IN/OUT instructions. Hardware considerations bus contention, slow memory interfacing. (8 Hours)

UNIT-5: Hardware interfacing and Handshaking
Simple hardware interface to 8085 of standard latches & buffers as I/O ports. Architecture and interface of 8255 & 8085. Handshaking concepts. Interfacing of multiplexed keyboard/ display interface and assembler directives. Interfacing of ADC & DAC, stepper motor Interface with 8085. (8 Hours)

UNIT-6: Architecture and Interface
Architecture and interface of 8253 with & 8085, Different modes of 8253. Architecture and interface of 8257 with & 8085, Different modes of operation of 8257, Application of microcontroller. (7 Hours)

Text Books:

SN	Title	Edition	Authors	Publisher
1	Programming and Interfacing 8085		Gaonkar	
2	Programming of 8085		D.V. Hall	

Reference Books:

SN	Title	Edition	Authors	Publisher
1	Microprocessor & Interfacing Manual , Intel Perpheral		Barry Brey	

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Chairperson	Dean (Acad. Matters)	Date of Release	Version	

IV Semester
EL2258-Lab. : Microprocessors

Course Objective	Course Outcomes
1) To learn the microprocessor applications in electrical engineering 2) To understand principle of microprocessor chip working. 3) To study Interfacing with memory and other peripherals	The students will be able to: CO1: List, select and explain types of memory devices and architecture of 8085 microprocessor CO2: Recall, experiment with and make use of assembly language instructions of 8085. CO3: Demonstrate and test microprocessors and its interfacing devices. CO4: Illustrate and make use of DMA controller and timer.

Mapped Program Outcomes	1	2	3	12

Practical based on following topics :-

Expt. No.	Experiments based on
01	Write Assembly Language Program (ALP) to add 16 bit numbers 1324 H & 4532 H.
02	Write Assembly Language Program (ALP) to add two 08 bit BCD numbers 78 + 45 & store result in memory 2150 H.
03	Write Assembly Language Program (ALP) to subtract two 08 bit BCD numbers78 – 45 store result in memory 215 H.
04	X & Y are two 32 bit numbers present in memory from address 2150 H & 2300 H. Write ALP to add these two 32 bit binary numbers & store result in memory from address 2710 H.
05	Ten 8 bit binary number are present in memory from address 2340 H. Write ALP to transfer this number to destination memory from address 2400 H.
06	Twelve 8 bit binary numbers are present in memory from address 2540 H. Write ALP to transfer this number to destination memory from address 2548 H.
07	Ten 8 bit binary nos. are present in memory from address 2200 H. Write ALP to transfer this number to destination memory from address 2190 H in reverse order.
08	Fifteen 8 bit binary numbers are present in memory from address 2200 H. Write ALP to transfer this number to destination memory from address 2190 H in reverse order.
09	Fifteen 8 bit binary numbers are present in memory from address 2340 H. Write ALP to find greatest number in data block & store result in memory at the end of data block.
10	Ten 8 bit binary numbers are present in memory from address 2345 H. Write ALP to find smallest number in a data block & store result in memory at end of block.
11	Write ALP to convert 8 bit BCD to binary number.
12	Write ALP to convert 8 bit binary number to BCD number.

IV Semester
EL2259- Signals & Systems

Course Objective	Course Outcomes
To make the student conversant with the analysis of the signal and how to represents the periodic and non-periodic signals.	The student will be able : 1) To classify signals and systems and analyze continuous and discrete time signals. To understand the properties of LTI system 2) To Interpret periodic signals and representing them by using Fourier series.ToInterpret continuous and discrete time signals in frequency domain and to summaries properties of Fourier transform. 3) To do the time and frequency characterization of signals and systems. 4) to understand the Laplace and Z-transform

Mapped Program Outcomes	1	2	3	12

UNIT-1: Signals and Systems
Continuous-Time and Discrete-Time Signals. Transformations of the Independent Variable. Exponential and Sinusoidal Signals. The Unit Impulse and Unit Step Functions. Continuous-Time and Discrete-Time Systems. Basic System Properties.

Linear Time - Invariant Systems
Discrete-Time LTI Systems: The Convolution Sum. Continuous-Time LTI Systems: The Convolution Integral. Properties of Linear Time-Invariant Systems. Causal LTI Systems Described by Differential and Difference Equations. Singularity Functions.

UNIT-2: Fourier Series Representation of Periodic Signals
The Response of LTI Systems to Complex Exponentials. Fourier Series Representation of Continuous-Time Periodic Signals. Convergence of the Fourier Series. Properties of Continuous-Time Fourier Series. Fourier Series Representation of Discrete-Time Periodic Signals. Properties of Discrete-Time Fourier Series. Fourier Series and LTI Systems. Filtering. Examples of Continuous-Time Filters Described by Differential Equations. Examples of Discrete- Time Filters Described by Difference Equations.

UNIT-3 : The Continuous-Time Fourier Transform
Representation of Aperiodic Signals: The Continuous-Time Fourier Transform. The Fourier Transform for Periodic Signals. Properties of the Continuous-Time Fourier Transform. The Convolution Property. The Multiplication Property. Systems Characterized by Linear Constant-Coefficient Differential Equations.

The Discrete-Time Fourier Transform
Representation of Aperiodic Signals: The Discrete-Time Fourier Transform. The Fourier Transform for Periodic Signals. Properties of the Discrete-Time Fourier Transform. The Convolution Property. The Multiplication Property. Duality. Systems Characterized by Linear Constant-Coefficient Difference Equations.
:

UNIT-4: Time & Frequency Characterization of Signals and Systems
The Magnitude-Phase Representation of the Fourier Transform. The Magnitude-Phase Representation of the Frequency Response of LTI Systems. Time-Domain Properties of Ideal Frequency-Selective Filters. Time-Domain and Frequency-Domain Aspects of Non - ideal Filters. First-Order and Second-Order Continuous-Time and Discrete- Time Systems.

IV Semester
EL2259- Signals & Systems

Sampling
Representation of a Continuous-Time Signal by Its Samples: The Sampling Theorem. Reconstruction of a Signal from Its Samples Using Interpolation. The Effect of Under - sampling : Aliasing. Discrete-Time Processing of Continuous- Time Signals. Sampling of Discrete - Time Signals.

UNIT-5 : The Laplace Transform
The Laplace Transform. The Region of Convergence for Laplace Transforms. The Inverse Laplace Transform. Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot. Properties of the Laplace Transform. Analysis and Characterization of LTI Systems Using the Laplace Transform. System Function Algebra and Block Diagram Representations. The Unilateral Laplace Transform.

UNIT-6: The Z-Transform
The z-Transform. The Region of Convergence for the z-Transform. The Inverse z-Transform. Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot. Properties of the z-Transform. Analysis and

Characterization of LTI Systems Using z-Transforms. System Function Algebra and Block Diagram Representations. The Unilateral z-Transform.

Text Books:

SN	Title	Edition	Authors	Publisher
1	Signals and Systems	2nd Edition, 2013	Alan V. Oppenheim, Alan S. Willsky, with S. Hamid	PHI Learning Private Limited.

Reference Books:

SN	Title	Edition	Authors	Publisher
1	Signals & Systems	2nd Edition., 2005	Simon Haykin and Van Veen	Wiley
2	Signals, Systems and Transforms	3rd Edition, 2004	C. L. Philips, J.M.Parr and Eve A.Riskin	Pearson education
3	Schaum's Outlines of Signals and Systems	3rd Edition, 2002	Hwei P. Hsu	McGraw Hill
4	Linear Systems and Signals	2nd Edition	B.P. Lathi	Oxford University Press

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Technology

SoE & Syllabus 2020

5th Semester

Electrical Engineering

28 June 2019

V Semester

GE 2312 - Fundamental of Economics

Objectives	Outcome (Students will be able to)
Recognizes consumer's behavior and pricing.	Relate their buyer behaviour to particular product and the pricing in the market.
Extrapolates an operations in market with productions constrain.	Examine and classify various market structure and factors of production and its role in production process.
Describes the national income accounting and public finance.	Analyse the national income accounting and the various issues related to banking, taxation, and inflation.
Interprets international trade and institutions.	Elaborate about international economics, foreign trade and its agreement, export, foreign exchange and the various international financial institutions.

UNIT-1: Introduction to Economics and Consumers' Behaviors:
Definitions, meaning and importance of economics Utility analysis: concept and measurement (cardinal and ordinal), Law of diminishing marginal utility, exceptions to law of diminishing marginal utility, law of equi-marginal utility, Indifference curve analysis: Meaning and properties of indifference curve, marginal rate of substitution, budget constraint, Complement and substitute goods, Consumer's equilibrium. Demand Analysis: Meaning and determinants of demand, law of demand, exception to law of demand, Elasticity of Demand-price, cross and income elasticity, measurement of elasticity of demand. **(8 Hours)**

UNIT-2: Production and Costs
Factors of Production: Land, Labour, Capital, Enterprise and their peculiarities, Importance of Capital in production process. Entrepreneur and Innovations, Product and Process innovations, Concepts and types of costs: Fixed vs variable, total, average and marginal costs, Short run and long run cost curves. Law of Variable proportions (Law of diminishing marginal returns) and Return to Scale (Increasing, constant and decreasing), Economies and diseconomies of scale. Depreciation: Meaning and various method of calculating depreciation. **(6 Hours)**

UNIT-3: Market structures - equilibrium output and price
Forms of market structures: Perfect competition, monopolistic competition, oligopoly, duopoly and monopoly, Demand and revenue curves for firm and industry in various forms of market structure, Total, average and marginal revenue curves, equilibrium of firms and industries under various forms of market structures, Price discrimination - Degrees and conditions of discrimination. **(7 Hours)**

UNIT-4: National income accounting:
Concepts of GDP and GNP, Estimation of GDP and GDP at factor and market prices, at constant and current prices, difference between GDP and NDP, GNP and NNP, per capita income as a measure of economic well-being, concepts of economic growth and development, Factors affecting economic growth and development. Capital formation and accumulation. **(5 Hours)**

UNIT-5: Money, Banking and Public Finance
Money: definition, functions and role, Evolution of money, Banking- reserve ratios and credit creation by commercial banks, Functions of a central bank and instruments of credit control, Functions of money market. Inflation: Meaning, types, causes and consequences, measures to control inflation, Concepts of deflation and Stagflation. Sources of public revenue and forms of government expenditure, Taxation: Cannons of taxation. Classification of taxes-Direct (Income tax, Wealth tax, Corporation tax, tax on capital, capital gains, etc) and Indirect Taxes (GST, Import duties), Revenue and capital expenditure.

(7 Hours)

V Semester
GE 2312 - Fundamental of Economics

UNIT-6: International Trade and Institutions

Definitions of closed vs. open economy, small open economy, Concept of exchange rate- Fixed, flexible and managed, Role of Multilateral institutions, viz., IMF, World Bank, WTO (GATT) in promoting, Trade, growth and international financial transactions. **(5 Hours)**

Text Books

SN	Title	Edition	Authors	Publisher
1	Modern Economics	13th Edition	H. L. Ahuja	S. Chand Publisher, 2009.
2	Modern Economic Theory	3rd edition	K. K. Devett	S. Chand Publisher, 2007

Reference Books

SN	Title	Edition	Authors	Publisher
1	Advance Economic Theory	17th Edition	H. L. Ahuja	S. Chand Publisher, 2009
2	International Trade	12th edition	M. L. Zingan	Vindra Publication, 2007
3	Macro Economics	11th Edition	M. L. Zingan	Vindra Publication, 2007
4	Economics: Samuelson,			
5	Monitory Economics	11th Edition	M. L. Sheth	Vindra Publication, 2007
6	Economics of Development and Planning	12th Edition	S. K. Misra and V. K. Puri	Himalaya Publishing House, 2006.

V Semester

EL2301 - Power Electronics

Objective	Course Outcome
The student should be able to) understand the basics of power electronics. 2)understand SCR"s, MOSFET, UJT, IGBT, Concept of rectification, inversion and commutation .	**On completion of this course, the student will be able to** 1) Demonstrate the learnings of various power semiconductor devices with their protection and apply them for various applications. 2) Analyse different Power Electronics Converter circuits and choose them for suitable applications. 3) Demonstrate the knowledge of chopper circuits, analyse and utilise them for different applications. 4) Analyse inverter circuits with different modulation techniques and identify their applications.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Demonstrate the learnings of various power semiconductor devices with their protection and apply them for various applications.	1											1	1	
CO2	Analyse different Power Electronics Converter circuits and choose them for suitable applications.	1	3	2									1	1	
CO3	Demonstrate the knowledge of chopper circuits, analyse and utilise them for different applications.	1	3	2									1	2	
CO4	Examine inverter circuits with different modulation techniques and identify their applications	1	3	2									1	2	
CO5	Develop practical aspects of power semiconductor devices, converters, inverters and chopper circuits.	1	1	2									1	2	

V Semester
EL2301 - Power Electronics

Unit No.	Contents	Max. Hrs.
1	**Power Semiconductor Devices** SCR and its characteristics, Gate characteristics, SCR turn off, ratings, Triggering circuits and opto-couplers	6
2	**Single Phase Line Commutated Converters** Series and parallel connections of SCRs, Single phase line commutated converters, single pulse converter, two pulse mid-point converter, single phase bridge converter, effect of source inductance, effect of freewheeling diode, single phase half controlled rectifier cyclo converter (single phase)	5
3	Three **Phase Line Commutated Converters** Three phase three pulse converter, three phase bridge converter, speed control of dc motors (with single phase rectifier).	5
4	**Forced Commutated Semiconductor Devices and Protection** Characteristic and working of MOSFET, Gate turn off thyristor and insulated gate bipolar transistor, protection of SCR, gate circuit protection, over voltage and over current protection, snubber circuit design.	5
5	**D.C. Choppers** Principles of step down chopper, step up chopper classification, Control strategies, time ratio control and current limit control Impulse commutated and resonant pulse choppers, Multiphase choppers, Application of choppers.	6
6	**Single Phase and Three Phase Bridge Inverters** Single phase and three phase bridge inverters, Output voltage control, Harmonics in output voltage waveforms, Harmonic attenuation by filters, Harmonic reduction by pulse width modulation techniques, analysis of single pulse width modulation, working of current source inverters, applications.	6

V Semester
EL2301 - Power Electronics

Text books:				
S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Power Electronics Circuit"s Devices and Applications	3rd Edition,2004	M.H.Rashid	Prentice Hall Limited
2	Power Electronics		D.Y.Shingare	Electrotech Publication Engineering Series

Reference books:				
S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Power Electronics	1981	C.W.Lander	McGraw Hill
2	Thyristors and their Applications	2nd Edition 2002	Dr.M.Ramamoorty	East West Press
3	Thyristors and their Applications		Dr.G.K.Dubey, Doralda Sinha and Joshi	New Age International
4	Power Electronics	1989	Ned Mohan, T.M.Undeland, and W.P.Robbins	John Wiley and Sons

V Semester

EL2302 - Power Electronics Lab

S.N	TITLE
1	To show V-I characteristics of SCR and measure holding and latching current of SCR.
2	To estimate sensitivity of four modes operation of TRIAC
3	To evaluate average dc voltage of single phase half wave rectifier with Resistive load.
4	To show transfer and output characteristics of Power MOSFET.
5	To show speed control of DC Shunt Motor with Semi Converter.
6	To demonstrate single phase step down Cycloconverter with Resistive load.
7	To demonstrate Forced Commutation methods of SCR.
8	To evaluate RMS AC Voltage of single phase MOSFET based full Bridge inverter.

V Semester

EL2303 - Fundamentals of Power System

Objective	Course Outcome
The student should be able to Calculate the basic parameters of transmission line of power systems. To know the power flow through transmission lines under different circumstances.	**On completion of this course, the student will be able to** 1) Define and explain basic components of power system and representation of its elements in terms of per unit. 2) Analyze and evaluate the transmission line parameters which limits the transmission capacity of a line. 3) Classify, evaluate and determine the performance of distribution and transmission system. 4) Choose, Compare and select the type of insulators and underground cables and improve the performance of system.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Define and explain basic components of power system and representation of its elements in terms of per unit.	2	2											1	
CO2	Analyze and evaluate the transmission line parameters which limits the transmission capacity of a line.	2	2	2										2	
CO3	Classify, evaluate and determine the performance of distribution and transmission system.	2	3	2	2								1	2	
CO4	Choose, Compare and select the type of insulators and underground cables and improve the performance of system.	2	2	2										1	

V Semester
EL2303 - Fundamentals of Power System

Unit No.	Contents	Max. Hrs.
1	**Introduction to power system** Structure of Electrical Power System, use of high voltage, idea about substation, classification, Indoor, outdoor substation, symbols for equipment used in substation, concept of real, reactive and complex power. Per unit system: Representation of power system elements, models and parameters of generator, transformer and transmission lines, Numericals.	6
2	**Inductance of transmission line** Constants of transmission line, flux linkages, inductance of single phase two wire line, inductance of 3 phase overhead line, self GMD and mutual GMD,Numericals	5
3	**Capacitance of transmission line** Electric Potential, Capacitance of single phase 2 wire line, capacitance of 3 phase overhead line, Symmetrical and unsymmetrical spacing, Numericals.	5
4	**Distribution system and Load flow analysis** Types of distribution system, comparison, Feeders and distributors, Numericals on DC and AC distribution Y Bus formation, Illustration of active and reactive power transmission, Introduction to load flow studies in multi bus system (SLFE).	5
5	**Insulators and Cables** Types, Potential distribution over suspension insulator string, String efficiency, Numericals on string efficiency. CABLES: Construction, classification, insulation resistance, capacitance, Dielectric stress, economical size, Grading of cables, Numericals.	6
6	**Transmission Systems** Short, medium (Nominal T and Nominal Π method) and Long line, Voltage regulation & efficiency of power transmission lines using simple series equivalent representation, ABCD parameters of transmission lines.	6

V Semester

EL2303 - Fundamentals of Power System

Text books:				
1	Power System		S.Chand	V.K.Mehta
2	Electrical Power Systems	5th edition	CBS	Ashfaq Hussain
3	Modern Power System Analysis	3rd -2008	Tata McGraw Hill	I. J. Nagrath and D.P. Kothari

Reference books:				
1	Elements of Power system analysis	4th - 1982	MGH	W. D. Stevenson
2	Electrical Power system	3rd -2005	New Age International	C.L Wadhwa

V Semester
EL2304 - Electrical Drives

Objective	Course Outcome
The student should be able to After studying Electrical machines this subject elaborates applications of different machines in industry. Characteristics under starting, running braking and speed control of different motors are explained. Programmable logic controller, contactors, tractions is also explained.	**On completion of this course, the student will be able to** 1) Classify and compare characteristics of AC and DC motors to interpret application of motors in electrical drives. 2) Apply Selection criteria for electrical drives by adapting electrical and mechanical characteristics of motor. 3) Categorize and compare contactors and relays for application of control circuit. 4) Explain the applications of PLCs in electrical drives and compare and assess control of electrical drive. 5) Estimate and adapt different motors for traction work.

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Classify and compare characteristics of AC and DC motors to interpret application of motors in electrical drives.	3	3												
CO2	Apply Selection criteria for electrical drives by adapting electrical and mechanical characteristics of motor	3	3												
CO3	: Categorize and compare contactors and relays for application of control circuit.	3												1	
CO4	Explain the applications of PLCs in electrical drives and compare and assess control of electrical drive.	3				3							1		1
CO5	Estimate and adapt different motors for traction work	3	3										1		

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V Semester

EL2304 - Electrical Drives

Unit No.	Contents	Max. Hrs.
1	**Introduction to Drives and Speed Control** Definition of a Drive, Classification of Drives, Brief idea about drives commonly used in industries, Speed-torque characteristics of common drive motors (DC and AC), Characteristics of Drives under starting and running, Types of braking, Speed Control of AC and DC motors.	6
2	**Selection of motors** Selection of motors and bearings of motor: Power capacity for continuous and intermittent periodic duties, Flywheel effect, Duty cycles of motor, transmission, enclosure systems for drives.	5
3	**AC and DC contactor and relays** AC and DC contactor and relays: Limit Switches, Lock out contactor, magnetic structure, operation, arc interruption, Contactor rating, H.V. Contactor, control circuit for automatic starting and braking of DC motor and three phase induction motor, Control panel design for Motor Control Centre(MCC).	5
4	**Programmable Logic Controllers** Programmable Logic Controllers (PLC), programming methods, Ladder programming with few examples, Applications of PLC"s in electrical drives.	5
5	**Traction motors** Traction motors: Motors use in AC/DC traction and their performance and desirable characteristics, requirement and suitability of motor for traction duty, Speed time characteristics of train, Traction motor control. Series parallel control with numerical method, Starting and braking of traction motor.	6
6	**Digital speed control of Electric motors** Digital speed control of Electric motors, comparison with Analog method of speed control, Block Diagram arrangement for microprocessor based speed control of AC/DC motor, Flowcharts and algorithms for speed control and speed reversal of motor. Digital signal processors (DSP"s) for drive control.Variable frequency Drive(VFD)	6

V Semester
EL2304 - Electrical Drives

Text Books:				
S.N	**TITLE**	**EDITION**	**AUTHOR**	**PUBLICATION**
1	A Course in Electrical Power	**1st-2005**	Soni, Gupta, Bhatnagar	Dhanpat Rai and Company
2	Magnetic control of motors	Industrial New York 1947	Heumann	Chapman and Hall
3	Introduction to Programmable Logic Controllers	3rd Edition, 2008.	Gary Dunning	Cengage Learning

Reference books:				
S.N	**TITLE**	**EDITION**	**AUTHOR**	**PUBLICATION**
1	Modern Electric Traction	**4th -2005**	H. Pratap	Dhanpat Rai and Company
2	Modern utilization of traction motor	2003	J.B. Gupta	
3	A Textbook of Electrical Technology Volume III Transmission, Distribution, Utilization		B.L.Theraja, A.K.Theraja	S.Chand

V Semester
EL2305 - Electrical Drives Lab

S.N	TITLE
1	To evaluate and explain the control circuit of star delta starter
2	To evaluate and explain control circuit of direct online starter (DOL)
3	To explain function of side rotary limit switch.
4	To categorize different types contactors
5	To classify and explain programming logic control (PLC) M-1200, M-1400 and LOGO PLC.
6	To make use of operating limit switch to turn ON contactor (output device).
7	To design ladder programming in PLC to control lamp.
8	To design ladder programming using LOGO PLC to control lamp.
9	To explain Implementation of timer using LOGO PLC
10	To design ladder programming in PLC to Control of lamps in pre defined sequence
11	To design a program for Reversal of synchronous motor using PLC
12	To make use of limit switch, and sensors to turn ON contactor motor, lamp .

V Semester

EL2311 - OE I : Renewable Energy Generation Systems

Objective	Course Outcome
This subject introduce the different renewable energy sources to the students. Students get knowledge of Electric Power generation by wind, solar, small hydro.	**On completion of this course, the student will be able to** 1) Summarize, classify and compare types of renewable energy sources, outline as per Global and Indian context. 2) Utilize solar energy for various applications, estimate solar radiation geometry and classify types of wind turbine generator. 3) Demonstrate, Classify and utilize geothermal and biomass energy. 4) Compare, classify and apply energy from ocean, tide, wave and hydro for power generation, explain storage methods for renewable energy sources.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Summarize, classify and compare types of renewable energy sources, outline as per Global and Indian context.	1		1			1	1							
CO2	Utilize solar energy for various applications, estimate solar radiation geometry and classify types of wind turbine generator.	1	2	1	1	1		2	1			1			
CO3	Demonstrate, Classify and utilize geothermal and biomass energy.	1		1		1	1	2	1			1			1
CO4	Compare, classify and apply energy from ocean, tide, wave and hydro for power generation, explain storage methods for renewable energy sources.	1		1		1		1				1		1	1

V Semester

EL2311 - OE I : Renewable Energy Generation Systems

Unit No.	Contents	Max. Hrs.
1	**Introduction** Fundamentals of Renewable / Non-renewable Energy Sources, Renewable Energy sources, Renewable Energy Potential in India, Renewable Energy Sources and their sustainable development. Storage methods for renewable energy sources.	6
2	Solar Energy Principles, scope and applications, solar radiation, its measurement & prediction, flat plate collectors-design & theory, solar water heating, solar dryers, solar stills, solar cooling and refrigeration. Solar cells, thermal storage, street lighting, solar power generation.	5
3	Wind Energy Introduction, Historical development, Wind energy resources, sites identification, blade element theory, aero-foil design, component of wind energy conversion system, wind turbine generator classification, and windmill and wind electrical generator, Advantages, disadvantages, economics and present status of wind energy generation systems, grid connection of wind energy.	5
4	Geothermal Energy and Biomass Energy Introduction, history of geothermal resources, basics of geological process, dry rock and hot aquifer analysis, geothermal exploration, geothermal well drilling and fluid extraction, utilization of geothermal resources, geothermal heat pump, site of geothermal energy in India. Biomass energy resources and conversion processes, urban waste to energy conversion.	5
5	Mini & Micro hydro-plants Introduction, Classification of water turbines, hydroelectric system, essential components of hydroelectric system, system efficiency, advantages and disadvantages of hydroelectric system, present Indian power scenario of mini- micro hydro.	6
6	Ocean Energy Ocean thermal energy conversion (OTEC), Open cycle and closed cycle OTEC, Ocean wave energy conversion, tidal energy conversion. Introduction of Fuel cells.	6

V Semester

EL2311 - OE I : Renewable Energy Generation Systems

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Non Conventional Sources of Energy	**4th edition**	G.D.Rai	Khanna Publisher
2	Energy Technology:Nonconventional Renewable and Conventional	,	S. Rao and B.B Parulekar	Khanna Publisher New Delhi

Reference books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Solar Energy : Principles of Thermal collection and storage	**3rd edition,1994**	S.P.Sukhatme,J.K.Nayak	Tata McGraw Hill
2	Wind and Solar Power System		M. R. Patel	CRC Press, New York
3	Renewable Energy Sources Basic Principles and Applications		G. N. Tiwari and M. K. Ghoshal	Narosa Publishing House,New Delhi

V Semester

EL2312 - OE I : Electrical Machines and their Applications

Objective	Course Outcome
The student should be able to This subject introduce the applications of different machines and commonly used drives	**On completion of this course, the student will be able to** 1) To explain speed-torque characteristics, need for starters, starting methods and braking of AC and DC motors. 2) To build/apply criterion for selection of motors, duty cycle, enclosures, transmission system and insulation classes. 3) To illustrate/interpret/explain the principle, operation and construction of 1-phase and 3-phase transformers and autotransformers. 4) To show/define the principle. Construction, types, characteristics and performance of special machines like BLDC, Stepper motor and Universal motor

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	To explain speed-torque characteristics, need for starters, starting methods and braking of AC and DC motors	3													1
CO2	To build/apply criterion for selection of motors, duty cycle, enclosures, transmission system and insulation classes	3	1					1							1
CO3	To illustrate/interpret/explain the principle, operation and construction of 1-phase and 3-phase transformers and autotransformers	2	1												2
CO4	To show/define the principle. Construction, types, characteristics and performance of special machines like BLDC, Stepper motor and Universal motor	3													1

V Semester

EL2312 - OE I : Electrical Machines and their Applications

Unit No.	Contents	Max. Hrs.
1	Introduction to Drives and Speed Control: Classification of Drives, brief idea about commonly used drives (AC and DC) drives in industry, speed- torque characteristics of different drive motors, their behaviour under starting and running conditions.	6
2	Need of starter, Starting methods, Braking and Speed Control of AC and DC motors.	5
3	Selection Criterion for Drive Motors: Criterion for selection of motors, Duty Cycle, Power Rating for Continuous and Intermittent Duty Cycles, Environment and Enclosures, Transmission System, Insulation Classes.	5
4	Single Phase transformer Review of Principle, constant flux machine, losses, efficiency etc., Operation on load (Phasor diagrams), Voltage regulation, effect of load power factor on regulation, Application of Single phase transformer in Electronic circuitry, autotransformer, welding transformer, furnace transformer.	5
5	Three Phase Transformer. Concept of three phase transformer, Comparison between unit and bank of single phase transformer, connections, All Day Efficiency, application in power system.	6
6	Special Machines: Brushless DC motor: - Principle, construction , operation, converter for BLDC, rotor position sensor (Hall Sensor), Stepper motor: types, slewing, torque-speed characteristics, stepper motor converter, Universal motor, applications Applications of three phase and single phase induction motors in cement industry, steel rolling mill, textile mill, etc.	6

V Semester
EL2312 - OE I : Electrical Machines and their Applications

Text books				
S.N	**Title**	**Year/Edition**	**Author**	**Publisher**
1	A Course in Electrical Power	First-2005	Soni, Gupta, Bhatnagar	Dhanpat Rai and Company
2	Fundamentals of Electric Drives	2nd Edition	G. K.Dubey	Narosa Publications
3	Electric Machines	2nd Edition	Ashfaq Husain	Dhanpat Rai and Company

Reference Books:

Sr. No.	Title	Year/Edition	Author	Publisher
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3	Electric Machines	2nd Edition	Ashfaq Husain	Dhanpat Rai and Company

V Semester

EL2313 - OE I : Testing and Maintenance of Electrical Equipment's

Objective	Course Outcome
The student should be able to To adopt various testing and maintenance procedures for electrical equipments by providing effective insulation to enhance their life and working condition	**On completion of this course, the student will be able to** 1) Classify, the causes of hazards, accidents, shock and the remedial action taken against the electrical shock. 2) Demonstrate, apply and evaluate different types of tests and the various maintenance techniques to be employed on various electrical machines and it installation. 3) Demonstrate, apply and estimate the factors affecting the life of insulation, its testing and maintenance. 4) Explain, develop and determine the various tests to be conducted on distribution transformer, I. S. Standards.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Classify, the causes of hazards, accidents, shock and the remedial action taken against the electrical shock.	1					2	1	3				3		1
CO2	Demonstrate, apply and evaluate different types of tests and the various maintenance techniques to be employed on various electrical machines and it installation	1					2		1				1	2	
CO3	Demonstrate, apply and estimate the factors affecting the life of insulation, its testing and maintenance.	1					2								
CO4	Explain, develop and determine the various tests to be conducted on distribution transformer, I. S. Standards.	1					1		1				1	2	

V Semester

EL2313 - OE I : Testing and Maintenance of Electrical Equipment's

Unit No.	Contents	Max. Hrs.
1	Safety & Prevention of Accidents Definition of terminology used in safety; safety, hazards, accident, major accident hazard, responsibility, authority, accountability, monitoring, I.E. Act & statutory regulations for safety of persons & equipments working with electrical installation, Dos & don"ts for substation operators as listed in IS Meaning & causes of electrical accidents factors on which severity of shock depends, Procedure for rescuing the person who has received an electric shock, methods of providing artificial respiration, Precautions to be taken to avoid fire due to electrical reasons, operation of fire extinguishers.	6
2	General Introduction Objectives of testing significance of I.S.S. concept of tolerance, routine tests, type tests, special tests, Methods of testing a) Direct, b) Indirect, c) Regenerative. Concept of routine, preventive & breakdown maintenance, advantages of preventive maintenance, procedure for developing preventive maintenance schedule, Factors affecting preventive maintenance schedule. Introduction to total productive maintenance.	5
3	Testing & maintenance of rotating machines Type tests, routine tests & special tests of 1 & 3 phase Induction motors, Routine, Preventive, & breakdown maintenance of 1 & 3 phase Induction motors as per IS 9001:1992. Parallel operation of alternators, Maintenance schedule of alternators & synchronous machines as per IS 4884-1968. Brake test on DC Series motor.	5
4	**Testing & maintenance of Insulation** Classification of insulating materials as per I.S. 8504(part III) 1994, factors affecting life of insulating materials, measurement of insulation resistance & interpretation of condition of insulating. Methods of measuring temperature of internal parts of windings/machines & applying the correction factor when the machine is hot.	5
5	**Testing & maintenance of Transformer** Listing type test, routine test & special test as per I.S. 2026-1981. Procedure for conducting following tests: Measurement of winding resistance, no load losses, & no load current, Impedance voltage, load losses, Insulation resistance, Induced over voltage withstand test, separate source voltage withstand test, Impulse voltage withstand test, Temperature rise test of oil & winding, Different methods of determining temp rise- back to back test, short circuit test, open delta (delta – delta) test. Preventive maintenance & routine maintenance of distribution transformer as per I.S. 10028 (part-III): 1981, Periodic checks for replacement of oil, silica gel, parallel operation of 1 & 3 phase transformer, load sharing calculations (numerical).	6
6	**Installation** Factors involved in designing the machine foundation, Requirement of different dimension of foundation for static & rotating machines procedure for levelling & alignment of two shafts of directly & indirectly coupled drives, effects of misalignment. Installation of rotating machines as per I.S. 900-1992. Use of various devices & tools in loading & unloading, lifting, carrying heavy equipment.	6

V Semester

EL2313 - OE I : Testing and Maintenance of Electrical Equipment"s

Text Books:			
S. N.	**Author**	**Title**	**Publisher**
01.	B. V. S. Rao	Operation and Maintenance of Electrical machines Vol – I	Media Promotors & Publisher Ltd. Mumbai
02.	B. V. S. Rao	Operation and Maintenance of Electrical machines Vol – II	Media Promotors & Publisher Ltd. Mumbai

Reference Books:			
S. N.	**Author**	**Title**	**Publisher**
01.	B. L. Theraja	Electrical Technology Vol I to IV	S. Chand & Co., New Delhi
02.	C. J. Hubert	Preventive Maintenance Hand Books & Journals	----------

V Semester
EL2314 – Solar power plant design and Installation

Course Objectives	Course Outcomes
This Course is aimed at training candidates for the job of a "Solar PV System Installation Engineer", in the "Energy" Sector/Industry and aims at building the following key competencies amongst the learner.	The students will be able to: CO1: Assess customer's PV system requirement. CO2: Plan and arrange for installation. CO3 Coordinate with colleagues at workplace CO4:Ensure safety at workplace

UNIT-1 Solar Power Plant
How solar is beneficial to Industry and Residences, Types of Solar Power Plant, Grid Connected solar Power Plant, Net Metering Solar Power Plant, Behind the meter, Gross meter, Off-Grid / Hybrid solar power plant, Schemes of solar power plant PV module structure inter row spacing calculation, Pitch analysis, Selection of PV module tilt angle, Near shading object calculation, Site survey and plant assessment, selection of site and shadow analysis, selection of site and shadow analysis, Selection of PV module technology.
UNIT-2 Selection of PV module technology and Sizing
Types Crystalline module cells, Manufacturing process of PV cells, Comparison between mono crystalline, Selection of PV cells, Selection of front and rear sheet Selection of PV module glass, Selection of EVA sheet , Bus bar and frame.
UNIT-3 Inverters Selection and Sizing
Types of solar inverter, Selection of string /central / off grid inverter, Selection of power conditioning unit (PCU), Sizing of solar inverter for roof top and grid connected projects, Selection and sizing of string inverter, Selection and sizing of central inverter.
UNIT-4 Selection and sizing of AC and DC Cable, Earthing and Lightning Arrestor
Sizing of solar cable /DC cable, Sizing of String cable, Derating factor of cables Sizing of AC cable (Inverter to ACDB ,ACDB to MDB), Sizing of DC cable (Module to SMB , SMB to Inverter), Solar Plant resistance calculation Preparation AC /DC earthing layout, Selection of lightening protection device Selection of ESE type Lightening Protection.
UNIT-5 Plant Installation and Government policies
IEC Standards, Equipment Installation, Monitoring Equipment, Commissioning System Installation & Pre-Commissioning Checklist, Commissioning Test Sheets. Introduction to State & Central policies, Net meter policy of Maharashtra state, Various scheme of Solar net metering. Case Study KUSUM & Ultra Mega solar power projects. Introduction to Solar PV Design and Simulation software like HOMER Pro, PV F-Chart, pvPlanner, PVsyst, RETscreen, System Advisor Model (SAM), Solar Pro
UNIT-6 Maintenance And Troubleshooting
Preparation of checklist for maintenance as per OEM recommendation for: Module, Inverter, DC cabling & SMB, AC Cabling ACDB, MDB, Checking functionality and protection system, Measurement of earthing resistance, Efficiency measurement of plant. Monitoring Equipment, Commissioning System Installation & Pre-Commissioning Checklist, Commissioning Test Sheets, Staff Management

Text books:				
S.N.	**Title of the book**	**Edition)**	**Author(s)**	**Publisher**
1	Solar Photovoltaic Technology And Systems	1st 2013	Chetan Singh Solanki	PHI Learning Delhi
2	Implementation of Solar Thermal and Photovoltaic Systems		Covrig Claudiu	• LAP Lambert Academic Publishing
3	Photovoltaics for Professionals - Solar Electric Systems- Marketing, Design and Installation		Falk Antony	Taylor & Francis Ltd
Reference books:				
1	The Solar Electricity Handbook: 2019 Edition 2019: A simple, practical guide to solar energy - designing and installing solar photovoltaic systems.	2019	Michael Boxwell	Greenstream Publishing

V Semester

EL2321 - OE II: Electrical Energy Audit and Safety

Objectives	Course Outcomes
The student should be able to Understand various operating characteristics of electrical equipments,its monitoring, tools used in comprehensive energy audit and its procedure to save the electricity with and without investment, calculation of energy saving and its global impact	**On completion of this course, the student will be able to** 1) Classify, the energy sources, methods of energy conservation and its pattern, electricity act 2003. 2) Demonstrate, apply and evaluate different forms of electrical and thermal energy. 3) Demonstrate, apply and estimate the Energy Management, Energy Audit, Energy Monitoring and Targeting. 4) Explain, develop and determine the various Global Environmental Concerns and Electrical safety procedures.

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Classify, the energy sources, methods of energy conservation and its pattern, electricity act 2003	1							1				1		
CO2	Demonstrate, apply and evaluate different forms of electrical and thermal energy.		1										1	1	
CO3	Demonstrate, apply and estimate the Energy Management, Energy Audit, Energy Monitoring and Targeting.		2			1	1	2					1		1
CO4	Explain, develop and determine the various Global Environmental Concerns and Electrical safety procedures.	1									1		1		1

V Semester

EL2321 - OE II: Electrical Energy Audit and Safety

Unit No.	Contents	Max. Hrs.
1	Energy Scenario Commercial and Non-commercial energy, primary energy sources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance. Re-structuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features, Salient Features of Electricity Act 2003.	6
2	Basics of Energy and its various forms Electricity basics- DC & AC currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.	5
3	Energy Management & Audit Definition, need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.	5
4	Energy Monitoring and Targeting Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM).	5
5	Global environmental concerns United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon fund (PCF).	6
6	Electrical Safety Primary hazards associated with electricity. Control measures and safety-related work practices to minimize the risk associated with electrical hazards. Response procedures in the event of electrical shock or fire.	6

V Semester

EL2321 - OE II: Electrical Energy Audit and Safety

Text Books:			
S. N.	**Author**	**Title**	**Publisher**
01	Archie,W Culp	Principles of Energy Conversion	McGraw Hill
02	Wayne C Turner	Energy Management Handbook Bureau	John Willey and Sons
03		Bureau of Energy Efficiency Study Material for Energy Managersand Auditors Examination	Bureau of Energy Efficiency www.beeindia.in

Reference Books:			
S. N.	**Author**	**Title**	**Publisher**
01.	Amit Kumar Tyagi	Handbook on Energy Audit and Management	TERI

V Semester

EL2322 - OE II: Utilization of Electrical Energy

Objectives	Course Outcomes
The student should be able to To understand the basic principle of electrical heating, welding, illumination, refrigeration and air conditioning, fans, pumps, compressors and digi sets.	**On completion of this course, the student will be able to** 1) Demonstrate and utilize electrical energy for various purposes including heating and traction system. Students will also be able to classify illumination, its types and purpose. 2) Demonstrate and apply electric energy to different types of welding 3) Explain how refrigeration system and air condition system works. 4) Analyse, determine and estimate proper economic generation.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Demonstrate and utilize electrical energy for various purposes including heating and traction system. Students will also be able to classify illumination, its types and purpose	3	2	2					2	1	1				1
CO2	Demonstrate and apply electric energy to different types of welding			1		1			1						
CO3	Explain how refrigeration system and air condition system works	1		1	1				1						
CO4	Analyse,determine and estimate proper economic generation	3	2	2	1		1		2	2	3	1		3	1

V Semester
EL2322 - OE II: Utilization of Electrical Energy

Unit No.	Contents	Max. Hrs.
1	**Electric Heating:** i) Electric Heating : Types and methods of electrical heating, advantages of electrically produced heat Types & application of electric heating equipment"s, transfer of heat. ii) Resistance Ovens: General constructions, design of heating elements, efficiency & losses, radiant heating. iii) Induction heating: Core type & core less induction furnace, indirect induction oven, medium and high frequency eddy - current heating. iv) Dielectric heating: Principle and application. v) Arc furnace: Direct & indirect arc furnace, power supply, characteristics & control.	6
2	**Electric Welding*:*** i) Importance, Advantages & Disadvantages of welding, classification of welding processes. ii) Resistance welding, Butt welding, Spot welding, Projection welding, Seam welding. iii) Electric arc welding: carbon arc welding, metal arc welding, submerged arc welding, Welding positions, Types of welding electrodes iv) Ultrasonic welding, electron beam welding, laser beam welding.	5
3	**Illumination*:*** Nature of light, terms used in illumination, solid angle, laws of illumination, polar curves, Colour Rendering Index (CRI), types of lamps, luminaries, Design of illumination systems, indoor lighting systems, factory lighting, outdoor lighting design, flood lighting, street lighting, energy saving in lighting systems.	5
4	**Refrigeration & Air conditioning:** Terminology, refrigeration cycle, refrigeration systems (Vapour compression, vapour absorption), domestic refrigerator, water cooler, desert cooler. Air conditioning: Factors involved in air conditioning, comfort air conditioning, industrial air conditioning, effective temperature, summer / winter air conditioning systems, types of air conditioning systems, room air conditioning, and central air conditioning.	5
5	**Electric Traction** Traction system, requirement of an ideal traction system, different systems for traction, system of railway electrification, comparison between AC and DC systems, power supply for electric traction system, overhead equipments (collector gear for overhead equipments, conductor-rail equipment)Speed- Time curve for train movement, crest speed, average speed and schedule speed, simplified speed-time curve	6
6	Economics of Power Generation, Electric Power Supply and Utilization Terms and Definitions, base load and peak load, selection of power plant equipment (boilers, prime-movers, size and number of generating units), economics in plant selection, economics of hydroelectric power plant, economics of combined hydro and steam power plant, performance and operating characteristics of power plants, power plant useful life, tariff for electrical energy, objective and requirements of tariff, general tariff forms, comparison between private generating plant and public supply.	6

V Semester

EL2322 - OE II: Utilization of Electrical Energy

Text books:				
S. N	**TITLE**	**EDITION**	**AUTHOR**	**PUBLISHER**
1	Utilization of Electric Power & Electric Traction		J.B. Gupta	Kataria & Sons
2	Art and Science of Utilization of Electrical Energy		H Pratap	Dhanpat Rai & Sons, Delhi
3	Utilization of Electrical Power		R. K. Rajput	Laxmi Publications Pvt. Ltd.

Reference books:				
	TITLE	**EDITION**	**AUTHOR**	**PUBLISHER**
1	Guide book for National Certification Examination for Energy Managers and Energy Auditors			Bureau of Energy Efficiency
2	Utilization of Electrical Power		Dr N. Suryanarayana V.	Wiley Eastern Ltd, Age International New
3	Utilization of Electrical Energy		E.Openshaw Taylor	Orient Longman

V Semester

EL2323- OE II: Power System Engineering

Objective	Course Outcome
The student should be able to :- (1) To comprehend the different issues related to overhead lines and underground cables. (2) To train the students with a solid foundation in power system concepts required to solve engineering problems. (3) To provide the knowledge about the system transients, sag and various issues related to cables and transmission lines. (4) To introduce the students to the general structure of the network for transferring power from generating stations to the consumers. (5) To expose the students to the different electrical & mechanical aspects of the power network along with its environmental and safety constraints	On completion of this course, the student will be able to (1) Articulate types of load and power system concepts required to engineering problems. (2) Develop the ability to implement the appropriate safety equipments for design of electrical power system with enhancing the efficiency of the transmission and distribution system with environment friendly technology. (3) Formulate A.C and D.C distribution networks for necessary variable calculation. (4) Ability to design and analyze switchgear protection system with respect to various electrical parameters which is required in substation.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Articulate types of load and power system concepts required to engineering problems.	2				1		1			1			1	
CO2	Develop the ability to implement the appropriate safety equipments for design of electrical power system with enhancing the efficiency of the transmission and distribution system with environment friendly technology.	1	2	1				1				1	1	2	
CO3	Formulate A.C and D.C distribution networks for necessary variable calculation.	2	1					1						2	
CO4	Ability to design and analyze switchgear protection system with respect to various electrical parameters which is required in substation.	1	1	2				1			1			1	

		June 2022	1.06	Applicable for AY 2022-23 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

V Semester
EL2323- OE II: Power System Engineering

Unit No.	Contents	Max. Hrs.
1	**Introduction to Power System** Restructuring of power sector, Constituents of present day power system, sources of electrical energy, types and characteristics of generating stations: Thermal, hydro, nuclear , solar ,wind and other renewable, salient features of electricity act 2003.	6
2	**Load on Power Stations** Load, Important terms and factors, and Units generated per annum , Load duration curve , Types of loads, Load demand and diversity factors, Load curves and selection of generating units, Base load and peak load on Power station, Method of meeting the load ,Interconnected grid system.	5
3	**Transmission System I** Electric supply system, A.C power supply scheme, D.C transmission scheme, Comparison of AC and DC transmission system, advantages of A.C. transmission system, Comparison of various transmission system (Two wire dc system, Single phase two wire A.C system, Single phase three wire system , three phase three wire system, Three phase four wire system) Elements of transmission line, Economic choice of transmission voltage, requirements of satisfactory electric supply, Concept of HVDC transmission.	5
4	**Transmission System II** Line support insulators, types of insulators (pin type, suspension type, strain type, shackle type), Commonly used conductor material, concept of corona, factor affecting corona, advantages and disadvantages of corona, methods of reducing corona effect, Sag and its effects, Constants of transmission line (R, L and C) , Resistance of transmission line, skin effect , Classification of overhead transmission line and voltage regulation .	5
5	**Distribution System** Classification of distribution system, Types of distribution AC and DC, Overhead verses underground system, Requirements of distribution system, Design consideration of distribution system, AC distribution types, Voltage drop calculations in different distribution system , importance of voltage control, location of voltage control equipment and its methods, Tap changing transformer , Concept of tariff, desirable characteristics of tariff, types of tariff.	6
6	**Introduction to Switchgear** Essential features of switchgear, switchgear equipment's, switches, fuses, circuit breakers, relays, HRC fuses, Bus Bar arrangement (single bus system, One and half feeder ,Main and transfer bus system) , MCB, MCCB, ELCB Introduction to Instrument transformer Current Transformer (CT) and Potential transformer (PT).	6

V Semester

EL2323- OE II: Power System Engineering

Text books:				
	Title	Edition	Author	Publication
1.	Power System Analysis	1st edition 2007	T.K. Nagsarkar, M.S. Sukhija	Oxford
2.	Principles of Power System	2nd edition 2005	V.K.Mehta, Rohit Mehta	S.Chand
3.	Electrical Power System	5th edition 2007	Ashfaque Hussain	CBS

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Technology

SoE & Syllabus 2020

6th Semester

Electrical Engineering

28 June 2019

VI Semester
GE2311 - Fundamentals of Management

Objective	Outcomes Students will be able to
To introduce the fundamentals and legal provision of Management	Explain the Legal provision and Functions of Management.
To introduce the Human Resource and Financial practice of organization	Analyze the role of Human Resource and Financial Management in the organization.
To Introduce the Project Management	Analyze the project life cycles.
To provide knowledge of Marketing Activities of Management	Identify tools and techniques for the marketing of goods and services.

Unit – 1 - Principle of Management
Evolution of Management Thought : Scientific and Administrative Theory of Management , Definition and Concept of Management, Functions of Management : Planning, Organizing, Directing, Coordinating and Controlling, Motivational Theories, Concept of Leadership

UNIT-2: Legal Aspects of Management
The Indian Contract Act, 1872 – Formation of Valid Contract, Discharge of Contract, Quasi Contract, Indemnity and Guarantee. The Indian Partnership Act, 1932- Essentials of Partnership, The Companies Act – Nature and Definition of Company, Registration and Incorporation, Memorandum and Article of Association, Kinds of companies, Winding up of the Company

UNIT-3: Human Resource Management
Human Resource Management-Meaning and Scope, Principles of HRD, Job Analysis – Job Description and Job Specification, Job Enrichment, Job Rotation, Training and Development – Purpose and Methods, Performance Appraisal- Purpose, Procedure and Techniques, Grievance Redressal Procedure .

UNIT-4: Project Management
Concept, Classification and Characteristics of Project, Project Life Cycle, Project Proposal, Tools and Techniques of Project Management, Network techniques - Introduction and Use of CPM &PERT for planning, SWOT Analysis, Project Risk Analysis, Project Control.

UNIT-5: Marketing Management
Marketing Management - Definition & scope, Selling & Modern Concepts of Marketing, Market Research, Customer Behaviors, Product Launching, Sales Promotion, Pricing, Channels of Distribution, Advertising, Market Segmentation, Marketing Mix, Positioning, Targeting

VI Semester
GE2311 - Fundamentals of Management

UNIT-6: Financial Management

Definition & Functions of Finance department, Sources of finance, Types of capital, Profit maximization vs. Wealth Maximization, Functions of Finance Manager in Modern Age, Concept of Risk and Return , Break Even Analysis, Budgets & Budgetary Control, Make or Buy Analysis, Introduction to financial statement – profit and loss A/c and Balance Sheet

Text book and Reference

1. Harold Koontz Ramchandra, Principles of Management, Tata McGrow hills
2. Bare Acts – Indian Contract Act, Indian Partnership Act and Company Law
3. Dr. V.S.P.Rao - Human Resource Management - Text and Cases
4. C.B.Mamoria and S.V.Gankar, A Text book of Human Resource Management,
5. Lock, Gower - Project Management Handbook
6. Ramaswamy V.S. and Namakumari S - Marketing Management: Planning, Implementation and Control (Macmillian, 3rd Edition).
7. Rajan Saxena: Marketing Management, Tata McGraw Hill.
8. Fabozzi - Foundations of Financial Markets and Institutions (Pretice hall, 3rd Ed.)
9. Parameswaran- Fundamentals of Financial Instruments (Wiley India)
10. Bhole L M - Financial Institutions and Markets (Tata McGraw-Hill, 3rd edition, 2003)
11. Khan M Y - Financial Services (Tata Mc Graw Hill, 19

VI Semester
EL2351- Control System

Course Learning Objectives	Course Outcomes
This is a first course in feedback control of dynamic systems. The main goal is to introduce and familiarize students with dynamic systems modeling and analysis techniques that can be employed on a large variety of engineering systems. Being an interdisciplinary course, students will learn: 1 the role of a control engineer in multi- disciplinary teams. 2 to apply the knowledge gained in basic mathematics, physical sciences and engineering courses to derive mathematical models of typical engineering processes. 3 to use transfer function and state space models for control system analysis in time and frequency domain. 4 the basic concepts of proportional, integral, and derivative (PID) control. 5 the importance of stability in control systems and the various methods to determine it. 6 to construct root locus plot and frequency response plots such as polar plot, Bode plot, Nyquist plot etc.	The students will be able to: CO1: Classify, select types of control systems, interpret transfer function of the system and compare and evaluate electrical and mechanical systems. CO2: Illustrate the time response, develop and evaluate the controller. CO3: Demonstrate, apply and evaluate stability using transfer function and state variable approach. CO4: Demonstrate, construct and select design parameters using root locus and frequency domain methods Mapped program outcomes:1,2,3,12

UNIT I : Introduction to Control Systems: History of control system, Basic Components of Control System, Open loop control and close loop control with examples, classification of control systems.

Transfer Function, Block Diagram and Signal Flow Graph : Transfer function and gain, Order of a system, block diagram algebra & reduction techniques, signal flow graph, its constructions and Mason"s gain formula.

Mathematical Modelling of physical systems: Mathematical modelling of physical system such as – electrical, mechanical, electro-mechanical, thermal, hydraulic, pneumatic etc., Analogous systems.

UNIT II: Characteristics of Feedback Control Systems : Effect of negative feedback compared to open loop system such as – sensitivity to parameter variation, speed of time response, bandwidth, disturbance rejection and linearizing effect, Effect of positive feedback.

UNIT III:Time Domain Analysis of Control Systems: Concept of transient response, Steady state response and time response, standard test signals, Time response of first order systems, Transfer function of second order system, Time response of second order system, Time response specifications of second order system, steady state error (e_{ss}) analysis, static error constants and system type, dominant poles, Approximation of high order systems by low order systems, Relation between roots of characteristic equation, damping ratio and transient response, effect of proportional(P), Integral (I) and derivative (D) controllers on the time response concept of transportation lag.

VI Semester
EL2351- Control System

UNIT IV: **Stability of Linear Control Systems :** Concept of stability, stable, unstable and marginally stable system, Absolutely stable and conditionally stable system, Necessary conditions for stability, method to determine stability, Routh-Hurwitz stability criterion with special cases, relative stability analysis.

State Variable Analysis : Concept of state, state variables and state model, state model of linear systems, state model using physical variables, phase variables and canonical variables, state model from differential equations, block diagram and signal flow graph, transfer function from state model, stability of systems modeled in state variable form, solution of state equations, state transition matrix, its properties and computation.

UNIT V: Root LocusTechnique : Definition, magnitude and angle criteria, properties of root locus, construction rules for root locus plot of negative feedback systems, determining the gain from root locus plot, effect of addition of poles and zeros of G(s)H(s).

UNIT VI: Frequency domain analysis of control systems: Concept of frequency response and sinusoidal transfer function, resonant frequency, resonant peak, cut off frequency, bandwidth, correlation between time and frequency response, polar plot, inverse polar plot, bode plot, all pass and minimum – phase system, experimental determination of transfer function, log magnitude versus phase plot.

Stability in Frequency domain : Principle of argument, Nyquist stability criterion, Assessment of relative stability using Nyquist criterion, concept of gain margin and phase margin and its computation using polar plot and log magnitude versus phase plot. Constant M and constant N circles, Nicholas chart.

Text books:

1	Control system Engineering	5TH Edition	I. J. Nagrath & M. Gopal	New Age International
2	Automatic control systems	7th Edition	B. C. Kuo	PHI Learning Private Limited

Reference Books:

1	Sigma Series: Control Systems	1st Edition	Ashok Kumar	McGraw - Hill
2	Control systems :Principles and Design	4th Edition	M. Gopal	McGraw - Hill
3	Modern Control Engineering	5th Edition	Katsuhiko Ogata	PHI Learning Private Limited

VI Semester
EL2352- Lab.: Control System

Practical based on above syllabus are to be covered.

	TITLE
1	To study transient response of a second order system.
2	Study of Stepper Motor
3	Study of Potentiometer as an Error Detector.
4	To study the Speed Torque Characteristic of AC Servo Motor
5	To study the Frequency Response of RLC network
6	To study the Synchros a)To plot the characteristic of synchro transmitter. b)To plot the characteristic of synchro receiver
7	Study of synchro as an error detector
8	Study of DC Position Servo Mechanism
9	Verification of Root Locus using MATLAB
10	Verification of Bode Plot using MATLAB
11	To Study Effect of Type of System on Steady State Error
12	PID Controller

VI Semester
EL2353- Power System Analysis

Course Objective	Course Outcomes
After learning basic concepts of power system this subject explain functioning of power system with balance, unbalanced condition. Concept of faults, stability, grounding and economics of power system is also explained.	The student will be able to understand the 1) Symmetrical component transformation and sequence networks. 2) Symmetrical fault analysis with various faults with and without pre fault load currents. 3) Unsymmetrical fault analysis with and without fault impedance for various faults using symmetrical components. 4) Steady state and transient stability analysis of power system. 5) Economic operation of power system and representation of transmission loss using loss formula co-efficient. 6) Concept of Neutral grounding, shunt and series compensation of power system.
Mapped Program Outcomes:a,b,c,d,e,f,g,l,j	

UNIT-I: Symmetrical Fault Analysis

Define fault & its causes, effect of fault on power system, purpose of fault analysis, assumptions made for fault analysis, transient in a series R-L circuit, short circuit analysis on synchronous machine at no-load & loaded condition, selection of circuit breaker & its short circuit MVA calculation, current limiting reactors.

UNIT-II: Symmetrical Component:-

Introduction, α-operator, symmetrical components of an unbalanced Three phase system, symmetrical components of voltage & current phasors, zero sequence components of voltage & current, power in terms of symmetrical components, phase shift in star-delta transformers, sequence network for fault calculation, sequence impedances of transmission line & synchronous machines, zero sequence networks of transformers, assembly of sequence networks of power system.

UNIT-III: Unsymmetrical Fault Analysis

Assumptions made for unsymmetrical fault analysis, sequence voltages of a generator, sequence voltages at a fault point, general procedure for analysis of various fault with and without fault impedance for Line to Ground (L-G), L-L-G, L-L, Open conductors faults analysis using symmetrical components.

UNIT-IV: Power System Stability

Stability of power system:-Steady state, Dynamic and Transient stability definition, Dynamics of synchronous machine, swing equation, swing equation for machines swinging coherently and Non-Coherently. Power angle equation, Steady state stability studies.

VI Semester
EL2353- Power System Analysis

Transient stability studies: - Swing curve, Equal Area criterion for transient stability, Application of equal area criterion for different disturbances. Solutions of swing equation by point by point method. Methods of improving transient stability.

UNIT-V: Economic operation of power system

Introduction, incremental fuel cost, economic dispatch neglecting transmission losses, transmission loss as a function of plant generation, general loss formula, and optimum load dispatch considering transmission losses

UNIT-VI: System Neutral Grounding & Reactive Power Compensation

Neutral Grounding: - Introduction to neutral grounding, methods of neutral grounding, peterson coil grounding. Compensation: - Series & shunt compensation, location of series capacitors, protective schemes for series capacitors, problem associated with series capacitors, Static VAR system with its different schemes.

Text Books				
	TITLE	**EDITION**	**AUTHOR**	**PUBLICATION**
	Electrical Power System	**5TH edition 2007**	Ashfaque Hussain	**CBS**

Reference books				
	TITLE	**EDITION**	**AUTHOR**	**PUBLICATION**
	Elements of Power System Analysis	4th-1984	W. D. Stevenson	Tata McGraw Hill
	Modern Power System analysis	4th-2011	I. J. Nagrath & D. P. Kothari	Tata McGraw Hill
	Electrical Power System	3rd - 2005	C. L. Wadhawa	NEW AGE INTERNATIONAL

VI Semester
EL2354- Lab.: Simulation of Power Electronics & Power System

Course Objective	Course Outcomes
To understand Power electronics and Drives through various software available for power electronics.	Students shall be able to understand practically the 1) Use of semiconductor devices for realizing uncontrolled and controlled rectifiers. 2) The implementations of inverters without and with PWMs 3) The working and implementation of multilevel inverter and the modulation control 4) The inverter fed AC drive with open loop control.

Expt.No.	Name of Experiment
1	To study half wave uncontrolled rectifier
2	To study half wave controlled rectifier
3	To study full wave controlled rectifier
4	To study single phase H-bridge inverter(withoutPWM)
5	To study three phase bridge inverter(180 degree mode)
6	To study sinusoidal pulse width modulation(APOD,POD and IPD)
7	To study single phase H-bridge inverter using SPWM
8	Introduction to multilevel inverter and implementation of 3 and 5 level inverter
9	To study voltage sag on distribution system using symmetrical fault
10	To study inverter fed induction motor

VI Semester
EL2355- Lab. Substation Design

Course Objectives	Course Outcomes
The student will understand different aspects of substation design that is layout drawing, earthing Drawing, lighting drawing and cable wiring.	The students will be able to: CO1: Illustrate and Explain, single line diagram of substation with rating of different equipment's, types of relays required and their settings CO2: Construct plan of equipment's and panels mounted in a substation. CO3: Design earthing system of a substation.

Mapped Program Outcomes				4	

Practical based on following topics may be performed.

1) One Line diagram
2) Switchyard and control panel layout for 132 and 11 kV substation.
3) Lighting layout of substation and switchyard.
4) Substation earthing.

Text books:				
1	Handbook of Electrical Power Distribution	2nd Edition	Gorti Ramamurthy	University Press
2	Electric Power Distribution	4th edition, 1997	A.S. Pabla	Tata Mc Graw-Hill Publishing Company

VI Semester
EL2361- PE-I: Advanced Power Electronics

Course Objective	Outcomes
To study soft switching and various soft switched converters, Multilevel inverters, Pulse Width modulation with different modulation strategies are covered.	1) To gain the knowledge of semi conductor devices regarding their structure and operation. 2) Concept of converters which uses the special switching techniques 3) Operation of different multilevel and hybrid multilevel inverter topologies. 4) Various types of modulation techniques, their significance, implementation and applications. 5) Causes, effects and remedies of different power quality problems 6) Various types of harmonics, their measuring indices and elimination methods.
Mapped Program Outcomes: a,b,c,d,f,j	

UNIT-1: Power Semiconductor Devices

Power Semiconductor Devices: Metal Oxide Turn off thyristor (MTO), Metal oxide Controlled Thyristor (MCT), Emitter Turn off Thyristor (ETO), Static Induction Thyristor (SIT). Injection enhanced gate transistors (IEGT), integrated gate commutated thyristor (IGCT).

UNIT-2: Hard Switched and Soft Switched Converters

Hard Switched and Soft Switched Converters: Load Resonant Converters, Series, Parallel & Hybrid Loaded Converters, Resonant Switch Converter, Zero Current, Zero Voltage switched Resonant Converter, DC-DC Resonant link inverters, Hybrid resonant link inverters.

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UNIT-3: Multilevel Inverters

Multilevel Inverters: Diode Clamped Inverters, Flying Capacitor Inverters, Cascaded multilevel Inverters and Hybrid Cascaded Inverter. Introduction to latest multilevel inverter topologies.

UNIT-4: Modulation Techniques

Modulation Techniques: Pulse Width Modulation, Selective Harmonic Elimination (SHE) Space Vector Pulse Width Modulation (SVPWM), Random PWM.

UNIT 5: Harmonics

Harmonics: Effects within power system, Interference with Communication Harmonic Measurements and.Harmonic Indices

Unit 6:Harmonics Mitigation Techniques

Passive Filter ,Active Power Filter-Series and Shunt(Open Loop and Closed Loop Control).

VI Semester
EL2361- PE-I: Advanced Power Electronics

Text Books				
S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Power Electronics:Converters,Application and Design	2007	Ned Mohan, T.M. Undeland and W.P. Robbins	Wiley Publication(Wiley Student Edition)
2	Power Electronics;Principles and Applications	2017	Joseph Vithayathil	Tata McGraw Hill Publication (Indian Edition)
3	Power Electronics and AC Drives	2003	B.K. Bose	Pearson Education
Reference Books				
1	Power Semiconductor Circuits	1984	S.B. Dewan and Straughen	John Wiley and Sons, Inc

VI Semester
EL2362- PEI: Electrical Distribution in Power System

Course Objectives	Course Outcomes
Student will be able to understand the various Aspects of distribution system **Mapped Program Outcomes: a,b,d,f,j**	The student will be able to understand the 1) The factors which affect the performance of distribution system, nature of load, its growth and forecasting. 2) Types of feeders, its loading, causes of unbalance, fault isolation, System restoration. 3) Distribution line parameter, supports and the causes and effects of voltage drop in distribution line 4) Different method Reactive power compensation Benefits of power factor improvement. 5) To decide optimal location of substation 6) Problems with existing distribution systems and function of substation automation system

UNIT-1: Load Forecasting
Introduction, Explanation of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor, load & load characteristics, load and load duration curve, relation between load and loss factor, load curve and diversified demand, load modeling,load growth and forecasting.

UNIT-2: Distribution Feeders:
Introduction, Primary and secondary distribution, Radial and loop types, Distribution substation location and planning, Feeder loading and voltage drop considerations, Voltage drop in feeder with different loading, Engineering considerations for voltage levels and loading, causes of unbalance and unequal drops, common faults in feeders, fault location, fault isolation, restoration.

UNIT-3: Overhead lines and Cables
Introduction, Line parameters, Overhead lines, insulators and supports, cables, Insulation resistance, Voltage drop and power loss in conductors, voltage drop in ac single phase distribution system, voltage drop computation based on load density, voltage drop in underground cable distribution.

UNIT-4: Reactive power compensation and applications of capacitors
Introduction, advantages and benefits of power factor improvement, power factor improvement using capacitors: mathematical calculations, location of capacitors, application of capacitor banks for power factor improvement, sub harmonic oscillations and ferro resonance due to capacitor banks, optimum power factor for distribution system.

UNIT-5: Substation & Metering, instrumentation & Tariffs
Introduction, substation types, substation components, equipment and layouts, substation location and size, Grounding, earth connection and earthing system, measurement of power, measurement of energy, maximum demand and trivector meter, automatic meter reading (AMR), AMR systems, substation instrumentation, tariffs and billing.

VI Semester

EL2362- PEI: Electrical Distribution in Power System

UNIT-6: Distribution automation (DA) & SCADA

Problems with existing distribution systems, need for distribution automation, distribution automation, feeder automation, communication requirements for DA. Remote terminal unit (RTU), Block diagram of SCADA, Components of SCADA, Functions of SCADA, SCADA applied to distribution automation, Advantages of DA through SCADA,DA integration mechanisms, Functions of substations automation systems, state and trends of substation automation.

Text books				
1	Electrical Power Distribution Systems	2009	V. Kama Raju	Tata Mcgraw Hill Education Private Ltd., New Delhi
2	A Text Book of Electric Power Distribution Automation	1st Edition, 2010	Dr. M. K. Khedkar And Dr. G. M. Dhole,.	University Science Press

Reference books:				
1	Electric Power Distribution	4th edition, 1997	A.S.Pabla	Tata Mc Graw-Hill Publishing Company
2	Electrical Distribution System	1st Edition,2013	Dr.H.P.Inamdar	Electrotech Publication

VI Semester
EL2363- PEI: Illumination Engineering (MOOC)

Unit I:
Radiation & Colour
Eye & Vision
Different entities of illuminating systems

Unit II:
Light sources: daylight, incandescent, electric discharge, fluorescent, arc lamps and lasers
Luminaries, wiring, switching & control circuits

Unit III:
Laws of illumination; illumination from point, line and surface sources
Photometry and spectrophotometry; photocells
Environment and glare

Unit IV:
General illumination design
Interior lighting – industrial, residential, office departmental stores, indoor stadium, theatre and hospitals

Unit V:
Exterior lighting- flood, street, aviation and transport lighting, lighting for displays and signalling- neon signs, LED-LCD displays beacons and lighting for surveillance Utility services for large building/office complex & layout of different meters and protection units

Unit VI:
Different type of loads and their individual protections
Selection of cable/wire sizes; potential sources of fire hazards and precautions. Emergency supply stand by& UPS
A specific design problem on this aspect

VI Semester
EL2364- PEI: Electric Vehicles

Unit 1:- Introduction to Electric Vehicles & Vehicle mechanism

EV System, Components of an EV, History of EV, EV Advantages, EV Market, Vehicle Mechanics:- Roadway Fundamentals, laws of Motion, Dynamics of Vehicle motion (Numerical), Propulsion power, Velocity and acceleration, Propulsion system design.

Unit 2:- Battery and other alternative Energy Sources

Battery basics, lead acid battery, alternative batteries, battery parameters (Numerical), technical characteristics of battery, targets and properties of batteries, battery modeling.

Fuel cells- Basic Operation, Fuel Cell model and cell voltage, No-Load and Load voltage of a PEM(Numerical), Basic Operation of super capacitorsand ultra-capacitors, Basic Operation of flywheels.

Unit 3:- Electric Machines

Motor and engine ratings, EV and HEV motor requirements, dc and three phase ac machines, space vector representation, dq modeling, induction machine dq model, power and electromagnetic torque, permanent magnet machines, switched reluctance machines, BLDC machines(Numerical).

Unit 4:- Power Electronics and motor Drives

Electric drive components, dc drives, operating point analysis, ac drives, Buck Converter in Continuous Conduction Mode (CCM) (Numerical), Boundary Conduction Mode (BCM) (Numerical), Discontinuous Conduction Mode (DCM),PM synchronous motor drives, Switched Reluctance motor drives, design of current and speed controller.

Unit 5: Drive Train

EV transmission configuration, transmission components, gears, automobile differential, clutch, brakes, ideal gear box, EV motor sizing(Numerical).

Unit 6: Hybrid Electric Vehicle

Types of Hybrids, series and parallel HEVs, IC engines, reciprocity engines, various air cycles, design of HEV, hybrid drive train, sizing of components, rated vehicle velocity, initial acceleration, maximum velocity and maximum gradeability

Text Book: -

1) Iqbal Husain, "**Electric and Hybrid Vehicles: Design Fundamentals**", CRC Press, 2005.
2) John G. Hayes, John G. Hayes,"**Electric Powertrain- Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles**", John Wiley & Sons, 2018

VI Semester
EL2365- PEI: Electric Power Utilization

Course Objectives	Course Outcomes
Student will understand. The knowledge about energy utilization .The application of electrical energy such as lightning, heating welding, fans and pumps.	The student on completion will be able to understand 1) Types of electric heating techniques, their field of application, relative advantages and limitations. 2) Types of electric welding techniques, their field of application, relative advantages and limitations, defects in welding, new advancements in welding technology. 3) Basic concepts of illumination, various types of lamps along with their light characteristic and field of application. They will be able to design illumination system for various criterions. 4) Basic refrigeration cycle, VCRS and VARS, various types of air conditioning systems and its use as per requirement. 5) Difference between fans and blowers with respect to its characteristics , various energy saving methods to be used. They can classify pumps with respect to its characteristic and field of application. 6) Classification of compressors, application of compressors as per requirement of compressed air. They will understand basics of DG system, its major components, working under different conditions and energy saving opportunities in DG system

UNIT-1: **Electric Heating**

Introduction, Advantages of electric heating, modes of heat transfer, methods of electric heating, resistance heating, arc heating, arc furnaces, induction heating, dielectric heating, infrared and radiant heating.

UNIT-2: **Electric Welding:**

Definition, welding process, resistance electric welding, electric arc welding, submerged arc welding, MIG welding, Ultrasonic welding, laser beam welding, welding of various metals, underwater welding, defects in welding, testing of welding joints.

UNIT-3: Illumination :

Nature of light, terms used in illumination, solid angle, laws of illumination, polar curves, Colour Rendering Index (CRI), types of lamps, luminaries, Design of illumination systems, indoor lighting systems, factory lighting, outdoor lighting design, flood lighting, street lighting, energy saving in lighting systems.

VI Semester
EL2365- PEI: Electric Power Utilization

UNIT-4: Refrigeration & Air conditioning:

Terminology, refrigeration cycle, refrigeration systems (Vapor compression, vapor absorption), domestic refrigerator, water cooler, desert cooler.

Air conditioning: Factors involved in air conditioning, comfort air conditioning, industrial air conditioning, effective Temperature, summer / winter air conditioning systems, types of air conditioning systems, room air conditioning, and central air conditioning.

UNIT-5: Fans & Pumps:

Fans and Blowers: Fan types, fan performance evaluation & efficient system operation, fan design & selection criteria, flow control strategies, fan performance assessment, energy saving opportunities.

Pumps: Pump types, system characteristics. Pump curves, factors affecting pump performance, efficient pumping system operation, flow control strategies, energy conservation opportunities in pumping system.

UNIT-6: Compressors and DG Sets:

Compressors: Compressor types, Compressor efficiency, Compressed air system components.

Diesel Generating Systems: Introduction, selection and installation factors, operational factors, energy performance assessment in DG sets, energy saving measures for DG sets.

Text books:

1	Utilization of Electric Energy		E. Openshaw Taylor	Orient Longman
2	Utilization of Electric Power & Electric Traction		J.B. Gupta	Kataria & Sons
3	Art and Science of Utilization of Electrical Energy		H Partap	Dhanpat Rai & Sons, Delhi
4	Utilisation of Electrical power	1st Edition, 2006	R. K. Rajput	Laxmi Publications Pvt. Ltd.

Reference books:

	Guide book for National Certification Examination for Energy Managers and Energy Auditors			Bureau of Energy Efficiency
	Utilization of Electrical Power		Dr N. V. Suryanarayana	Wiley Eastern Ltd, New Age International

VI Semester
EL2366 – PEI: Grid Integration of Renewable Energy

Course Outcomes:

Upon successful completion of the course the students will be able to

1. Analyse the need of integrating large renewable energy sources in the existing power system.
2. Assess renewable energy applications in the context of grid integration.
3. Enhance the understanding of renewable energy policy environment.
4. Explain the impacts of renewable energy integration on grid and environment.

Unit:1	**Introduction**	**6 Hours**
Concept of nano/micro/mini grid. Need of integrating large renewable energy sources, Concept of Virtual Power Plant (VPP).		
Unit:2	**Grid Integrated Solar PV System**	**7 Hours**
Basics of solar photovoltaics: cell, modules and arrays. Structure and components required for grid connected PVsystem, it's working. Introduction to energy storage for PV application.		
Unit:3	**Grid Integrated Wind Energy Conversion System**	**6 Hours**
Structure and components required for grid connected Wind Energy Conversion System, types of wind turbines, it's working.		
Unit:4	**Policies and various schemes for Renewable Energy in India**	**7 Hours**
Introduction to Indian Energy Policy, Grid Code, Green Corridor, policy and regulatory framework for rural electrification: Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM), various other schemes (eg. JNNSM etc.)		
Unit:5	**Impact of Renewable Energy Generation on Environment**	**7 Hours**
Environmental impacts of wind power, solar power, biomass, hydroelectric power, geothermal power, Carbon credits, National action plan on climate change: 1. National Solar Mission 2. National Mission for Enhanced Energy Efficiency 3. National Water Mission 4. National Mission for a Green India 5. National Mission for Sustainable Agriculture		
Unit :6	**Impact of Renewable Energy Generation on Grid**	**7 Hours**
Importance of power quality and corresponding standards, THD, voltage regulation. Voltage rise, voltage unbalance, frequency change and its effects, system protection.		
	Total Lecture Hours	**39 Hours**

Text book	
1	Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P.Kothari, CRC Press (Taylor & Francis group), 2017.
Reference Books	
1	Renewable Energy Grid Integration, Marco H. Balderas, Nova Science Publishers, New York, 2009.
2	Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow, IET Power and Energy Series 50 (IETdigital library), 2007.
3	Integration of Alternative sources of Energy, Felix A. Farret and M. Godoy Simoes, IEEE Press –Wiley-Interscience publication, 2006.
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	Vijay Vittal, Raja Ayyanar, Grid Integration and Dynamic Impact of Wind Energyhttp://link.springer.com/openurl?genre=book&isbn=978-1-4419-9322-9
2	Francis McGowan, European Energy Policies in a Changing Environment http://link.springer.com/openurl?genre=book&isbn=978-3-7908-0951-0
MOOCs Links and additional reading, learning, video material	
1	P R Krithika and Siddha Mahajan, Background paper: Governance of renewable energy in India: Issues and challenges http://www.gpgl.in/assets/governance-of-renewable-energy-in-india-issues-challenges.pdf
2	ÇSE Presentation: Renewable Energy in India: Growth and Targets http://cseindia.org/docs/photogallery/ifs/Renewable%20Energy%20in%20India%20Growth%20and%20Targets.pdf
3	Charles K Ebinger, India's Energy and Climate Policy Can India Meet the Challenge of Industrialization and ClimateChange? https://www.brookings.edu/wp-content/uploads/2016/07/india_energy_climate_policy_ebinger.pdf
4	Guidelines Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Scheme of Government of India for rural electrification.https://www.ddugjy.gov.in/assets/uploads/1548234273fykio.pdf
5	Gisele Schmid, The development of renewable energy power in India: which policies have been effective? https://unige.ch/gsem/iee/files/3313/9574/8551/11103_v2.pdf
6	Impact of wind power on the power system imbalances in Finland, A. Helander1, H. Holttinen, J. Paatero, IET Renew.Power Generation., Vol. 4, No. 1, pp. 75–84, 2010.
7	Impact of widespread photovoltaic generation on distribution systems, M. Thomson and D.G. Infield, IET Renew. PowerGeneration, Vol. 1, No.1, pp. 33–40, 2007.
8	A. Rahman, S. Agrawal, A. Jain, "Powering Agriculture in India: Strategies to Boost Components A & C under PM-KUSUM Scheme", Council on Energy, Environment and Water (CEEW), New Delhi, India, 2021.

VI Semester
EL2367 – PEI: Switched Mode Power Supply

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Outline the basic working principle and operation of DC-DC converter 2. Design the Closed Loop Control of Power Converter 3. Describe the operation of Soft Switching Converters 4. Describe the basic working of Unity Power Factor Rectifiers

Unit:1	**DC-TO-DC Converter**	**6 Hours**
Introduction, DC-DC Converter, Switched Mode Power Converter, Versatile power converter, Isolated DC-DC Converter.		
Unit:2	**Dynamic Analysis of DC-DC Converters**	**7 Hours**
Formulation of dynamic equation of buck and boost converters, averaged circuit models, linearization technique, small-signal model and converter transfer functions		
Unit:3	**Controller Design:**	**7 Hours**
Review of frequency-domain analysis of linear time-invariant systems, concept of bode plot, phase and gain margins, bandwidth, controller specifications, proportional (P), proportional integral (PI), proportional derivative (PD) proportional integral derivative controller (PID), selection of controller parameters.		
Unit:4	**Closed Loop Control of Power Converter**	**7 Hours**
Closed loop control, closed loop performance function, Effect of Input filter on the converter performance, Design criteria for selection of Input filter.		
Unit:5	**Soft Switching Converters**	**7 Hours**
Resonant Load Converters, SMPS Using Resonant Circuit, Resonant Switch Converters: Concept of Zero voltage switching, principle of operation, analysis of M-type and L-type Buck or boost Converters. Concept of Zero current switching.		
Unit:6	**Unity Power Factor Rectifiers**	**5 Hours**
Power Circuit of UPF Rectifiers, Average Current Mode Control, Voltage Feedforward Controller, Resistor Emulator UPF Rectifiers, Non-linear Carrier Control.		
	Total Lecture Hours	**39 Hours**

Text book	
1	Course Material on Switched Mode Power Conversion Department of Electrical Engineering Indian Institute of Science Bangalore 560012 V. Ramanarayanan January 15, 2008
2	Muhammad H. Rashid, Power Electronics – Circuits, Devices and Applications, Pearson Education
3	Benjamin kuo, "Automatic Control Systems" 2008
4	R. A. Barapate, "feedback control systems" Tech Max 2009
Reference Books	
1	Robert Ericson, Fundamentals of Power Electronics, Chapman & Hall, 2004.
2	V. Ramanarayanan, Switched Mode Power Conversion, 2007.
3	Umanand.L, Power Electrionics: Essentials and Applications, Wiley India, 2009.
4	B. Jayant Baliga, Power Semiconductor Devices; PWS 1996.
5	B. S. Manke, Control System Design, 2010
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://link.springer.com/openurl?genre=book&isbn=978-1-4471-4548-6
2	http://link.springer.com/openurl?genre=book&isbn=978-0-85729-915-4
MOOCs Links and additional reading, learning, video material	
1	https://www.youtube.com/watch?v=P0MK7sWfs9k&list=PLbMVogVj5nJRY--U9E7dvmqgB9RhGuymk
2	https://www.youtube.com/watch?v=P0MK7sWfs9k&list=PLuv3GM6-gsE3onbCZCZLY2sTozcFF71xL
3	https://www.youtube.com/watch?v=HcwJKKG_LYY&list=PLwdnzlV3ogoWVgA9fHBV36L_bxWZlpa7X

VI Semester
EL2368 – PEI: Programming in C for beginners

Course Outcome
Upon successful completion of the course the students will be able to 1.Write algorithms, flowcharts and programs. 2.Implement different programming constructs and decomposition of problems into functions. 3.Use and implement data structures like arrays and structures to obtain solutions. 4.Define and use of pointers with simple applications.

UNIT I: Introduction to C Programming

Introduction to Computing: Introduction, Art of Programming throughAlgorithms and Flowcharts

Overview of C: History and importance of C, Basic structure of C program, executing a C program.

Constants, Variable and Data Types: Introduction, Character Set, C Tokens, Keywords and Identifiers, Constants, Variables, Data Types, Declaration of Variables, Assigning Values to Variables, Defining Symbolic Constants.

Managing Input and Output Operations: Reading a Character, Writing a Character, Formatted Input, Formatted Output.

Operators and Expressions: Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Type Conversions in Expressions, Operator Precedence and Associativity.

UNIT II: Control Structures

Decision Making and Branching: Introduction, Decision Making with IF Statement, Simple IF Statement, the IF-ELSE Statement, Nesting of If-ElseStatements, The Else If Ladder, The Switch statement, Operator, The goto statement.

Decision Making and Looping: Introduction, The while Statement, The do statement, The For statement, Jumps in LOOPS.

UNIT III: Introduction to Arrays and Strings

Arrays: One-dimensional Arrays, Declaration of One-dimensional Arrays, Initialization of One-dimensional Arrays, Example programs- Bubble sort, Selection sort, Linear search, Binary search, Two-dimensional Arrays, Declaration of Two-dimensional Arrays, Initialization of Two-dimensional Arrays, Example programs-Matrix Multiplication, Transpose of a matrix.

Character Arrays and Strings: Declaring and Initializing String Variables, Reading Strings from Terminal, Writing Strings to Screen, Arithmetic Operations on Characters, String-handling Functions, Example Programs.

UNIT IV : FUNCTIONS
User-defined Functions: Need for functions, Elements of User-definedFunctions, Definition of Functions, Return Values and their Types, FunctionCalls, Function Declaration, Category of Functions, No Arguments and noReturn Values, Arguments but no Return values, Arguments with ReturnValues, No Arguments but Returns a Value, Passing Arrays to Functions,Recursion, The Scope, Visibility and Lifetime of variables.
UNIT V: POINTERS AND STRUCTURES
Pointers: Introduction, Declaring Pointer Variables, Initialization of Pointervariables, accessing a Variable through its Pointer, Pointer Expressions, Pointer Increments and Scale Factor. **Structures:** Introduction, Defining a structure, declaring structure variables,accessing structure members, structure initialization, array of structures.
UNIT VI: FILE MANAGEMENT
File Management in C: Introduction, Defining and opening a file, closing a file, Input/output and Error Handling on Files.

Text Books:				
Sr.No.	**Title**	**Edition**	**Author**	**Publisher**
1	"Programming in C"	8th Edition	E. Balaguruswamy	McGraw Hill Education
Reference Book:				
	Title	**Edition**	**Author**	**Publisher**
1	Programming in C	2nd Edition	Pradip Dey, Manas Ghosh	Oxford University Press
2	The C Programming Language	2nd Edition	Kernighan B.W and Dennis M. Ritchie	Pearson Education India
3	Let Us C	16th Edition	Yashavant P. Kanetkar	BPB Publications
4	Problem Solving with C		Jacqueline A Jones and Keith Harrow	Pearson Education
5	C Programming for Problem Solving"		Dr. Guruprasad Nagraj	Himalaya Publishing House
Weblinks and Video Lectures (e-Resources):				
1	http://elearning.vtu.ac.in/econtent/courses/video/BS/14CPL16.html https://nptel.ac.in/courses/106/105/106105171/ https://nptel.ac.in/courses/106104128			

VI Semester
EL2371- OEIII: Renewable Energy Generation System

Course Objective	Course Outcomes
This subject introduce the different renewable energy sources to the students. Students get knowledge of Electric Power generation by wind, solar, small hydro.	1. Basic aspects of renewable energy supply presenting fundamental characteristics of the resource base (solar radiation, wind energy, geothermal, etc.) and principles of related technical systems (photovoltaic, wind, hydroelectric power generation, etc.).Fundamentals of fuel cells. 2. Solar radiation geometry , basic concepts of solar energy to heat conversion, different types of solar energy collectors with different applications. 3. Concepts of wind energy conversion system, types of WECS and their connection with the grid. 4. Basics of geological process, tapping geothermal energy, biomass energy resources and its conversion processes. 5. Basic concept of Mini & Micro hydro-plants with site selection criteria. 6. Basic concepts of energy from ocean including tidal and wave energy with focus on conversion cycles from ocean energy to electrical energy.

UNIT-1: Introduction

Fundamentals of Renewable / Non-renewable Energy Sources, Renewable Energy sources, Renewable Energy Potential in India, Renewable Energy Sources and their sustainable development. Storage methods for renewable energy sources

UNIT-2: Solar Energy

Principles, scope and applications, solar radiation, its measurement & prediction, flat plate collectors-design & theory, solar water heating, solar dryers, solar stills, solar cooling and refrigeration. Solar cells, thermal storage, street lighting, solar power generation.

UNIT-3: Wind Energy

Introduction, Historical development, Wind energy resources, sites identification, blade element theory, aero-foil design, component of wind energy conversion system, wind turbine generator classification, and windmill and wind electrical generator, Advantages, disadvantages, economics and present status of wind energy generation systems, grid connection of wind energy.

VI Semester
EL2371- OEIII: Renewable Energy Generation System

UNIT-4: Geothermal Energy and Biomass Energy

Introduction, history of geothermal resources, basics of geological process, dry rock and hot aquifer analysis, geothermal exploration, geothermal well drilling and fluid extraction, utilization of geothermal resources, geothermal heat pump, site of geothermal energy in India. Biomass energy resources and conversion processes, urban waste to energy conversion.

UNIT-5: Mini & Micro hydro-plants

Introduction, Classification of water turbines, hydroelectric system, essential components of hydroelectric system, system efficiency, advantages and disadvantages of hydroelectric system, present Indian power scenario of mini-micro hydro.

UNIT-6: Ocean Energy

Ocean thermal energy conversion (OTEC), Open cycle and closed cycle OTEC, Ocean wave energy conversion, tidal energy conversion. Introduction of Fuel cells.

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Non Conventional Sources of Energy	**4th edition**	G.D.Rai	Khanna Publisher
2	Energy Technology:Nonconventional Renewable and Conventional	,	S. Rao and B.B Parulekar	Khanna Publisher New Delhi

Reference books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Solar Energy : Principles of Thermal collection and storage	**3rd edition,1994**	S.P.Sukhatme,J.K.Nayak	Tata McGraw Hill
2	Wind and Solar Power System		M. R. Patel	CRC Press, New York
3	Renewable Energy Sources Basic Principles and Applications		G. N. Tiwari and M. K. Ghoshal	Narosa Publishing House,New Delhi

VI Semester
EL2372- OEIII: Electrical Machines and their Applications

Course Objective	Course Outcomes
This subject introduce the applications of different machines and commonly used drives.	1. To explain speed-torque characteristics, need for starters, starting methods and braking of AC and DC motors. 2. To build/apply criterion for selection of motors, duty cycle, enclosures, transmission system and insulation classes. 3. To illustrate/interpret/explain the principle, operation and construction of 1-phase and 3-phase transformers and autotransformers. 4. To show/define the principle. Construction, types, characteristics and performance of special machines like BLDC, Stepper motor and Universal motor

Unit 1: Introduction to Drives and Speed Control:

Classification of Drives, brief idea about commonly used drives (AC and DC) drives in industry, speed- torque characteristics of different drive motors, their behaviour under starting and running conditions.

Unit 2:

Need of starter, Starting methods, Braking and Speed Control of AC and DC motors.

Unit 3: Selection Criterion for Drive Motors:

Criterion for selection of motors, Duty Cycle, Power Rating for Continuous and Intermittent Duty Cycles, Environment and Enclosures, Transmission System, Insulation Classes.

Unit 4: Single Phase transformer

Review of Principle, constant flux machine, losses, efficiency etc., Operation on load (Phasor diagrams), Voltage regulation, effect of load power factor on regulation, Application of Single phase transformer in Electronic circuitry, autotransformer, welding transformer, furnace transformer.

Unit 5: Three Phase Transformer.

Concept of three phase transformer, Comparison between unit and bank of single phase transformer, connections,

All Day Efficiency, application in power system.

VI Semester
EL2372- OEIII: Electrical Machines and their Applications

Unit 6: Special Machines:

Brushless DC motor: - Principle, construction , operation, converter for BLDC, rotor position sensor (Hall Sensor), Stepper motor: types, slewing, torque-speed characteristics, stepper motor converter, Universal motor, applications Applications of three phase and single phase induction motors in cement industry, steel rolling mill, textile mill, etc.

Text books

S.N	Title	Year/Edition	Author	Publisher
1	A Course in Electrical Power	First-2005	Soni, Gupta, Bhatnagar	Dhanpat Rai and Company
2	Fundamentals of Electric Drives	2nd Edition	G. K.Dubey	Narosa Publications
3	Electric Machines	2nd Edition	Ashfaq Husain	Dhanpat Rai and Company

Reference Books:

Sr. No.	Title	Year/Edition	Author	Publisher
1	A Course in Electrical Power	First-2005	Soni, Gupta, Bhatnagar	Dhanpat Rai and Company
2	Fundamentals of Electric drives	2nd Edition	G. K.Dubey	Narosa Publications
3	Electric Machines	2nd Edition	Ashfaq Husain	Dhanpat Rai and Company

VI Semester
EL2373 - OEIII: Testing and Maintenance of Electrical Machines

Course Objective	Course Outcomes
To adopt various testing and maintenance procedures for electrical equipment's by providing effective insulation to enhance their life and working condition	The students will be able to: CO1: Classify, the causes of hazards, accidents, shock and the remedial action taken against the electrical shock. CO2: Demonstrate, apply and evaluate different types of tests and the various maintenance techniques to be employed on various electrical machines and it installation. CO3: Demonstrate, apply and estimate the factors affecting the life of insulation, its testing and maintenance. CO4: Explain, develop and determine the various tests to be conducted on distribution transformer, I. S. Standards.
Mapped program outcomes:1,6,7,8,12	

Unit 1: Safety & Prevention of Accidents

Definition of terminology used in safety; safety, hazards, accident, major accident hazard, responsibility, authority, accountability, monitoring, I.E. Act & statutory regulations for safety of persons & equipments working with electrical installation, Dos & don"ts for substation operators as listed in IS Meaning & causes of electrical accidents factors on which severity of shock depends, Procedure for rescuing the person who has received an electric shock, methods of providing artificial respiration, Precautions to be taken to avoid fire due to electrical reasons, operation of fire extinguishers.

Unit 2: General Introduction

Objectives of testing significance of I.S.S. concept of tolerance, routine tests, type tests, special tests, Methods of testing a) Direct, b) Indirect, c) Regenerative. Concept of routine, preventive & breakdown maintenance, advantages of preventive maintenance, procedure for developing preventive maintenance schedule, Factors affecting preventive maintenance schedule. Introduction to total productive maintenance.

Unit 3: Testing & maintenance of rotating machines

Type tests, routine tests & special tests of 1 & 3 phase Induction motors, Routine, Preventive, & breakdown maintenance of 1 & 3 phase Induction motors as per IS 9001:1992. Parallel operation of alternators, Maintenance schedule of alternators & synchronous machines as per IS 4884-1968. Brake test on DC Series motor.

VI Semester
EL2373 - OEIII: Testing and Maintenance of Electrical Machines

Unit 4: Testing & maintenance of Insulation

Classification of insulating materials as per I.S. 8504(part III) 1994, factors affecting life of insulating materials, measurement of insulation resistance & interpretation of condition of insulating. Methods of measuring temperature of internal parts of windings/machines & applying the correction factor when the machine is hot.

Unit 5: Testing & maintenance of Transformer

Listing type test, routine test & special test as per I.S. 2026-1981. Procedure for conducting following tests:

Measurement of winding resistance, no load losses, & no load current, Impedance voltage, load losses, Insulation resistance, Induced over voltage withstand test, separate source voltage withstand test, Impulse voltage withstand test, Temperature rise test of oil & winding, Different methods of determining temp rise- back to back test, short circuit test, open delta (delta – delta) test. Preventive maintenance & routine maintenance of distribution transformer as per I.S. 10028 (part-III): 1981, Periodic checks for replacement of oil, silica gel, parallel operation of 1 & 3 phase transformer, load sharing calculations (numerical).

Unit 6: Installation

Factors involved in designing the machine foundation, Requirement of different dimension of foundation for static & rotating machines procedure for levelling & alignment of two shafts of directly & indirectly coupled drives, effects of misalignment. Installation of rotating machines as per I.S. 900-1992. Use of various devices & tools in loading & unloading, lifting, carrying heavy equipment.

Text Books:

S. N.	Author	Title	Publisher
01.	B. V. S. Rao	Operation and Maintenance of Electrical machines Vol - I	Media Promotors & Publisher Ltd. Mumbai
02.	B. V. S. Rao	Operation and Maintenance of Electrical machines Vol - II	Media Promotors & Publisher Ltd. Mumbai

Reference Books:

S. N.	**Author**	**Title**	**Publisher**
01.	B. L. Theraja	Electrical Technology Vol I to IV	S. Chand & Co., New Delhi
02.	C. J. Hubert	Preventive Maintenance Hand Books & Journals	----------

VI Semester
EL2381 - OEIV: Electrical Energy Audit and Safety

Course Objectives	Course Outcomes
Understand various operating characteristics of electrical equipments, its monitoring, tools used in comprehensive energy audit and its procedure to save the electricity with and without investment, calculation of energy saving and its global impact	The students will be able to: CO1: Classify, the energy sources, methods of energy conservation and its pattern, electricity act 2003. CO2: Demonstrate, apply and evaluate different forms of electrical and thermal energy. CO3: Demonstrate, apply and estimate the Energy Management, Energy Audit, Energy Monitoring and Targeting. CO4: Explain, develop and determine the various Global Environmental Concerns and Electrical safety procedures. 1) Mapped program outcomes:1,3,5,6,7,8,9,10,12

UNIT-1: Energy Scenario

Commercial and Non-commercial energy, primary energy sources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance. Re-structuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features, Salient Features of Electricity Act 2003.

UNIT-2: Basics of Energy and its various forms

Electricity basics- DC & AC currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT-3 : Energy Management & Audit

Definition, need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

UNIT-4: Energy Monitoring and Targeting

Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM).

VI Semester
EL2381 - OEIV: Electrical Energy Audit and Safety

UNIT-5: Global environmental concerns

United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon fund (PCF).

UNIT-6: Electrical Safety

Primary hazards associated with electricity. Control measures and safety-related work practices to minimize the risk associated with electrical hazards. Response procedures in the event of electrical shock or fire.

Text Books:			
S. N.	**Author**	**Title**	**Publisher**
01	Archie,W Culp	Principles of Energy Conversion	McGraw Hill
02	Wayne C Turner	Energy Management Handbook Bureau	John Willey and Sons
03		Bureau of Energy Efficiency Study Material for Energy Managersand Auditors Examination	Bureau of Energy Efficiency www.beeindia.in

Reference Books:			
S. N.	**Author**	**Title**	**Publisher**
01.	Amit Kumar Tyagi	Handbook on Energy Audit and Management	TERI

VI Semester
EL2382 - OE IV: Utilization of Electrical Energy

Course Objectives	Course Outcomes
To understand the basic principle of electrical heating, welding, illumination, refrigeration and air conditioning, fans, pumps, compressors and digi sets.	On completion of this course, students will be able to 1. understand working of various electric heating equipment 2. understand electric welding methods and its operation 3. understand nature of light and design various lighting schemes and fittings in use 4. Understand operation of refrigeration , AC system 5. figure-out the different schemes of traction schemes and its main components. Design a suitable scheme of speed control for the traction systems 1) understand economics of various power generating units, tariff

UNIT 1: Electric Heating:

i) Electric Heating : Types and methods of electrical heating, advantages of electrically produced heat Types & application of electric heating equipment"s, transfer of heat.
ii) Resistance Ovens: General constructions, design of heating elements, efficiency & losses, radiant heating.
iii) Induction heating: Core type & core less induction furnace, indirect induction oven, medium and high frequency eddy - current heating.
iv) Dielectric heating: Principle and application.
v) Arc furnace: Direct & indirect arc furnace, power supply, characteristics & control.

UNIT-2: Electric Welding:

i) Importance, Advantages & Disadvantages of welding, classification of welding processes.
ii) Resistance welding, Butt welding, Spot welding, Projection welding, Seam welding.
iii) Electric arc welding: carbon arc welding, metal arc welding, submerged arc welding, Welding positions, Types of welding electrodes
iv) Ultrasonic welding, electron beam welding, laser beam welding.

UNIT-3: Illumination:

Nature of light, terms used in illumination, solid angle, laws of illumination, polar curves, Colour Rendering Index (CRI), types of lamps, luminaries, Design of illumination systems, indoor lighting systems, factory lighting, outdoor lighting design, flood lighting, street lighting, energy saving in lighting systems.

UNIT-4: Refrigeration & Air conditioning:

Terminology, refrigeration cycle, refrigeration systems (Vapour compression, vapour absorption), domestic refrigerator, water cooler, desert cooler.

Air conditioning: Factors involved in air conditioning, comfort air conditioning, industrial air conditioning, effective temperature, summer / winter air conditioning systems, types of air conditioning systems, room air conditioning, and central air conditioning.

VI Semester
EL2382 - OE IV: Utilization of Electrical Energy

UNIT-5: Electric Traction

Traction system, requirement of an ideal traction system, different systems for traction, system of railway electrification, comparison between AC and DC systems, power supply for electric traction system, overhead equipments (collector gear for overhead equipments, conductor-rail equipment)Speed- Time curve for train movement, crest speed, average speed and schedule speed, simplified speed-time curve

UNIT-6: Economics of Power Generation, Electric Power Supply and Utilization

Terms and Definitions, base load and peak load, selection of power plant equipment (boilers, prime-movers, size and number of generating units), economics in plant selection, economics of hydroelectric power plant, economics of combined hydro and steam power plant, performance and operating characteristics of power plants, power plant useful life, tariff for electrical energy, objective and requirements of tariff, general tariff forms, comparison between private generating plant and public supply.

Text books:

S. N	TITLE	EDITION	AUTHOR	PUBLISHER
1	Utilization of Electric Power & Electric Traction		J.B. Gupta	Kataria & Sons
2	Art and Science of Utilization of Electrical Energy		H Pratap	Dhanpat Rai & Sons, Delhi
3	Utilization of Electrical Power		R. K. Rajput	Laxmi Publications Pvt. Ltd.

Reference books:

	TITLE	EDITION	AUTHOR	PUBLISHER
1	Guide book for National Certification Examination for Energy Managers and Energy Auditors			Bureau of Energy Efficiency
2	Utilization of Electrical Power		Dr N. V. Suryanarayana	Wiley Eastern Ltd, New Age International
3	Utilization of Electrical Energy		E.Openshaw Taylor	Orient Longman

VI Semester
EL2383 - OEIV: Power System Engineering

Unit 1: Introduction to Power System

Restructuring of power sector, Constituents of present day power system, sources of electrical energy, types and characteristics of generating stations: Thermal, hydro, nuclear , solar ,wind and other renewable, salient features of electricity act 2003.

Unit 2: Load on Power Stations

Load, Important terms and factors, and Units generated per annum , Load duration curve , Types of loads, Load demand and diversity factors, Load curves and selection of generating units, Base load and peak load on Power station, Method of meeting the load ,Interconnected grid system.

Unit 3: Transmission System I

Electric supply system, A.C power supply scheme, D.C transmission scheme, Comparison of AC and DC transmission system, advantages of A.C. transmission system, Comparison of various transmission system (Two wire dc system, Single phase two wire A.C system, Single phase three wire system , three phase three wire system, Three phase four wire system) Elements of transmission line, Economic choice of transmission voltage, requirements of satisfactory electric supply, Concept of HVDC transmission.

Unit 4: Transmission System II

Line support insulators, types of insulators (pin type, suspension type, strain type, shackle type), Commonly used conductor material, concept of corona, factor affecting corona, advantages and disadvantages of corona, methods of reducing corona effect, Sag and its effects, Constants of transmission line (R, L and C) , Resistance of transmission line, skin effect , Classification of overhead transmission line and voltage regulation .

Unit 5: Distribution System

Classification of distribution system, Types of distribution AC and DC, Overhead verses underground system, Requirements of distribution system, Design consideration of distribution system, AC distribution types, Voltage drop calculations in different distribution system , importance of voltage control, location of voltage control equipment and its methods, Tap changing transformer , Concept of tariff, desirable characteristics of tariff, types of tariff.

Unit 6: Introduction to Switchgear

Essential features of switchgear, switchgear equipment's, switches, fuses, circuit breakers, relays, HRC fuses, Bus Bar arrangement (single bus system, One and half feeder ,Main and transfer bus system) , MCB, MCCB, ELCB Introduction to Instrument transformer Current Transformer (CT) and Potential transformer (PT).

VI Semester
EL2383 - OEIV: Power System Engineering

Text books:				
	Title	**Edition**	**Author**	**Publication**
1.	Power System Analysis	1st edition 2007	T.K. Nagsarkar, M.S. Sukhija	Oxford
2.	Principles of Power System	2nd edition 2005	V.K.Mehta, Rohit Mehta	S.Chand
3.	Electrical Power System	5th edition 2007	Ashfaque Hussain	CBS

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering
SoE & Syllabus 2020
7th & 8th Semester
Electrical Engineering

28 June 2019

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

SoE No. EL-202.1

B.TECH SCHEME OF EXAMINATION 2020-21

(Revised Scheme of Examination w.e.f. 2022-23 onward)

Electrical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Seventh Semester														
1	7	PC	EL2401	Switchgear & Protection	**T**	3	0	0	3	3	30	20	50	3 Hours
2	7	PC	EL2402	Lab.:Switchgear & Protection	**P**	0	0	2	2	1		60	40	
3	7	PC	EL2403	High Voltage Engineering	T	3	0	0	3	3	30	20	50	3 Hours
4	7	PC	EL2404	Lab.:High Voltage Engineering	**P**	0	0	2	2	1		60	40	
5	7	PE		**Professional Elective II**	**T**	3	0	0	3	3	30	20	50	3 Hours
6	7	PE		**Professional Elective III**	**T**	3	0	0	3	3	30	20	50	3 Hours
7	7	PE		**Professional Elective IV**	**T**	3	0	0	3	3	30	20	50	3 Hours
8	7	STR	EL2409	Mini Project	**P**	0	0	4	4	2		60	40	
9	7	STR	EL2410	Campus Recrutment Training (CRT)	**P**	0	0	0	0	2		100		
					TOTAL	**15**	**0**	**8**	**23**	**21**				

Professional Electives -II

1	7	PE	EL2411	**PEII:** Fundamentals of Power Quality
2	7	PE	EL2412	**PEII:**Electrical Installation Design
3	7	PE	EL2413	**PEII:**Electrical Machine Design
4	7	PE	EL2421	**PEII:** Power System Operation and Control
5	7	PE	EL2428	**PEII:** Sensors and Actuators
6	7	PE	EL2429	**PEII:** Micro Grid

Professional Electives -III

7	7	PE	EL2422	**PEIII**:FACTS Devices
8	7	PE	EL2423	**PEIII**: Electrical Energy Management and Audit
9	7	PE	EL2424	**PEIII:**Advanced Control System
10	7	PE	EL2425	**PEIII:**Artificial Intelligence Based System
11	7	PE	EL2426	**PEIII:** Converters and Configurations of Renewable Energy Systems
12	7	PE	EL2427	**PEIII:** Distributed Generation in Power System

Professional Electives -IV

13	7	PE	EL2431	**PEIV:**Advanced Electrical Drives
14	7	PE	EL2432	**PEIV**:Fundamentals of Smart Grid
15	7	PE	EL2433	**PEIV**:Computer Methods in Power System
16	7	PE	EL2434	**PEIV**:EHVAC-HVDC Transmission
17	7	PE	EL2436	**PEIV:**Project Planning
18	7	PE	EL2437	**PEIV:** Industrial Safety

Coursera Electives				
1	6	PE	EL2366	**PEI**:Energy Production, Distribution and Safety
1	7	PE	EL2435	**PEIV**: Power Electronics Specialization

MSEs* = Two MSEs of 15 Marks each will conducted and marks of these 2 MSEs will be considered for Continuous Assessment

TA ** = for Theory : 5 marks on lecture quizzes, 11 marks on TA2+TA4 activitied decided by course teacher, 4 marks on class attendance

TA = for Practical : MSPA will be 15 marks each**

		June 2020	**1.04**
Chairperson	**Dean (Acad. Matters)**	**Date of Release**	**Version**

Applicable for AY 2020-21 Onwards

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

SoE No. EL-202.1

B.TECH SCHEME OF EXAMINATION 2020-21

(Revised Scheme of Examination w.e.f. 2022-23 onward)

Electrical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Eigth Semester														
1	8	STR	EL2451	Major Project	**P**	0	0	12	12	9		60	40	
2	8	STR	EL2452	Extra curricular Activity Evaluation	**P**	0	0	0	0	1		100		
				TOTAL		**0**	**0**	**12**	**12**	**10**				
				GRAND TOTAL		**86**	**0**	**46**	**132**	**163**				

MSEs* = Two MSEs of 15 Marks each will conducted and marks of these 2 MSEs will be considered for Continuous Assessment

TA ** = for Theory : 5 marks on lecture quizzes, 11 marks on TA2+TA4 activitied decided by course teacher, 4 marks on class attendance

TA = for Practical : MSPA will be 15 marks each**

		June 2022	**1.05**	**Applicable for AY 2022-23 Onwards**
Chairperson	**Dean (Acad. Matters)**	**Date of Release**	**Version**	

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B.Tech SoE and Syllabus 2020

(Revised Scheme of Examination w.e.f. 2021-22 onward)

ELECTRICAL ENGINEERING

VII Semester

EL2401 : Switchgear and Protection

Objective	Course Outcome
The student should be able to 1. The theory and applications of the main components used in power system Protection. 2. The protection systems used for electric machines, transformers, bus bars, Transmission lines. 3. The theory, construction, and applications of main types of circuit breakers. 4. To design the feasible protection systems needed for each main part of a power system.	On completion of this course, the student will be able to 1) Explain and define the various basic principles of protection system 2) Compare & apply overcurrent protection Principle 3) Develop , Compare & Solve the problems of distance protection. 4) Explain , Justify and Compare the types of circuit breaker **5)** Explain, Determine and decide the Equipment Protection

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Explain and define the various basic principles of protection system	1						1							
CO2	Compare & apply overcurrent protection Principle	1	1	2				1		1		1	1	2	1
CO3	Develop , Compare & Solve the problems of distance protection.	1	1	2				1		1		1	1	2	1
CO4	Explain , Justify and Compare the types of circuit breaker	1		1				1					1	2	
CO5	Explain, Determine and decide the Equipment Protection	1	1	1				1		1		1	1	2	1

Unit No.	Contents	Max. Hrs.
1	**Introduction** General Philosophy of Protective Relaying:- Protective Zones. Primary Protection, Back up protection. Primary and Local Back Up. Desirable properties of relay. Introduction to Static relays: - Comparison of static and electro-mechanical relays, two input amplitude and phase comparators. Introduction to Numerical relays:- Basic elements of digital protection, Signal conditioning subsystem, Conversion system subsystem & Digital processing relay subsystem.	7
2	**Overcurrent Protection** Medium voltage Line Protection: Overcurrent relaying, directional overcurrent relays.	7

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

VII Semester
EL- 2401 Switchgear and Protection

Unit No.	Contents	Max. Hrs.
3	**Distance protection** High voltage line Protection: - Distance relays, carrier distance schemes, Generation of various distance relay characteristics using static comparators.	7
4	**Circuit Breaker** **Circuit breakers** Switchgear : Circuit breakers Arc interruption theory, recovery and Restriking voltage ,RRRV, breaking of inductive & capacitive currents, C. B. rating, different media of arc interruption, overview of oil circuit breakers, Air blast, SF6 and vacuum breakers.	6
5	**Equipment Protection** Equipment Protection: Principles of differential relaying, protection, transformers and busbars by differential relaying and other relays. Miniature circuit breakers, moulded case circuit breaker, release, earth leakage circuit breaker.	7
6	**Equipment Protection** **Protection of Generators** Various Faults and Abnormal Operating Conditions, Transverse Differential Protection, Rotor Faults, Abnormal Operating Conditions, Loss of Prime Mover **Protection of Induction Motors** Various Faults and Abnormal Operating , Inter-turn Faults, Abnormal Operating Conditions from Supply Side and Mechanical Side, Overload. Fuse (wire and HRC).	6

Text Books

SN	Title	Edition	Authors	Publisher
1	Protection and Switchgear	2012	R.P.Maheshwari, Nilesh G.Chothani, Bhavesh Bhalija	Oxford University Press
2	Switchgear and Protection	2003	S.R.Bhide and Y.G. Paithankar	PHI
3	Power System Protection and Switchgear	2007	Badri Ram	TMH.
4	Switchgear and Protection	**1990**	S. S. Rao Khanna	

Reference Books

SN	Title	Edition	Authors	Publisher
1	The Art and science of protective relaying	**1992**	Russel, Mason	Wiley Eastern
2	Computer relaying for power system	2009	Arun G. Phadke and JamesThorpe	S John Wiley

VII Semester
EL 2402 - Lab: Switchgear and Protection

Minimum 8 practicals to be performed

S.N	TITLE
1	Design a protection system to protect system for given fault currents & plot the characteristics of relay used *(IDMT)*
2	Design a protection system to protect system for fault direction & plot the characteristics of relay used
3	Design a protection system to protect system for Reactance fault only & plot the characteristics of relay used
4	Design a protection system to protect system for Impedance type fault & plot the characteristics of relay used
5	Plot the Characteristics of Numerical Relay L&T make *MC61C*
6	Study of Differential Protection Scheme
7	Study of Relay Test set & to verify Relay Characteristics of *ICM21N*
8	Identify Different Circuit Breaking Devices
9	To Study ANSI Device Numbers (ANSI - American National Standards Institute)
10	To study MICOM P430 distance protection relay.
11	To Study Minliec make SPPR & Overload Relay
12	To study Generator Protection Scheme*
13	To study Feeder Protection Scheme*
14	To Study Percentage biased Differential Protection

VII Semester

EL2403 - High Voltage Engineering

Objective	Course Outcome
The course objective is understanding of high-voltage phenomena, and the basics of high voltage insulation design with the analytical and modern numerical tools available to high-voltage equipment designers. The areas covered comprise a short but fundamental introduction to dielectric properties of materials, non-destructive tests applicable also to on-site monitoring of power equipment. The purpose of this is to provide information on transient and temporary over voltages and currents in end-user AC power systems	**On completion of this course, the student will be able to** 1) Explain Breakdown of various dielectrics and calculate their breakdown voltage. 2) Explain causes of overvoltage's due to lightning and switching and protective devices used for the same. 3) Explain propagation of travelling waves along with insulation coordination. 4) Explain generation and measurement of high voltage and current. 5) Explain Non-destructive and high voltage testing of electrical apparatus.

CO	Statement	Mapped PO												PSO	
		PO 1	PO	PO	PO	PO	PO	PO	PO	PO	PO 10	PO 11	PO 12	PS 1	PS 2
CO	Explain Breakdown of various dielectrics and calculate their breakdown voltage	2	3	1	1								1	2	
CO	Explain causes of overvoltage's due to lightning and switching and protective devices used for the same.	2	3	1	1								1	2	
CO	Explain propagation of travelling waves along with insulation coordination.	2	3	3	1								2	2	
CO	Explain generation and measurement of high voltage and current	2	3	3	1								2	2	
CO	Explain Non-destructive and high voltage testing of electrical apparatus.	2	3	3	1								2	2	

VII Semester
EL2403 - High Voltage Engineering

Unit No.	Contents	Max. Hrs.
1	**Breakdown Mechanism in Dielectrics** Ionisation process : Townsend"s criterion for breakdown, Break-down in electro-negative gases, Time -lag for breakdown, Streamer theory for breakdown in gases, Paschen's law, Breakdown in non-uniform fields, corona discharges and introduction of corona, post breakdown phenomenon and applications, practical considerations in using gases for insulation purposes, vacuum insulation, liquid as insulators, conduction and breakdown in pure and commercial liquids. Intrinsic electromechanical and thermal breakdown. Breakdown of solid dielectric in practice, breakdown in composite dielectric.	7
2	**Lightning and switching over voltages** Mechanism of lightning types of strokes, parameter and characteristics of lightning strokes, characteristics of switching surges; power frequency over voltages, control of over voltages due to switching. Protection of lines by ground wire, protection by Lightning Arrester (LA), gap type and gapless LA, selection of LA ratings, Surge absorbers.	7
3	**Travelling Waves and Insulation Co-ordination** Travelling waves on transmission lines, classifications of lines, attenuation and distortion of travelling waves, reflection and transmission of waves, behaviour of rectangular waves at transition points. Introduction to insulation co-ordination and associated terms, impulse wave-form, introduction to Basic Insulation Level (BIL), Reduced BIL and Switching Impulse Level (SIL).	6
4	**Generation of High Voltage and Currents** Generation of High D.C. voltages by rectifiers, voltage doubler and multiplier circuits (Derivation not required) electrostatic machines. Generation of high ac voltage by cascade transformers, resonant transformers. Generation of high impulse voltages: Standard impulse wave shapes, analyses of model and commercial impulse generation circuits, waveshape control, Marx Circuit, tripping and control of impulse generation, generation of switching surges, generation of impulse current.	7
5	**Measurement of High Voltage and Current** Measurement of high AC and DC voltages by micro ammeter, generating voltmeters, resistance and capacitance potential dividers, series impedance voltmeter, Capacitive Voltage Transformer (CVT), Magnetic type potential transformers, electrostatic voltmeter, peak reading AC voltmeters, sphere gap arrangement, measurement of impulse voltage by potential dividers and peak reading voltmeters. Measurement of High AC/DC currents: Measurement of high frequency and impulse current by resistive shunts (Bifilar strip shunt only).	7
6	**Non Destructive and High Voltage Testing of Electrical Apparatus** Non-destructive testing : Measurement of DC Resistivity, measurement of dielectric constant and loss-factor (low and power frequency only), Schering bridge for high voltage circuits, for high dissipation factor for three terminal measurements, transformer ratio arm bridges, partial discharge measurements by straight detector, balance detectors, calibration of detectors, discharge detection in power cables. High voltage testing: Testing of insulators, bushings, isolators, circuit breakers, cables, transformers, lightning arresters and power capacitors.	6

VII Semester
EL2403 - High Voltage Engineering

Text books:				
SN	**Title**	**Edition**	**Author**	**Publisher**
1	EHV AC Transmission	2nd	R.D.Begamudre	New Age international Publisher
2	High Voltage Engineering	3rd -2006	M. S. Naidu and V. Kamaraju	Mc GrawHill Publisher
3	High Voltage Engineering	1st -1994	C.L. Wadhwa	New Age international Publisher

Reference Books				
SN	**Title**	**Edition**	**Authors**	**Publisher**
1	Advances in High Voltage Engineering	**2004**	M.Haddat and Warne	IET

VII Semester
EL2404 – Lab : High Voltage Engineering

Minimum 8 practicals to be performed

S.N	TITLE
1	Study of High Voltage Laboratory Equipments.
2	Calibration of Panel Voltmeter by Sphere Gap.
3	Study of Corona effect
4	Study of Movement of arc in horn gap
5	To determine Flash over voltage test: 11 kV pin type insulator.
6	Determination of string efficiency of suspension insulator
7	Determination of breakdown voltage for transformer oil sample
8	Determination of breakdown voltage for solid insulator
9	To study Cable Fault locator
10	Measurement of Resistivity of Transformer oil. .
11	Measurement of dielectric constant of transformer oil.
12	Measurement of Loss Angle of transformer oil
13	Study of 100 kV AC/ 140 kV DC test set and calibration of Panel Voltmeter by Sphere gap.
14	Study of 150 kV, 225 Joules Impulse Generator and test on Pin type Insulator.

VII Semester

EL2411- PEII: Fundamentals of Power Quality

Objective	Course Outcome
• To introduce students the power quality issues their causes, effects and solutions. • To familiarize students to the synthesis of voltage sag, principle operation, analysis and applications of passive power filter, active power filter and custom power devices. • To provide strong foundation for further study of power quality issues	**On completion of this course, the student will be able to** **1.** Illustrate power quality disturbances and typical problems associated with it. **2.** Analyse and evaluate the voltage sag. **3.** Appraise the fundamentals of harmonics and develop solutions through filters to minimise the harmonic distortion. **4.** Plan of mitigating the power quality events through custom power and network configuring devices with applying suitable control strategies

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Illustrate power quality disturbances and typical problems associated with it	3												1	
CO2	Analyse and evaluate the voltage sag.	3	2											2	
CO3	Appraise the fundamentals of harmonics and develop solutions through filters to minimise the harmonic distortion	3	2	2										2	1
CO4	Appraise the fundamentals of harmonics and develop solutions through filters to minimise the harmonic distortion	3													1

VII Semester
EL2411- PEII: Fundamentals of Power Quality

Unit No.	Contents	Max. Hrs.
1	**Overview and definition of power quality** Overview and definition of power quality (PQ): Sources of pollution and regulations, Power quality problems: rapid voltage fluctuations voltage unbalance, Voltage dips and voltage swells, Short duration outages, long duration variations, power acceptability curves.	6
2	**Voltage sag analysis** Definitions Voltage sag analysis: Sag caused by motor starting, Sag caused by utility fault clearing, Sag magnitude and duration calculations, RMS voltage, calculation in single phase systems, Computers, AC and DC drives etc. performance in presence of sag.	7
3	**Harmonics** Power system harmonics: Harmonic analysis, Harmonic sources and their effects, Introduction to power converters, Fourier analysis, Total harmonic distortion, rms & average value calculation, Effects of harmonic distortion on power factor.	7
4	**Filter Design** Filters: passive filters, active filters, hybrid filter design and working principles.	6
5	**Control of APF and configuring devices** Control of APF : Instantaneous reactive power theory (p-q theory) ,Synchronous reference frame theory(d-q theory), Synchronous detection theory, Regulation of DC link voltage and frequency domain control. Network configuring devices: Solid State Current Limiter (SSCL),Solid State Breaker(SSB),Solid State Transfer Switch(SSTS)	7
6	**Custom power devices** Introduction to custom power devices, Dynamic Voltage Restorer (DVR) ,Distribution Static Compensator (DSTATCOM) and Unified Power Quality Conditioner (UPQC), Control strategies, Applications.	7

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Electrical Power Systems Quality	2nd edition.	R. C. Dugan, M. F. Mcgranaghan	McGraw-Hill
2	Power Quality	1st edition 2002 E book 2017	C. Sankaran	CRC Press
3	Understanding Power Quality Problems: Voltage sag and interruptions	2011	M. H. Bollen Ledwich	Wiley India

Reference books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Power System Harmonics	2nd edition, 2003	J. S. Arillaga	Wiley
2	Power Quality Enhancement using custom power devices	2002	Arindam Ghosh Ledwich	Kluwer Academic Publishers

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

VII Semester

EL2412- PEII: Electrical Installation Design

Objective	Course Outcome
The student should be able to To understand and design the methods used in electrical installation for commercial building and the tools used for it as per IE and IS Standards .	**On completion of this course, the student will be able to** 1) Classify, various techniques used to identify the load pattern. 2) Demonstrate, apply and evaluate the various wires and cables and their tests. 3) Demonstrate, apply and estimate the various types of luminaries and its calculation. 4) Explain, develop and determine the components involves in substation and their function.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Classify, various techniques used to identify the load pattern.	1													1
CO2	Demonstrate, apply and evaluate the various wires and cables and their tests.	2	1										1		
CO3	Demonstrate, apply and estimate the various types of luminaries and its calculation.	1	2	3		1							2	1	
CO4	Explain, develop and determine the components involves in substation and their function.	3		1			1		1	1			2	2	1

Unit No.	Contents	Max. Hrs.
1	Load forecasting, regression analysis, numerical based on linear and exponential trends, Electrical installation for domestic, commercial and industrial consumers, calculation of connected load, selection of transformers, switchgears, cables and wires, single line diagram, special provisions for high rise buildings (IER-50-A), earthing requirements, megger and earth tests, use of earth leakage circuit breakers (special reference to be given to IER 2 (i, n, o, p, v, aa, aaa, aq, aqq, ar, av).	7
2	Cables: PVC and XLPE cables, their construction in brief, current ratings, specifications, derating factors, Megger and continuity test. Overhead distribution lines upto 33 kV, Line apparatus and basic construction, clearances, selection of AAC and ACSR conductors, voltage drop calculations, Selection of Insulators, earthing requirements. (Special reference to be given to IER 77, 79, 80, 81, 87, 89, 90, 91, 92)	7

VII Semester
EL2412:PEII: Electrical Installation Design

Unit No.	Contents	Max. Hrs.
3	Definitions, polar curves, simple calculations, working principles of fluorescent, sodium vapour and mercury vapour lamps, Capacitors and power factor improvement: Determination of rating and location of capacitors, calculation of payback period for additional capacitors.	6
4	Single line diagram, plan, elevation and clearances for 11 kV pole mounted, 11 kV plinth mounted (upto 1000 kVA and above 1000 kVA), 33 kV (upto 2500 kVA and above 2500 kVA) substations. Single line diagram for substation with two transformers in parallel, specifications of isolators, lightening arrestors, horn gap fuses, D.O. fuses, circuit breakers, instrument transformers, power transformers, LV HRC fuses, LV circuit breakers, (Special reference to be given to IER 31, 33, 35, 43, 44, 47, 48, 50, 51, 54, 58, 64, 64A, 67 and IS3043)	7
5	Determination of fault levels of various locations in substation, use of current limiting reactors, philosophy of protective relaying, over current, earth fault, REF protection, earth leakage protection, OTI, WTI, Buchholz relays, Firefighting equipments, restoration of a person affected by electric shock, Earthing: types, measurement of earth resistance.	6
6	Site testing of transformers (Visual, pre-commissioning tests like megger, magnetic balance, turns ratio), testing of oil, operational test for Buchholz, OTI, WTI, alarm and trip functions.	7

Text Books:

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Electric Power	2016	Soni, Gupta, Bhatnagar	Dhanpat Rai Publication
2	Electrical Installation Design	2012	Jain, Bajaj	Laxmi Publication
3	Power Electronics and AC Drives	2003	B.K. Bose	Pearson Education

Reference books:

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Electric Power Distribution Systems	2004	Pabla	McGraw Hill
2	Electrical Substation	1992	S. Rao	Khanna Publication
3	Electrical Engineering handbook	2018	C.L.Wadhwa	New Age International
4	IER (Latest edition)			

VII Semester

EL2413- PEII: Electrical Machine Design

Course Objective	Course Outcome
The course will help the students to understand the step by step procedure for the complete design of electrical machine specificifically diameter,length,height aand such other parameters depending on application or requirement	**On completion of this course, the student will be able to** 1. Classify, select various materials used in construction of electrical machines and interpret their rating and performance 2. Demonstrate, apply and evaluate design ers of transformer 3. Demonstrate, apply and estimate stator, rotor design of induction motor 4. Explain, develop and determine design parameters of synchronous machine

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO
CO1	Classify, select various materials used in construction of electrical machines and interpret their rating and performance	3	2	1	1									1	
CO2	Demonstrate, apply and evaluate design parameters of transformer	3	2	1	1									2	
CO3	Demonstrate, apply and estimate stator, rotor design of induction motor	3	2	1	1									2	
CO4	Explain, develop and determine design parameters of synchronous machine	3	2	1	1									3	

Unit No.	Contents	Max. Hrs.
1	**Review of material used in construction of electrical machines** Magnetic material such as amorphous, ferrite etc. Classification of insulating materials depending upon permissible temperature rise, properties of transformer oil, standard specifications, C.M.R. and short time of machines, Heating and cooling characteristics.	6
2	**Transformer design : Main Dimensions** Output equation, equation for voltage per turn for power and distribution transformer, core design, overall dimensions of single phase and three phase transformer.	7

VII Semester
EL2413 - PEII: Electrical Machine Design

Unit No.	Contents	Max. Hrs.
3	**Transformer design : Performance Characteristics** Resistance and leakage reactance of winding for concentric cylindrical and sandwich type winding, estimation of no load current , method of cooling and cooling tank design.	7
4	**Induction motors: Stator Design** Total loading, specific loading on the machine, output equation, main dimension, estimation of axial lengths and air gap diameter based on different design criterion, estimation of number of slots, area of slot, stator teeth and stator core dimensions, length of mean turn, stator winding.	7
5	**Induction motor rotor design** Air gap length, no. of rotor slots, cage rotor and wound rotor , Design of rotor bar and slots, design of end ring, design of wound rotor, rotor teeth and rotor core design, Calculation of no load current, stator and rotor resistance and other performance characteristics for design data.	7
6	**Synchronous machines** Types of synchronous machines, Output equation , specific loadings, Design of salient pole (Main dimensions, length of air gap, shape of pole face, armature design) and turbo alternators (Main dimensions , length of air gap, stator and rotor design), Effect of SCR on machine performance, ventilation of synchronous generator, cooling circuit design, Hydrogen and water as cooling media	6

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Performance and Design of A.C. Machine	1995	M.G. Say.	English L B S
2	Electrical Machine Design	2016	A.K. Sawhney	Dhanpat Rai & Sons, Delhi

Reference books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Electrical Machine Design	3rd	Balbir Singh	Brite Student Publication, Pune
2	Power Transformers	2nd	S.B.VasuBinsky	

VII Semester

EL2421- PEII: Power System Operation and Control

Objective	Course Outcome
The student should be able to The student will understand the economic aspects of power system operation, methods of power frequency control, economic dispatch control, reactive power control and voltage control. .	**On completion of this course, the student will be able to** **1.** Explain, analyse reserve requirement & load forecasting methods. **2.** Analyse optimal scheduling of generating units, determine with the help of flowcharts. **3.** Develop and illustrate optimal unit commitment problem & its solution methods. **4.** Discuss various methods of voltage control & Load Frequency Control and design of reactive power compensation equipment used for transmission line.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO
CO1	Explain, analyse reserve requirement & load forecasting methods		3	3									1	1	
CO2	Analyse optimal scheduling of generating units, determine with the help of flowcharts.		3	3									1	1	
CO3	Develop and illustrate optimal unit commitment problem & its solution methods		3	3	2								1	1	
CO4	Discuss various methods of voltage control & Load Frequency Control and design of reactive power compensation equipment used for transmission line.		1	1	2								1	1	

VII Semester

EL2421:PEII: Power System Operation and Control

Unit No.	Contents	Max. Hrs.
1	**Economic Aspects** Introduction, system load characteristics curves-chronological load curves-load duration curves-energy time curves load factor utilization factor-diversity factor- coincidence factor- demand factor- reserve requirements installed reserve- spinning reserve- cold reserve- hot reserve – operational restrictions, load dispatching.	6
2	**Pre requisite of Load Dispatchi** Load forecasting- components of system load- classification of base load- forecasting of the base load by method of least square fit introduction to unit commitment, unit commitment using priority ordering.	7
3	**Load Frequency Control (LFC)** Introduction, necessity of maintaining frequency constant, Load frequency Control, Governor Characteristics of single Generator, Adjustment of Governor Characteristic of Parallel Operating Unit, LFC (P-f control) Q-V Control, Generator Controller (P-f control & Q-V controllers), P-f control versus Q-V control, Dynamic Interaction between P- F and Q-V Loops, Speed-Governing System, Control Area Concept, Incremental Power Balance of Control Area, Requirements of the Control Strategy, Integral control, Concept of two area.	7
4	**Economic Dispatch Control** Incremental cost curve- co-ordination equations with loss included (No derivation of B_{mn} coefficient) solution of co- ordination equations using B_{mn} co-efficient by iteration method Base point & participation factors- Economic dispatch controller added to LFC.	7
5	**Reactive Power Control** Introduction, objective of load compensation, theory of load compensation, uncompensated transmission line, compensated transmission line, shunt compensator, series compensator, basic relationship for power flow control, Sub synchronous resonance, comparison of different types of compensating equipment for transmission systems,	6
6	**Voltage Control** Introduction, necessity of voltage control, generation and absorption of reactive power, location of voltage control equipment, methods of voltage control, rating of synchronous phase modifier.	7

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Power System Operation and control	1st edition	S. Sivanagarju and G. Srinivasan	Pearson Publisher
2	Power System Stability and control	1st edition	P. Kundur	TMH Publisher
3	Electrical Power system	6th edition	C. L. Wadhwa	New Age International Pvt Ltd Publisher
4	Economic Operation of power system studies	3rd edition 2010	L. K. Kirchmayer	Wiley Eastern India, New Delhi

Reference books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Power Generation, Operation and control	2nd Edition	A. J. Wood and B.F. Woolenberg	John Wiley & Sons
2	Power System: Operation & Control	1st edition, 2013	Dr. K. Uma Rao	Wiley

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

VII Semester
EL2428- PEII: Sensors and Actuators

Objective	Course Outcome
1. To understand basics of sensors, actuators and their operating principle. 2. To educate the students on different types of microfabrication techniques for designing and developing sensors. 3. To explain working of various types of electrochemical sensors and actuators. 4. To provide information about interfacing of sensors and signal conditioning circuits to establish any control system or monitoring system. To provide an understanding on characteristic parameters to evaluate sensor performance.	

PREREQUISITES: Basic Electronics

Unit No.	Contents
1	**UNIT 1:** Basics of Energy Transformation: Transducers, Sensors and Actuators, Understanding of thin film physics: Application in MOSFET and its variants
2	**UNIT 2:** Thin Film Deposition Techniques: Chemical Vapor Deposition (APCVD, LPCVD, UHVCVD, PECVD, ALCVD, HPCVD, MOCVD)**,** Thin Film Deposition Techniques: Physical Vapor Deposition (Thermal Deposition, E-beam Evaporation, Sputtering, Pulsed Laser Deposition)
3	**UNIT 3:** Basics understanding of Photolithography for pattering layer. Detailed overview of Etching methods, Understanding various gas sensors: Optical gas sensor, Metal oxide semiconductor gas sensor, Field effect transistor gas sensor, Piezoelectric gas sensor, Polymer gas sensor, Nano-structured based gas sensors
4	**UNIT 4:** Design and fabrication process of Microsensors: Force Sensors, Pressure Sensors, Strain gauges and practical applications, explain working principles of Actuators. Piezoelectric and Piezoresistive actuators, micropumps and micro actuators with practical applications
5	**UNIT 5:** Understanding basics of microfluidics to assist Photomask design using Clewin Software, pattern transfer techniques, PDMS moulding and degassing, device bonding techniques, Simulation, Optimization and characterization of various sensors using COMSOL Multiphysics
6	**UNIT 6:** Understanding of Sensor Interfacing with Microprocessor to build electronic system**,** Static and Dynamic Characteristic Parameters for Sensors and Actuators, Calibration of Sensor based electronics systems.

References Books:

SN	Title	Year	Author	Publication
1	Sensors and Signal Conditioning :Handbook of modern sensors	2008	Jacob Fraden, Stefan Johann Rupitsch	Wiley-Blackwell Springer
2	Piezoelectric Sensors and Actuators: Fundamentals and Applications	2018	Senturia S. D.	Springer
3	Microsystem Design	2001	J.D. Plummer, M.D. Deal, P.G. Griffin	Kluwer Academic Publisher
4	Silicon VLSI Technology	1998	S.M. Sze	Pearson Education
5	VLSI Technology	1998	Madou	McGraw Hill
6	Fundamentals of Microfabrication	1997		CRC Press

VII Semester
EL2429 – PEII: Micro Grid

Course Objective:	**Course Outcome**
1. To illustrate the concept of distributed generation 2. To analyze the impact of grid integration. 3. To study concept of Micro Grid and its configuration 4. To find optimal size, placement and control aspects of DGs	Students will be able to 1. Find the type, size and optimal placement DG and storage systems. 2. Analyze the impact of DGs grid integration and its control aspects 3. Describe the operational impacts and performance analysis of DGs connected to integrated power systems 4. Analyze the Micro Grid taking into consideration the operational and control issues of the DGs

UNIT I : Introduction:
Introduction, Definition and Benefits of DG**,** Distributed generation (DG) overview and technology trend, Renewable and Non-renewable DG Technologies. Comparison amongst different DG technologies, Brief overview of various Distribution Generations.

UNIT II : Distribution Generation (DG) and Storage Technologies
Concept of distributed generations (DG) or distributed energy resources (DERs) topologies, Renewable DG Technologies: PV, Wind, Fuel Cell, micro hydro. Hybrid system. Classification and comparison of Energy Storage Systems (ESS), Battery, Super Capacitor, Flywheel, SMES, etc. Optimal placement of DG sources in distribution systems

UNIT III : Operational benefits of Grid connected Renewable DG systems :
Benefits of Renewable DG integration on : Reliability of Distribution System (Methods of improving reliability, reliability indices), Power loss reduction (optimal sizing of DG), Voltage profile improvement, Economic benefits, Emission reduction

UNIT IV: Technical impacts of DGs on Grid:
Grid interconnection issues for grid connected operation of various types of DG systems.
Impact of DGs upon transient and dynamic stability, grid power quality, and protective relaying of existing distribution systems.

UNIT V: Introduction and Operation Control and Modeling of Micro Grid:
Concept and definition of Micro Grid, Types of Micro Grid (AC, DC and Hybrid AC-DC), review of sources of Micro Grid, typical structure and configuration of a microgrid, Autonomous and non-autonomous grids, Sizing of Micro Grid, Micro grid with multiple DGs – Power Electronics interfaces in DC and AC microgrids, communication infrastructure, Micro Grid implementation in Indian and international scenario.

UNIT VI: Controls & Protection of Micro Grid:
Control techniques for voltage, frequency, active and reactive power control of AC Micro Grid system, transients in Micro Grid, Protection of Micro Grid. DC Microgrid: Unipolar and Bipolar LVDC.

Textbooks:

	Title	Edition	Author	Publisher
1	Distributed Power Generation – Planning and Evaluation'	2000	H. Lee Willis, Walter G. Scott	Marcel Decker Press
2	Renewable Energy Systems – Design and Analysis with Induction Generators'		M.GodoySimoes, Felix A.Farret	CRC press

Reference Book:

	Title	Edition	Author	Publisher
1	'Microgrids and Active Distribution Networks'	2009	S. Chowdhury, S.P. Chowdhury and P. Crossley	The Institution of Engineering and Technology, London, U.K,

VII Semester

EL2422- PEIII: FACTS Devices

Objective	Course Outcome
The student should be able to To understand the problems and constraints related with stability of large interconnected systems and to study their solutions using different FACTS Controllers, Shunt (SVC,STATCOM),Series (TCSC,GCSC,SSSC),Series Shunt(UPFC),Series Series(IPFC)	**On completion of this course, the student will be able to** 1. Define FACTS Concept, various FACTS Controllers, its classification and explain its applications in Transmission system. 2. Explain, show, implement and design different shunt and series compensators and its control schemes 3. Demonstrate, examine and apply voltage and phase angle regulators in power system 4. Extend, apply and analyze the FACTS concept using combine series-shunt and series-series controllers to evaluate the improved transmission system performance

CO	Statement	Mapped PO												PSO	
		PO 1	PO 2	PO 3	PO 4	PO	PO	PO	PO	PO	PO 10	PO 11	PO 12	PS 1	PS 2
1	Define FACTS Concept, various FACTS Controllers, its classification and explain its applications in Transmission system.	1												1	
2	Explain, show, implement and design different shunt and series compensators and its control schemes	1	2	2										3	
3	Demonstrate, examine and apply voltage and phase angle regulators in power system	1	2	2										3	
4	Extend, apply and analyze the FACTS concept using combine series-shunt and series-series controllers to evaluate the improved transmission system performance	1	2	2										3	

VII Semester
EL2422- PEIII: FACTS Devices

Unit No.	Contents	Max. Hrs.
1	**Flexible AC Transmission Systems (FACTS)** FACTS concept and General System Consideration, Transmission interconnections, Flow of power in an AC System, factors affecting the Loading Capability, power flow and Dynamic Stability Consideration of Interconnected Transmission. Importance of controllable Parameters, FACTS Controller. HVDC and FACTS.	7
2	**Static shunt compensators** SVC and STATCOM, Objectives of Shunt Compensation, Methods of Controllable Var Generation, Static Var Compensators SVC and STATCOM,Control scheme for SVC and STATCOM ,Comparison between STATCOM and Static Var System (SVS).	7
3	**Static Series Compensators** GCSC, TSSC, TCSC and SSSC, Objectives of series Compensation, Variable Impedance Type Series compensators, Switching Converter Type Series Compensators, Control Schemes for GCSC,TSSC,TCSC and SSSC, External (System) Control for Series Reactive Compensators	6
4	**Static Voltage and Phase Angle Regulators** TCVR and TCPAR, Objectives of Voltage and phase angle regulators, Approaches to Thyristor Controlled Voltage Regulators (TCVR) and Thyristor Controlled Phase Angle Regulators (TCPAR), Switching Converter- Based Voltage and Phase Angle regulators, Hybrid Phase Angle Regulators.	7
5	**Shunt-Series Compensators:UPFC** Shunt series Compensators UPFC, Operating modes of UPFC, Basic control system for P and Q control, Comparison of UPFC to Series Compensators and Phase angle regulators.	6
6	**Other FACTS Controllers** Series –series compensators IPFC,Basic structure and operation,Thyristor controlled braking resistor	7

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Understanding FACTS	2001	Narayan G.Hingorani	Standard Publishers
2	FACTS : Controllers in Power	1st edition 2007	K. R. Padiyar	New Age International
3	Transmission & Distribution	1st edition 2002	R. Mohan Mathur, Rajiv K Verma	Wiley

Reference Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Flexible AC Transmission System(FACTS)		Edited by Yong Hua and Johns	IEEE Press

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VII Semester

EL2423:PEIII: ELECTRICAL ENERGY AUDIT AND SAFETY ANALYSIS

Objective	Course Outcome
The student should be able to Understand various operating characteristics of electrical equipments, its monitoring, tools used in comprehensive energy audit and its procedure to save the electricity with and without investment, calculation of energy saving, its global impact and its performance evaluation.	On completion of this course, the student will be able to 1. Classify, the energy sources, methods of energy conservation and its pattern, electricity act 2003. 2. Demonstrate, apply and evaluate different forms of electrical and thermal energy. 3. Demonstrate, apply and estimate the Energy Management, Energy Audit,Energy Monitoring and Targeting. 4. Evaluating the Performance of Electric Motor and variable Speed drivesand cogeneration systems. .

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS 1	PS 2
1	Classify, the energy sources, methods of energy conservation and its pattern, electricity act 2003.	1				1	1		1				2	1	1
2	Demonstrate, apply and evaluate different forms of electrical and thermal energy	1	1			1				1			1		1
3	Demonstrate, apply and estimate the Energy Management, Energy Audit,Energy Monitoring and Targeting	1	1	1		1	2			1			2	1	1
4	Evaluating the Performance of Electric Motor and variable Speed drivesand cogeneration systems.	1	1		3					2			2	1	2

VII Semester
EL2423:PEIII: ELECTRICAL ENERGY AUDIT AND SAFETY ANALYSIS

Unit No.	Contents	Max. Hrs.
1	Energy Scenario Commercial and Non-commercial energy, primary energy sources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance. Re-structuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features, Salient Features of Electricity Act 2003.	6
2	Basics of Energy and its various forms Electricity basics- DC & AC currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion	7
3	Energy Management & Audit Definition, need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.	7
4	Energy Monitoring and Targeting Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM).	7
5	Performance Evaluation of Electric Motor and variable Speed Drives Methods for determining motor loading, methods of determining motor efficiency, evaluating performance of rewound motors, variable speed drive: principles and applications, factors for successful implementation of variable speed drive.	7
6	Captive and Cogeneration Systems Introduction, purpose of the performance test, performance terms and definitions, reference standards, field testing procedure, examples, Case study of bottoming cogeneration in industries.	6

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Principles of Energy Conversion		Archie,W Culp	McGraw Hill
2	Energy Management Handbook		Wayne C Turner	John Willey and Sons
3	Bureau of Energy Efficiency Study Material for Energy Managers and Auditors Examination			Bureau of Energy Efficiency www.beeindia.in

Reference books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Handbook on Energy Audit and Management		Amit Kumar Tyagi	

VII Semester

EL2424 - PEIII: ADVANCED CONTROL SYSTEM

Objective	Course Outcome
The student should be able to elaborate concept of compensation in control system. Compensation design is explained. Optimal control and sample data control system is also discussed in this subject	On completion of this course, the student will be able to **1)** Explain concept of lag and lead compensator design in time and frequency domain, theory of PI, PD and PID control in time domain and frequency domain. **2)** Illustrate and apply state variable approach with solution of state models and concepts of controllability, observability and state variable feedback. **3)** Classify and analyse non-Linear Control System, types of non-linearities, its cha[illegible]tudents will a[illegible]e to demonstrate and apply different me[illegible]ating non-linea[illegible] like describing function method and phase plane method for stability analysis. **4)** Explain sample data control system, Stability analysis with Z-transforms and solution of discrete time systems.

CO	Statement	Mapped PO												PSO 1	PSO 2
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12		
1	Explain concept of lag and lead compensator design in time and frequency domain, theory of PI, PD and PID control in time domain and frequency domain.	2	1	1	1								1	1	3
2	Illustrate and apply state variable approach with solution of state models and concepts of controllability, observability and state variable feedback.	3	2	1											3
3	Classify and analyse non-Linear Control System, types of non-linearities, its characteristics. Students will also be able to demonstrate and apply different methods of evaluating non-linear control like describing function method and phase plane method for stability analysis.	3	2		1									1	3
4	Explain sample data control system, Stability analysis with Z-transforms and solution of discrete time systems.	3	2		1										3

VII Semester
EL2424:PEIII: ADVANCED CONTROL SYSTEM

Unit No.	Contents	Max. Hrs.
1	**UNIT-1**: **Compensation** Compensation: - Review of performance Analysis of type O, type 1 & type 2 systems. Need for compensation. Performance Analysis of Compensators in time & frequency domain, Bode Plots and Design of Compensators.	6
2	**Design of PID Controller:** Fixed configuration design, theory of PI, PD and PID control in time domain and frequency domain, Zeigler Nichol"s method of PID tuning.	7
3	**State variable Feedback** Design by State variable Feedback: Review of state variable representations. Solution of state equation Controllability & observability, Design of State Feedback.	7
4	**Non Linear control system (NLCS)** Non Linear Control System: Types of non-linearities, characteristics of NLCS. Inherent & intentional non- linearities. Describing function method for Analysis Describing functions of some common non-linearities. Stability analysis. Limit cycles & stability of limit cycles.	7
5	**Phase -Plane Method** Phase -Plane Method:Singular points stability from nature of singular points Construction of trajectory by Isocline and Delta Method Computation of time.	6
6	**Sample Data control System (SDCS)** Sample Data control System; - Representation of SDCS, Sample and Hold Circuit Z-Transform, Inverse Z- Transform & solution of difference equation "Z" & "S" domain relationship. Stability by Bi-linear transformation & Jury"s test. Discretization of continuous time state equation.	7

Text Books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Control Systems Analysis	4th edition2008	I.J.Nagrath, M.Gopal	
2	Modern Control Theory	2014	M.Gopal	New Age International Private Limited

Reference books

S.N	TITLE	EDITION	AUTHOR	PUBLICATION
1	Modern Control Engineering	4th	Katsuhiko Ogata	Prentice Hall Pearson Edcation International
2	Automatic Control Systems	9th	B C..Kuo Farid Golnaraghi	WILEY
3	Modern Control System		B.C.Kuo	2003

VII Semester

EL 2425 - PEIII: ARTIFICIAL INTELLIGENCE BASED SYSTEM

Objective	Course Outcome
The student should be able to understand the concept of fuzzy logic and neural network and the basic concepts and mathematical models of fuzzy and neural network are covered	On completion of this course, the student will be able to **1)** Recall, explain, solve and analyse the principles of fuzzy logic and control. **2)** Explain and discuss adaptive fuzzy control. **3)** Explain, analyse and solve problems in basic neural networks and associative memories **4)** Explain, analyse and solve problems on recurrent networks and neural control.

CO	Statement	Mapped PO												PSO	
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	Recall, explain, solve and analyse the principles of fuzzy logic and control.	3	3	2	1									3	3
2	Explain and discuss adaptive fuzzy control.	3	3	2	1									3	3
3	Explain, analyse and solve problems in basic neural networks and associative memories	3	3	2	1									3	3
4	Explain, analyse and solve problems on recurrent networks and neural control.	3	3	2	1									3	3

VII Semester

EL 2425 - PEIII: ARTIFICIAL INTELLIGENCE BASED SYSTEM

Unit No.	Contents	Max. Hrs.
1	**Introduction:-** Fundamental concepts of fuzzy systems Fuzzy sets, Approximate reasoning Representing set of rules. Fuzzy knowledge based (FKBC) parameters. Introduction rule and data base inference engine, choice of fuzzification and defuzzification processes.	6
2	**Nonlinear fuzzy control** Introduction, Control problem, FKBC as nonlinear transfer element, types of FKBC.	7
3	**Adaptive Fuzzy control** Introduction, design and performance evaluation, main approach to design.	7
4	**Artificial Neural Network** Fundamental concept of ANN. Model of artificial neural network (ANN), Learning & adaptation learning rules. **Feed forward networks:** Classification Model, features & decision, regions, Minimum distance classification, perceptron, delta learning rules for multi perceptron layer, generalized learning rules, back propagation algorithm, back propagation training, learning factors.	7
5	**Recurrent networks** Mathematical foundation of discrete time & gradient type Hopfield networks, transient response & relaxation modeling.	7
6	**Associative memories, self-organizing networks and Neural Control** Basic concept & recurrent associative memory, Bi-directional associative memory, Hamming net & MAXNET Unsupervised learning of clusters, , feature mapping, self-organizing feature maps, Basics of Neural Network Control, Predictive Control.	6

Text books

S.N	Title	Year/Edition	Author	Publisher
1	Introduction of Artificial Neural Networks	1992	Jacek Zurada	JPH
2	An Introduction to Fuzzy Control	2010	D. Drianko	Springer
3	Design of Neural Networks	2nd edition	Hagen,Demuth,Beale	Cengage Learning,ISBN-10:0-9717321-1-6,ISBN-13:978-0-9717321-1-7

Reference books

S.N	Title	Year/Edition	Author	Publisher
1	Neural Network & Fuzzy Systems	1992	Bart Kosko	Prentice Hall of India
2	Neural Networks	2009	Simon Haykin	(Maxwell) Macmillan Canada Inc.)
3	Fuzzy ets:Uncertainty and information	1988	Klir and Folger	Prentice Hall of India
4	MATLAB Toolbox			

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

VII Semester
EL2426 – PEIII: Converters and Configurations of Renewable Energy Systems

Course Outcomes:
Upon successful completion of the course the students will be able to
1. Outline the operating principles and characteristics of renewable energy sources for sustainable energy conversion. 2. Describe and analyze the various solar photovoltaic systems, inverters topologies and configurations. 3. Explain fixed speed and variable speed wind energy conversion systems and configurations. 4. Understand the power quality issues in grid connected systems for ensuring the quality of power.

Unit:1	**Introduction to Renewable Energy System**	**6 Hours**
Qualitative study of different renewable energy resources: Solar, wind, Fuel cell, and hybrid renewable energy systems.		
Unit:2	**Solar Photovoltaic System**	**7 Hours**
Solar Photovoltaic: PV cell equivalent and V-I, P-V characteristics, DC-DC Converters and its role in Maximum Power Point Tracking (MPPT), MPPT techniques. (Reference and non-reference cell-based algorithm)		
Unit:3	**Solar PV Converters and Configurations**	**7 Hours**
PV inverters: PV inverter Configurations, PV Configuration: Standalone, Grid interactive, Bi-Modal systems, Basic introduction to synchronization, Islanding, and control for PV inverters.		
Unit:4	**Wind Energy Conversion System (Fixed Speed)**	**7 Hours**
WECS: Introduction to WECS, Wind aerodynamics, Wind turbine technologies, WECS configurations, operation and analysis of fixed speed WECS.		
Unit:5	**Variable Speed Wind Energy Conversion System**	**7 Hours**
Variable speed WECS: Introduction, classification, configuration using Induction generator and synchronous generator based variable WECS.		
Unit:6	**Power Quality Issue in Grid Integrations.**	**5 Hours**
Type of Hybrid systems, PQ issues in grid interconnections for PV and wind systems, impact on voltage quality and remedial measures.		
	Total Lecture Hours	**39 Hours**

Text book	
1	Power Electronics Hand book Rashid .M. H Academic press, 2001
2	Power Electronics for Modern Wind Turbines 2006 F. Blaabjerg and Z. Chen Morgan & Claypool Publishers, 2006
3	Non-conventional Energy Sources 2006 B. H. Khan Tata McGraw Hill
4	Modern Power Electronics and AC Drives 2001 B. K. Bose Prentice Hall PTR
5	Non-Conventional Energy Resources B H Khan McGraw-Hill Education (India) Pvt Limited, 2006
6	Non Conventional Energy Sources J D Rai Khanna Publisher, 2008

Reference Books	
1	Wind energy system Gray, L. Johnson Prentice Hall
2	Power Conversion and Control of Wind Energy System 2011 Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro John Willey & Sons Inc., Publications , IEEE Press.2011
3	Grid Converters for Photovoltaic and Wind Power Systems 2011 Remus Teodorescu. Marco Liserre, Pedro Rodriguez John Willey & Sons Inc., Publications , IEEE Press.2011
4	Analysis of Electric Machinery and Drive Systems P. C. Krause, O. Wasynzuk, and S. D. Sudhoff John Willey & Sons Inc., Publications , IEEE Press
5	Wind Power in Power System 2005 T. Ackermann John Willey & Sons Inc., Publications , IEEE Press.2005

YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://link.springer.com/openurl?genre=book&isbn=978-1-4471-4548-6
2	http://link.springer.com/openurl?genre=book&isbn=978-0-85729-915-4

MOOCs Links and additional reading, learning, video material	
1	https://www.youtube.com/watch?v=khzMZ8VL8Q4&list=PLuv3GM6-gsE2KyXoBTQ6lbrwn22Z3SiVm
2	https://www.youtube.com/watch?v=MocCm-3mA7c
3	https://www.youtube.com/watch?v=jL9L8Pd5HDM&list=PLRWKj4sFG7-6bNeM6uiDbv2ztE2ktCd8f

VII Semester
EL2427– PEIII: Distributed Generation in Power System

Course Objective	Course Outcomes
Students will be able to (1) understand the principles of conversion of renewable and distributed energy sources (2) model Photovoltaic and wind turbine systems (3) possess basic understanding of energy storage devices (4) understand concepts of the smart grid, ac, dc and hybrid **(5)** model energy storage systems	(1) understand the principles of conversion of renewable and distributed energy sources (2) model Photovoltaic and wind turbine systems and different renewable energies (3) possess basic understanding of energy storage devices and energy system management (4) understand concepts of the power quality of smart grid

Unit 1- Introduction to Distributed generations system

Introduction - ,Advantages of DG systems,DG system Energy sources,Functions of power electronics interface,Solar Energy for Distributed Generation,wind Energy for DG,fuel cell for DG,Anti-Islanding protection,Operating Conflicts,IEEE standard 11547-2003,Applications of DG systems.

Unit 2- Solar and Wind Energy

Solar photovoltaic (PV) systems –Photovoltaic solar energy conversion:- Introduction, Equivalent Structure of PV cell, Series – Parallel combination, Partial shading, Introduction to DC – DC converter, solar MPPT, Solar PV systems,Grid converters and control

Wind energy conversion systems (WECS)

Basic components of wind energy conversion systems(WECS),Classification of WEC systems Application of wind energy, On – land and off – shore applications, Stand alone and Grid Connected Applications, types of wind turbines, Introduction to soft starters, Reduced and full capacity converters and wind MPPT, Introduction to control mechanism

Unit 3 -Hydro power station

Small-scale hydroelectric power generation, Schematic arrangement of Hydroelectric Power Station, Constituents of Hydroelectric power plant, Advantages and Limitations of Hydro-electric Plants ,Hydrology, stream flow, flow duration curve, power duration curve, mass curve, reservoir capacity

Unit 4- Energy storage devices

Introduction, Necessity of energy storage, specifications of energy storage ,energy storage methos:mechanical,Electrochemical,chemical energy,electromagnetic,electrostatic ,thermal energy storage

Unit 5 -Energy management system

Load Curves-,Load forecasting, Load Shaping Objectives Methodologies - Peak load shaving - Energy management-Role of technology in demand response- Demand Side Management – Numerical Problems

Unit6 -Power Quality of Smart grid

Power quality: Introduction - Types of power quality disturbances - Voltage sag (or dip), transients, short duration voltage variation, Long duration voltage variation, voltage imbalance, waveform distortion, and voltage flicker - Harmonic sources: SMPS arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights) Power quality aspects with smart grids.

Text Books				
1	Generation of Electrical Energy	2014	By B.R.Gupta	S.Chand
2	Non conventional energy sources	2017	B.H.Khan	Mc Graw Hill
3	Essentials of Distributed Generation System	2009	Massey	Jones & Bartlett Learning
Reference books				
1	Distributed Systems :Concept And Design-	2017	Coulouris George, Dollimore Jean, Kindberg Tim	PEARSON
2	Power Quality in Microgrids Based on Distributed Generators	2019	Ambrish Chandra and Hua Geng	Mdpi AG publisher

VII Semester

EL 2431 - PEIV: ADVANCED ELECTRICAL DRIVES

Objective	Course Outcome
The student should be able 1) To study the converter and Chopper control of DC drives. 2) To study the semiconductor based control of Induction and Synchronous motors. 3) To learn the basics of Switched reluctance motor and Brushless DC motor. 4) To Study the non-conventional and renewable energy based drives	On completion of this course, the student will be able to 1) Analyse and determine the converter parameters of bridge and chopper controlled DC drives. 2) Analyse the various schemes for Induction motor control and estimate the parameters of converters for Induction motor drives. 3) Explain synchronous motor, stepper motor and switched reluctance motor drives. **4)** Explain and compare the various drives used in electrical traction and explain solar and battery powered drives.

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Analyse and determine the converter parameters of bridge and chopper controlled DC drives	3	2	2	1										2
CO2	Analyse the various schemes for Induction motor control and estimate the parameters of converters for Induction motor drives	3	2	2	1										2
CO3	Explain synchronous motor, stepper motor and switched reluctance motor drives	3	2	2	1										2
CO4	Explain and compare the various drives used in electrical traction and explain solar and battery powered drives.	3	2	2	1										2

VII Semester
EL 2431 - PE IV: ADVANCED ELECTRICAL DRIVES

Unit No.	Contents	Max. Hrs.
1	**Introduction to Electric Drives** Dynamics of electric drives and control of electric drives, Fundamental Torque equation, Control Schemes, Power modulator, Four Quadrant operation, Energy conservation in electric drives.	6
2	**D.C. Drives** Controlled rectifier fed D.C. drives, single phase and three phase rectifier control of Separately excited D.C. motor; Dual Converter control of separately excited D.C. motor; Power factor, supply harmonics and ripples in motor current; Chopper controlled of separately excited dc motor; chopper control of series motor; source current harmonics.	7
3	**Induction Motor Drives** Stator voltage control, V/f control, static rotor resistance control, slip power recovery schemes, variable frequency control using voltage source inverter. Current sources inverter and cyclo converter, Introduction to vector control of Induction motor	7
4	**Synchronous Motor Drives** Starting and Braking of Synchronous motor; variable frequency control; self-controlled synchronous motor drive employing load commutated thyristor inverter , Introduction of Cyclo-converter control of Synchronous motor; starting of large synchronous motors.	7
5	**Special Motors Drives** Brush less dc motor, stepper motor switched reluctance motor drives and eddy current drives. Introduction to solar and battery powered drives.	7
6	**Traction Drives** DC and AC traction drives, semiconductor converter controlled Drives; 25 KV AC traction using semi conductor converter controlled DC motor; DC traction using semiconductor chopper controlled dc motors; polyphase AC motors for traction drives.	6

Text books

S.N	Title	Year/Edition	Author	Publisher
1	Fudamentals of Electric drives	2nd Edition	G. K.Dubey	Narosa Publications
2	Modern Electric Traction	2003	H.Pratap	Dhanpat Rai & Company
3	Electric drives concepts and applications	2005	V.Subramaniam	Tata McGraw Hill
4	Electric Motor Drives	2001	R. Krishnan	Prentice Hall India

Reference books

S.N	Title	Year/Edition	Author	Publisher
1	Electrical Machines Drives and Power Systems	6th edition 2008	Theodore Wildi	Pearson Education

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

VII Semester

EL 2432 - PE IV: FUNDAMENTALS OF SMARTGRID

Course Objectives	Course Outcomes
• To introduce the students with basics of Smart Grid. • To inform about components and communication tools of smart grid. • To explain methodology to identify computational tools and performance analysis of smart grid. • Knowledge about Strategic issues related with sustainable development, storage and renewable energy.	**The student should be able to:** 1. To compare conventional and smart grid and illustrate role of stake holders and functions of smart grid. 2. To identify components and computational tools for smooth functioning of smart grid. 3. To determine the performance of smart grid based on congestion, security and contingency studies for optimal solutions. 4. To discuss designing of smart grid with options like automation, sustainable energy and storage.

CO	Statement	Mapped PO											PSO	
		PO	PO	PO	PO	PO	PO	PO	PO	PO	PO 10	PO 11	PO 12	PS 1	PS 2
1	To compare conventional and smart grid and illustrate role of stake holders and functions of smart grid	2	1				1							3	
2	To identify components and computational tools for smooth functioning of smart grid	2				2	3						1	2	
3	To determine the performance of smart grid based on congestion, security and contingency studies for optimal solutions.	3	2		2	2	2						1	2	
4	To discuss designing of smart grid with options like automation, sustainable energy and storage.	2		3	2	2	1	3	1		1	1	1	3	

VII Semester

EL 2432 - PE IV: FUNDAMENTALS OF SMARTGRID

Unit No.	Contents	Max. Hrs.
1	**Introduction to Smart Grid & Power System Enhancement:** Introduction to smart grid, Comparison between Present grid and Smart grid, Electricity Act 2003, Energy Conservation Act 2001, Energy Independence and Security, computation intelligence, Communication Standards, Environment and Economics. General view of the Smart grid market drivers, Function and role of stakeholder, Smart grid based performance measures, Representative Architecture, Functions of smart grid components	6
2	**Smartgrid Communications :** Communication and measurement, Monitoring, PMU, Smart meters, Measurement technologies, GIS and Google mapping tools, multi agent technology, microgrid and smart grid comparison.	7
3	**Performance Analysis Tools for Smart grid Design** Congestion management effect, load flow for smart grid design, Static Security assessment (SSA) and contingencies, Contingencies and their classification, contingency studies for smart grid.	7
4	**Computational Tools for Smart grid Design** Introduction to computational tools, Decision support Tools (DS), Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Hybridizing optimization techniques and applications to the smart grid, Computational Challenges.	7
5	**Pathway for designing Smart grid:** Introduction to Smart Grid Pathway Design, Barriers and Solutions to Smart Grid Development, General Level Automation, Bulk Power Systems Automation of the Smart Grid, Distribution System Automation Requirement of the Power Grid, End User/Appliance Level of the Smart Grid, Applications for Adaptive Control and Optimization.	7
6	**Renewable Energy and Storage:** Sustainable energy options for the smart grid, Penetration and variability issues associated with sustainable energy technology, Demand-response issue, Electric vehicles and Plug-in Hybrids, PHEV Technology, Environmental Implications, Storage Technologies, Tax Credits.	6

Text books:

	TITLE	YEAR	AUTHOR	PUBLICATION
1	Smart Grid: Fundamentals of Design and Analysis	2012	James Momoh	Wiley

Reference books:

1	Smart Grid: Technology and Applications	March 2012	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama	Wiley

VII Semester
EL 2433 - PE IV: COMPUTER METHODS IN POWER SYSTEM

Course Objectives	Course Outcomes
The student should be able to 1. The theory and applications of the main components used in power system Protection. 2. The protection systems used for electric machines, transformers, bus bars, Transmission lines. 3. The theory, construction, and applications of main types of circuit breakers. 4. To design the feasible protection systems needed for each main part of a power system.	**The student should be able to:** 1) Explain, different types of Matrix using graph theory , Apply different methods to Build & Develop the A, B, C, K and Bus Impedance Matrix 2) Classify, Compare, Make use of different methods and Analyze Load Flow studies 3) Analyze & Inspect the system for different types of faults 4) Analyze & make use of different methods for Transient Stability Studies .

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	Explain, different types of Matrix using graph theory , Apply different methods to Build & Develop the A, B, C, K and Bus Impedance Matrix	1	1	2		1				1			1		
2	Classify, Compare, Make use of different methods and Analyze Load Flow studies	1	1	2		1				1			1	2	1
3	Analyze & Inspect the system for different types of faults	1	1	2		1		1	1				1	2	1
4	Analyze & make use of different methods for Transient Stability Studies	1	1	1		1		1	1	1			1	2	

VII Semester
EL 2433 - PE IV: COMPUTER METHODS IN POWER SYSTEM

Unit No.	Contents	Max. Hrs.
1	**UNIT-1**: **Incidence and network matrices** Incidence and network matrices: - Graph incidence Matrices, Primitive network, formation of network matrices by singular transformations	6
2	**Algorithm for single phase network** Algorithm for formation of Bus Impedance and Bus Admittance matrix for system without mutual coupling	7
3	**Three Phase Networks** Three Phase Networks: - Three phase balance network elements with balanced and unbalanced excitation incidence and network matrices for three phase element Algorithm for formation of three phase bus impedance matrices without mutual coupling	6
4	**Short circuit studies** Short circuit studies: Three phase network short circuit calculations using bus impendence matrix for balanced and unbalanced faults. Computer programme for short circuit studies on simple system	7
5	**Transient stability studies** Transient stability studies: Modelling of synchronous machine, power system network for transient stability studies. Numerical solution of swing equation by modified Euler and Runge Kutta 4th order method..	7
6	**Load Flow Studies** Load Flow Studies: Power system load flow equation, solution technique: Gauss Seidal , Newton Raphson and fast decoupled technique with and without (voltage) control buses. Representation of tap changing and phase shifting transformers. Elementary load flow programmes	7

Text books:

S. N	TITLE	EDITION	AUTHOR	PUBLISHER
1	Computer Methods in Power Systems	1st 1968	Stag and El – Abiad	Mc Graw Hill
2	Elements of Power System Analysis	1982	William D.Stevenson	Mc Graw Hill

Reference books:

	TITLE	EDITION	AUTHOR	PUBLISHER
1	Computer Analysis in Power System Modern Power System Analysis	1982	R.N.Dhar	Mc Graw Hill
2	Modern Power System Analysis	3rd-2006	D.P.Kothari and I.J.Nagrath	TMH

VII Semester
EL 2434 - PE IV: EHVAC-HVDC TRANSMISION

Objective	Course Outcome
The student should be able The student will understand the various aspects of transmission system, systems for power flow control, design parameters of filters and layout of HVDC power plant .	On completion of this course, the student will be able to **1)** Design and analyse Power handling capacity of EHVAC Transmission systems. **2)** Explain and analyse Corona, the concept of Electrostatic and electromagnetics, Electrical safety. **3)** Demonstrate , Classify HVDC Transmission system , Analyse the methods of HVDC Control. **4)** Design of Harmonic filters and reactive power configuration, HVDC Circuit breaker and Types and applications.

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	Design and analyse Power handling capacity of EHVAC Transmission systems	3	2	1									1	1	
CO2	Explain and analyse Corona, the concept of Electrostatic and electromagnetics, Electrical safety	3	2				3						1		
CO3	Demonstrate , Classify HVDC Transmission system , Analyse the methods of HVDC Control	2	3										1		
CO4	Design of Harmonic filters and reactive power configuration, HVDC Circuit breaker and Types and applications	3	2	2									1		1

VII Semester
EL 2434 - PE IV: EHVAC-HVDC TRANSMISION

Unit No.	Contents	Max. Hrs.
1	**Power handling and voltage gradient** 1) Power handling capacities of EHV AC transmission lines. 2) Voltages gradients: Electric field of point charge, sphere gap line-charge. Single and three phase lines, and bundled conductors. Maxwell"s potentials coefficients.	6
2	**Electrostatic and electromagnetic fields of EHV lines & corona** 1) Electrostatic and electromagnetic fields of EHV lines, electric shock and Threshold current , calculation of electrostatic field of A.C. lines (3 phase single and double circuit lines only). Effect of high electrostatic field. 2) Corona: Types, critical disruptive voltages, Factors affecting corona, Methods for reducing corona power loss (empirical formula), corona current waveform, audible noise and radio interference.	7
3	**HVDC Power transmission** DC Power transmission technology: Introduction, comparison of AC and DC Transmission, application of DC transmission, Description of DC transmission system, configuration, planning for HVDC transmission, types of DC link. Introduction to HVDC light, Earth electrode and earth returns. Introduction, objectives, location and configuration, resistance of electrodes, means of reducing earth electrode resistance	7
4	**Analysis of HVDC converters** Analysis of HVDC converters: Pulse number, choice of converter configuration, simplified Graetz circuit, converter bridge characteristics, characteristics of twelve pulse converter Power flow control in HVDC system :- Constant current. Constant voltage, constant ignition and excitation angle control, control characteristics.	7
5	**Harmonic Filters & Reactive power compensation** Harmonic Filters :- Introduction, Filters, surge capacitors and damping circuits, shunt filters, series filters, AC filters, design of AC filters and tuned filters, double frequency and damped filters, cost considerations and ratings. Harmonics on D.C side of converters. DC Harmonics filters. - Reactive power requirement of HVDC converters, substations.	6
6	**HVDC circuit breakers** HVDC circuit breakers: - Introduction, construction and principle of operation. Interruption of DC current, application of MRTB, Type of HVDC circuit breaker, capability and characteristics of HVDC circuit breakers	7

Text books:

	Title	Edition	Author	Publication
1.	EHV AC & HVDC Transmission & Distribution	**3rd-2006**	S. Rao	Khanna
2.	EHV AC Transmission	2nd	Begamudre	New Age international Publisher
3.	Power system Stability and Control	**2nd - 2006**	P. Kundur	Publisher

Reference books:

1	HVDC Power Transmission System	1982	R.N.Dhar	Publisher

VII Semester
EL2436 – PEIV: Project Planning

Course Objective	Course Outcome
The course objective is to impart knowledge of- 1. Role of Project Manager, various tools involved and its planning for the execution of assigned task 2. Total project cost, inventory required, and the risk involved during execution 3. operation of heavy equipment's used during execution of project 4. Procedure involved from accepting the project till handover to the owner.	Students will be able to- 1. Define the methodologies involved in project planning, the role of project manager and various project planning tools involved. 2. Analyze the cost, and the risk involved 3. Synthesis the material handling and earth moving equipment's 4. Remember the documents and formats involved in project execution and its control

Unit 1: Project and Project Management:
Introduction, Characteristic, Definition, Objectives, Stages, Project planning process, Establishing project organization, Life cycle of project, Project planning methodologies, and growth, Role of project manager.

UNIT II : Unit 2: Project Planning Tools
Bar chart, Milestone chart, CPM, and PERT, Time estimates, Frequency distribution, Mean, Variance, and standard deviation, Probability distribution, Network analysis, slack, Float, Critical path, Crashing of activity.

Unit 3: Cost Analysis and Updating
Introduction, Projects cost: Direct cost, Indirect cost, Slope of direct cost curve, Total project cost and optimum duration, Cost optimization.
Project Updating: Introduction, Updating process, Data required for updating, Steps in process updating.

UNIT IV: Risk analysis and Resource allocation
Certainty, Risk and uncertainty, Risk management, Identification and nature of construction risks, Contractual allocation of risk, Types of risks, Minimizing risks and mitigating losses, Use of expected values, Utility in investment decisions, Decision trees, Sensitivity analysis.

UNIT V: Construction Equipment

Types of compaction Equipment's, Types of Excavation and digging Equipment's, Types of hoisting equipment's, Types of Material handling Equipment's and types of heavy earth moving equipment's.

UNIT VI: Project Execution Monitoring and Control

Types of Contract, Tendering (Techno-commercial aspects), Motivation Theories, Communication and reporting, Importance of coordination, Logistick management, Inspection, Testing, Transportation, Commissioning, Trial run, Documentation required for project handover, Preparing a project report for failure reference.

Textbooks:

	Title	Edition	Author	Publisher
1	Project Management: A Systemic Approach to Planning, Scheduling and Controlling	2002	Horald Kerzner	CBS Publishers
2	Project Planning and Control with PERT and CPM		B. C. Punmia, K.K. Khandelwal	Laxmi Publication.
3	Construction equipment and management		Sharma S.C.	Khanna Publishers,New Delhi.

Reference Book:

	Title	Edition	Author	Publisher
1	Construction Project Scheduling		Callahan M. T., Quackenbush D. G. and rowing J. E.	McGraw Hill ,New York
2	Construction Planning and Equipment Methods		Peurifoy R. L., Ledbetter W. B and schexnayder C.	McGraw Hill, Singapore.

VII Semester
EL2437 – PEIV: Industrial Safety

Course Objective	Course Outcome
The course objective is to impart knowledge of- (1) Safety in various places such as domestic, commercial, and Industrial sectors and the policies associated. (2) Types and selection of fire fighting equipoments with respect to the type of fire (3) Various aspects of safety management (4) Various safety related issues in day-to-day working environment.	Students will be able to- (1) Understand the necessity of safety, safety policy, hazards, and risk assessment (2) Classify the types of fire and respective fire extinguishers employed (3) Develop safety management system with respective pocies involved (4) Examine the safety issues involved in construction and machine work

Unit 1: Introduction
Need, Safety and Productivity, Accident, Injury, Unsafe act, Unsafe condition, Reportable accidents. Theories of accident causation, Objectives of safety, Role of management, Supervisors, Workmen, Unions, Government and voluntary agencies. Safety policy. Safety Officer-responsibilities, and authority. Need of safety committee, Personnel protective equipment (PPE).

Unit 2: Safety Planning and Industrial Hazards
Safety planning, Strategic planning, Safety procedure, Safety tools, Introduction to Industrial Hazards, Causes, Various methods for analyzing hazards, Risk assessment analysis, Qualitative, and quantitative analysis, Failure mode and effect analysis (FMEA), Maximum credible accident analysis (MCAA), Failure tree analysis, Event tree analysis, HAZAN, HAZOP, Managerial oversight review technique (MORT), Incident and critical incident review technique, Safety integrity level (SIL), Safety audit objective, and procedure.

Unit 3: Fire
Combustible matter, Flammable/Combustible liquids, Classification of petrochemicals Liquids as per NFPA, Combustible gases, Combustion and it's types, Oxygen content in air by weight, and volume, Combustion of solid, Liquid and gases Exothermic and Endothermic reactions, Jet and Flash, Flames and its types, Premixed, Diffusion, turbulent stationary and propagating flames burning velocity, Fire, Classification.

Unit 4: Fire Protection Equipment

Types of extinguishing media of agent, Principles of fire extinguishing methods, Cooling, Starvation, Smothering (Blanketing), Retarding chain reaction, Extinguishing property of water, Characteristics of ideal liquid extinguishing agent, Various forms of water like solid stream, Fog and spray, Types of foam concentrate, Protein, AFFF, Fluoro protein, Alcohol types, Low, Medium and high expansion foam, Physical and chemical properties of foam, Various types of dry chemical powders and their uses, Carbon dioxide, Halons, FM200 and similar extinguishing, Agents, Sprinklers, Automatic alarms water tenders, Fire extinguishers, Fire prevention and inspection procedures, Fire protection law.

Unit 5: Safety Management System

Principle of organizing for health, and, environmental, Activities, Organization structure, Function & Responsibilities, Safety management system, Objectives of health, Safety and environment policy, Responsibility for implementation of HSE policy, Factory safety committee, Structure and functions, Accedent prevention.

Unit 6: Safety Issues in Construction, and Machine

Construction safety during excavation and filling, under-water works, Under-pinning & shoring. ladders & scaffolds, Tunneling, Blasting, Demolition, Confined space, Temporary structures, Indian standards and the National Building Code provisions on construction safety, Machinery safeguard-Point-of-Operation, Principle of machine guarding, Safety in turning, and grinding, Welding and Cutting-Safety, Precautions of Gas welding and Arc Welding, Material Handling-Classification, and safety consideration, Material Handling equipment-operation & maintenance.

Textbooks:

	Title	Edition	Author	Publisher
1	Industrial Safety Management	2005	L. M. Deshmukh	McGraw Hill Education, NewYork
2	Hazard Analysis Techniques for System Safety	2005	Ericson, Clifton A.	Wiley Publication, N. J. USA
3	Industrial Safety and Health Management	2009	Asfahl, C. Ray Rieske, David W.	Prentice Hall, N. J. USA
4	Essentials of Fire Fighting	–	Carl Goodson	Fire Protection Publication, 5th edition

Reference Book:				
	Title	**Edition**	**Author**	**Publisher**
1	Industrial Safety, Health and Environment management systems	2000	R.K Jain	Khanna Publications
2	Safety management System and Documentation training Programme handbook	2000	Paul S V	CBS Publication

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B.Tech SoE and Syllabus 2020

ELECTRICAL ENGINEERING

VIII Semester

EL2451 - Major Project

COURSE OBJECTIVES	COURSE OUTCOME
1. To apply knowledge of mathematics, science and engineering in a global, economic, environmental and societal context and engage in life-long learning. 2. To design a model, a system or components considering environmental, economic, social, political, ethical and sustainability and analyze and interpret the data. 3. To work on multidisciplinary teams, tackle engineering problems, understand professional and ethical responsibility and communicate effectively. 4. To apply knowledge of contemporary issues and use the techniques, skills, and modern engineering tools necessary for engineering practices. 5. To analyze and design RCC & steel structures, draw and prepare cost estimates of civil engineering structures.	On successful completion of the course students will be able to: 1. Demonstrate a sound technical knowledge of their selected project topic. 2. Undertake problem identification, formulation and solution. 3. Design engineering solutions to complex problems utilizing a systems approach including ability to work in a team. 4. Communicate effectively to discuss and solve engineering problems.
Mapped Program Outcomes : 1,2,3,4,5,6,7,8,9,10,11,12 **PSO** : i,ii,iii	

The group of students will continue to work for the project allotted previously and will submit a project report based on their studies. Evaluation will be done continuously and viva voce conducted at the end of the semester.

VIII Semester
EL2452 - Extra-Curricular Activity Evaluation

COURSE OBJECTIVES	COURSE OUTCOME
1. To expose to culture and tradition. 2. To provide opportunity for student to perform and present their hidden talent, still and art. 3. To nurture hobbies. 4. To organize co-curricular activities to make competitive spirit, cooperation, leadership, diligence, punctuality, team spirits. 5. To develop creative talent, self-confidence, sense of achievement. 6. To be able to design process on environmental, social, political, ethical, health and safety. 7. To develop broad education to understand the impact of engineering solution in a global economic, environmental, society.	1. An ability to work initially as well as part of team to achieve set goals. 2. An ability to work to serve society and for betterment of society. 3. An ability to communicate with people at large.
Mapped Program Outcomes : 5,6,7,9,10,11	

Due credits will be given to the students based on their performance and involvement in different extra and co-curricular activities conducted within the college or by other organizations/ institutions. Due credit will also be given to the student if they are successful in different competitive examinations conducted by different organizations. The guidelines as given in academic regulations will be followed for evaluation.