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RAMDEOBABA UNIVERSITY, NAGPUR

Formerly Shri Ramdeobaba College of Engineering & Management (RCOEM) Est. 1984

RAMDEOBABA UNIVERSITY, NAGPUR–440013

(Formerly, Shri Ramdeobaba College of Engineering and Management, Nagpur 440013)

School of Electrical and Electronics Engineering

Department of Electrical Engineering

Teaching and Evaluation Scheme and Syllabi

(as per National Education Policy-2020)

B. Tech Electrical Engineering

Specialization AI and Applications

(With effect from Academic Year 2024-25)

Ramdeobaba University, Nagpur
School of Electrical and Electronics Engineering
Department of Electrical Engineering
Teaching and Evaluation Scheme
B.Tech Electrical Engineering
Specialization AI and Applications

Program Educational Objectives

PEO1: Our graduates will be able to plan, design and develop AI based solutions and practice in electrical systems.

PEO2: Our graduates will be able to work in multidisciplinary environments including IT applications and adapt themselves as per the emerging technological needs of Industry.

PEO3: Our graduates will be able to progress in their career by demonstrating in practice the technical and communication skills effectively with understanding of ethical and social values.

Program Outcomes

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals to the solution of engineering problems.

PO2: Problem analysis: Identify, formulate, review literature, and analyze complex engineering problems using first principles of mathematics, natural sciences and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public safety, societal and environmental considerations.

PO4: Conduct problem investigations: Use research-based knowledge including experimentation, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Select, and apply appropriate techniques, resources, and modern engineering and IT tools for analyzing the engineering activities with an understanding of the limitations.

PO6: The engineer, industry and society: Apply contextual knowledge to assess industrial, societal and safety related issues and understand consequent relevance to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities such as, being able to understand and write effective reports, make effective presentations and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes

PSO1: Analyze, design and develop electrical systems considering Energy efficiency, Industry applications, and Power Scenario and Environmental issues.

PSO 2: Apply Artificial Intelligence (AI) techniques and methodologies to solve complex problems in various domains of electrical engineering.

PSO 3: Apply the knowledge of modern IT tools to Electrical Engineering applications.

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Semester I

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	BSC	24HS05TH0103	Semiconductor Physics	3	0	3	50	50	100	3
2	BSC	24HS05PR0103	Semiconductor Physics Lab	0	2	1	25	25	50	-
3	BSC	24HS03TH0104	Differential Calculus and Basics of Statistics	3	0	3	50	50	100	3
4	BSC	24HS03PR0102	Computational Mathematics Lab	0	2	1	25	25	50	-
5	PCC	24EE07TH0101	Fundamental of Electrical and Electronics Engineering	3	0	3	50	50	100	3
6	PCC	24EE07PR0101	Fundamental of Electrical and Electronics Engineering Lab	0	2	1	25	25	50	-
7	ESC	24EE07TH0102	Digital Circuits	3	0	3	50	50	100	3
8	ESC	24EE07TH0103	Fundamentals of Programming	2	0	2	50	50	100	2
9	ESC	24EE07PR0103	Fundamentals of Programming Lab	0	2	1	25	25	50	-
10	AEC	24HS02TH0101	English for Professional Communication	2	0	2	50	50	100	2
11	AEC	24HS02PR0101	English for Professional Communication Lab	0	2	1	25	25	50	--
12	CCA	24HS02PR0105-01 to 24HS02PR0105-14 and 24EE07PR0105	Liberal/Performing Art Lab	0	2	1	25	25	50	--
13	VEC	24HS02TH0104	Foundational Course in Universal Human Value	1	0	1	25	25	50	--
			TOTAL	**17**	**12**	**23**				

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Semester II

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	BSC	24HS01TH0203	Engineering Chemistry	2	0	2	50	50	100	2
2	BSC	24HS01PR0203	Engineering Chemistry Lab	0	2	1	25	25	50	-
3	BSC	24HS03TH0219	Linear Algebra and Integral Calculus	3	0	3	50	50	100	3
4	PCC	24EE07TH0201	Electrical Technology	3	0	3	50	50	100	3
5	PCC	24EE07PR0201	Electrical Technology Lab	0	2	1	25	25	50	-
6	ESC	24EE07TH0202	Analog Electronics Circuits	3	0	3	50	50	100	3
7	ESC	24EE07PR0202	Analog Electronics Circuits Lab	0	2	1	25	25	50	-
8	ESC	24EE07TH0203	Data Structures and Algorithms	2	0	2	50	50	100	2
9	ESC	24EE07PR0203	Data Structures and Algorithms Lab	0	2	1	25	25	50	-
10	IKS	24HS02TH0203	Foundational Literature of Indian Civilization	1	0	1	25	25	50	-
11	CCA	24HS04PR0201	Sports-Yoga-Recreation	0	2	1	25	25	50	-
			TOTAL	**14**	**10**	**19**				

Exit option: Award of UG Certificate in Major after the completion of 42 credits and an additional 8 credits.					
Sr. No.	Course Code	Course Offline/ Online **Any two of following courses:**	Lecture	Practical	Credits
1		Electrical Maintenance	3	0	3
		Electrical Appliances Electrical Measurements and Instrumentation Equivalent NSQF/COURSERA/ MOOC courses approved by the Department	3	0	3
2		Internship	Four Weeks		2
OR					
1		Project/ Internship/On-Job Training (OJT)	Eight weeks		8

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Semester III

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	ESC	24HS03TH0304	Probability and Transform	3	0	3	50	50	100	3
2	PCC	24EE07TH0301	Signals and Systems	3	0	3	50	50	100	3
3	PCC	24EE07TH0302	Electrical Machines	4	0	4	50	50	100	3
4	PCC	24EE07PR0302	Electrical Machines Lab	0	2	1	25	25	50	--
5	PCC	24EE07TH0303	Electrical Measurements and Instrumentation	3	0	3	50	50	100	3
6	PCC	24EE07PR0303	Electrical Measurements and Instrumentation Lab	0	2	1	25	25	50	--
7	MDM		MDM Course-I	3	0	3	50	50	100	3
8	OE		Open Elective-I	2	0	2	50	50	100	2
9	VEC	24HS01PR0301	Environmental Science	0	2	1	25	25	50	---
10	FP/CEP	24EE07PR0305	Field Project / Community Engagement Project-I	0	2	1	25	25	50	---
			TOTAL	**18**	**08**	**22**				

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Semester IV

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	PCC	24EE07TH0401	Network Analysis	3	0	3	50	50	100	3
2	PCC	24EE07PR0401	Network Analysis Lab	0	2	1	25	25	50	--
3	PCC	24EE07TH0402	Electrical Power System	3	0	3	50	50	100	3
4	VSC	24EE07TH0403	Microcontroller Programming and Applications	3	0	3	50	50	100	3
5	VSC	24EE07PR0403	Microcontroller Programming and Applications Lab	0	2	1	25	25	50	--
6	MDM		MDM Course –II	3	0	3	50	50	100	3
7	OE		Open Elective-II	2	0	2	50	50	100	2
8	FP/CEP	24EE07PR0406	Field Project / Community Engagement Project-II	0	2	1	25	25	50	---
9	VEC	24HS02TH0401	Constitution of India	2	0	2	50	50	100	2
10	SEC	24ID27TH0408	Creativity, Innovation and Design Thinking	1	0	1	25	25	50	---
11	SEC	24EE07PR0407	*Skill Enhancement Course-I	0	2	1	25	25	50	--
12	HSSM	24SM07TH0401	Innovation and Entrepreneurship	1	0	1	25	25	50	
13	HSSM	24SM07PR0401	Innovation and Entrepreneurship Lab	0	2	1	25	25	50	
			TOTAL	**18**	**10**	**23**				

*Floating Credit: To be acquired before IV Semester

Exit option: Award of UG Diploma in Major after the completion of 87 credits and an additional 8 credits.					
Sr. No.	Course Code	Course (Offline/ Online) **Any two of following courses:**	L	P	C
1		Computer Aided Electrical Engineering Drawing	3	0	3
		Electrical Energy Conservation and Audit Energy Storage Systems Equivalent NSQF/COURSERA/ MOOC courses approved by the Department	3	0	3
2		Internship	Four weeks		2
OR					
1		Project/ Internship/On-Job Training(OJT)			8

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Semester V

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal evaluation	Total	Duration of End Semester (Hrs)
1	PCC	24EE07TH0501	Power Electronics	3	0	3	50	50	100	3
2	PCC	24EE07PR0501	Power Electronics Lab	0	2	1	25	25	50	--
3	PCC	24EE07TH0502	Control Systems	3	0	3	50	50	100	3
4	PCC	24EE07PR0502	Control Systems Lab	0	2	1	25	25	50	--
5	PCC	24EE07TH0503	Artificial Intelligence	3	0	3	50	50	100	3
6	PCC	24EE07PR0503	Artificial Intelligence Lab	0	2	1	25	25	50	--
7	PEC	24EE07TH0504	Program Elective-I	3	0	3	50	50	100	3
8	MDM		MDM Course-III	3	0	3	50	50	100	3
9	OE		Open Elective-III	2	0	2	50	50	100	2
10	AEC	24HS02TH0501	Business Communication	1	0	1	25	25	50	---
11	AEC	24HS02PR0501	Business Communication Lab	0	2	1	25	25	50	---
			TOTAL	**18**	**08**	**22**				

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Semester VI

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	PCC	24EE07TH0602	Machine Learning	3	0	3	50	50	100	3
2	PCC	24EE07PR0602	Machine Learning Lab	0	2	1	25	25	50	--
3	PCC	24EE07TH0603	Power System Analysis	3	0	3	50	50	100	3
4	PCC	24EE07TH0604	Automation with PLC	3	0	3	50	50	100	3
5	PCC	24EE07PR0604	Automation with PLC Lab	0	2	1	25	25	50	--
6	MDM		MDM Course-IV	3	0	3	50	50	100	3
7	PEC	24EE07TH0606	Program Elective-II	3	0	3	50	50	100	3
8	PEC	24EE07TH0607	Program Elective-III	3	0	3	50	50	100	3
9	Project	24EE07PR0608	Project Phase-I	0	2	1	25	25	50	---
10	SEC	24EE07PR0609	Simulation Lab	0	2	1	25	25	50	---
11	SEC	24EE07PR0610	*Skill Enhancement Course-II	0	2	1	25	25	50	--
			TOTAL	**18**	**10**	**23**				

*Floating Credit: To be acquired before VI Semester.

Exit option: Award of B. Voc in Major after the completion of 132 credits and an additional 8 credits.					
Sr. No.	Course Code	Course (Offline/Online) **Any two of following:**	Lecture	Practical	Credits
1		Industrial Electrical Systems	3	0	3
		Power Quality Flexible AC Transmission Equivalent NSQF/COURSERA/ MOOC courses approved by the Department	3	0	3
2		Internship	Four weeks		2
OR					
1		Project/Internship/On-Job Training(OJT)			8

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Semester VII

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	PCC	24EE07TH0701	Digital Protection and Switchgears	3	0	3	50	50	100	3
2	PCC	24EE07PR0701	Digital Protection and Switchgears Lab	0	2	1	25	25	50	--
3	PCC	24EE07TH0702	Industrial Electrical Systems	3	0	3	50	50	100	3
4	PCC	24EE07TH0703	AIML Applications in Electrical Engineering	2	0	2	50	50	100	2
5	PEC	24EE07TH0704	Program Elective-IV	3	0	3	50	50	100	3
6	HSSM	24HS02TH0702	Principles of Economics and Management	2	0	2	50	50	100	2
7	SEC	24EE07PR0705	*Participative Learning	0	2	1	25	25	50	--
8	Project	24EE07PR0706	Project Phase-II	0	6	3	50	50	100	---
			TOTAL	**13**	**10**	**18**				
OR										
1	Internship	24EE07PR0707	Full Semester Internship	**0**	**0**	**18**	350	350	700	---

*Floating Credit: To be acquired before VII Semester

Semester VIII

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	PEC	24EE07TH0801	Program Elective-V	3	0	3	50	50	100	3
2	PEC	24EE07TH0802	Program Elective-VI	3	0	3	50	50	100	3
3	Project	24EE07PR0803	Project Phase-III	0	12	6	100	100	200	---
			TOTAL	**6**	**12**	**12**				
OR										
1	Internship / OJT	24EE07PR0804	Full Semester Industry Internship /TBI	**0**	**0**	**12**	200	200	400	---
OR										
1	RM	24EE07PR0805	Research Methodology	4	0	4	50	50	100	3
2	Internship	24EE07PR0806	Research Internship	0	0	8	150	150	300	---
			TOTAL	**4**	**0**	**12**				

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Basket of Program Elective Courses

Sem	**Program Elective**					
5	I	Electromagnetic Fields	Electrical Energy Conservation and Audit	Utilization of Electrical Energy	Biology for Engineers	Renewable Energy Sources
		Track I	**Track II**		**Track III**	
6	II	Optimization Techniques	Power Plant Engineering		Electric Drives and Control	
	III	Data Analytics	Smart Grid Technology		Solar Photovoltaic Engineering	
7	IV	Robotics and Automation	High Voltage Engineering		Electric Vehicle	
8	V	Digital Signal Processing	Power Quality		Power Semiconductor Based Drives	
	VI	Deep Learning	Flexible AC Transmission		Energy Storage Systems	

Multidisciplinary Minor (MDM) Courses offered by Electrical Engineering Department

"Renewable Energy and E-mobility"

S. No	Sem	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	III	24EE07TH0309	Introduction to Renewable Energy Sources Instrumentation	3	0	3	50	50	100	3
2	IV	24EE07TH0409	EV Architecture and Components	3	0	3	50	50	100	3
3	V	24EE07TH0509	Energy Storage Systems in E- Mobility	3	0	3	50	50	100	3
4	VI	24EE07TH0609	Autonomous Vehicle	3	0	3	50	50	100	3
			TOTAL	**12**	**00**	**12**				

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Honors in "Electric Vehicle Technology"

Sem	Course Type	Course code	Course Name	L	P	C	Continuous Assessment	End Semester / Internal Evaluation	Total	Duration of End Semester (Hrs)
III	Honors	24EE07HT0301	Electric Vehicle Fundamentals	3	0	3	50	50	100	3
IV	Honors	24EE07HT0401	Electric Vehicle: Components and Systems	3	0	3	50	50	100	3
V	Honors	24EE07HT0501	Energy Storage and EV Charging Infrastructure	4	0	4	50	50	100	3
VI	Honors	24EE07HT0601	Electric Vehicle Drives and Control OR Equivalent SWAYAM NPTEL course approved by the Department	4	0	4	50	50	100	3
VII	Honors	24EE07HT0701	Autonomous Vehicle OR Equivalent SWAYAM NPTEL course approved by the Department	4	0	4	50	50	100	3
			TOTAL	**18**	**00**	**18**	250	250	500	

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Honors in "Electrical Engineering by Research"
(to be done in VII and VIII Semester)

S. No	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal Evaluation	Total	Duration of End Semester (Hrs)
1	RM	24EE07HT0702	Research Methodology /SWAYAM – NPTEL approved by the Department	3	0	3	50	50	100	3
2	Project	24EE07HP0703	Research Project Phase-I	0	12	3	50	50	100	---
3	Project	24EE07HP0801	Research Project Phase-II	0	12	12	200	200	400	---
			TOTAL	**3**	**24**	**18**	300	300	600	

Minors in "E-Mobility"

Sem	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal evaluation	Total	Duration of End Semester (Hrs)
III	Minor	24EE07MT0301	Basics of Electrical Engineering and E-Mobility	3	0	3	50	50	100	3
IV	Minor	24EE07MT0401	Energy Storage Systems for EV applications	3	0	3	50	50	100	3
V	Minor	24EE07MT0501	Introduction to EV Drives	4	0	4	50	50	100	3
VI	Minor	24EE07MT0601	EV Communication and Instrumentation	4	0	4	50	50	100	3
VII	Minor	24EE07MT0701	EV Policies and Safety Aspects	4	0	4	50	50	100	3
			TOTAL	**18**	**00**	**18**				

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Open Elective Courses offered by the Department

Sem	Course Type	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal evaluation	Total	Duration of End Semester (Hrs)
III	OE	24EEOEI07TH0305-1	Electrical Engineering: Introduction and Applications	2	0	2	50	50	100	2
		24EEOEI07TH0305-2	Renewable Energy Systems							
		24EEOEC07TH0305	COURSERA/ MOOC courses approved by the Department							
		24EEOEI07TH0305-3	CDPC offered Elective-I							
IV	OE	24EEOEI07TH0405-1	Electrical Appliances	2	0	2	50	50	100	2
		24EEOEI07TH0405-2	Energy Storage Systems							
		24EEOEI07TH0405-3	Solar Photovoltaic Systems							
		24EEOEC07TH0405	COURSERA/ MOOC courses approved by the Department							
		24EEOEI07TH0405-4	CDPC offered Elective-II							
V	OE	24EEOEI07TH0505-1	Energy Management and Audit	2	0	2	50	50	100	2
		24EEOEI07TH0505-2	Automation with PLC							
		24EEOEI07TH0505-3	Electric Vehicles							
		24EEOEC07TH0505	COURSERA/ MOOC courses approved by the Department							
		24EEOEI07TH0505-4	CDPC offered Elective-III							

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Semester I	
Course Code: 24HS05TH0103	**Course:** Semiconductor Physics
L: 3 Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** BSC

Course Outcomes: After completion of the course, students will be able to	
CO1	Apply fundamental knowledge of quantum mechanics to examine electrons behavior in solids at the quantum level.
CO2	Classify materials on the basis of band theory and its importance for semiconductors.
CO3	Outline the difference between intrinsic and extrinsic semiconductors and explain their carrier transport phenomena in semiconductor.
CO4	Illustrate the working and design aspects for the various photonic devices like LEDs, solar-cells and LASER diodes.
CO5	Analyze the simple harmonic oscillator, damped oscillator and forced oscillator.

Syllabus

Module I: Introduction to Quantum Mechanics
Wave-particle duality, Heisenberg uncertainty relations, the quantum state wave function and its probability interpretation, Schrodinger's equation, Particle in an infinite potential well, Quantum tunneling,

Module II: Electronic Materials
Formation of energy bands in solids, Classification of electronic materials, Kronig-Penny model, E-k diagram, Direct and indirect bandgaps, Valence and conduction bands, Density of states, Fermi-Dirac statistics, Fermi level, Effective mass.

Module III: Intrinsic and Extrinsic Semiconductors
Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature, Carrier transport: diffusion and drift.

Module IV: Non-Equilibrium Semiconductors
Carrier generation and recombination, Continuity equation, p-n junction diode, Zero-applied bias, forward bias, reverse bias.

Module V: Optoelectronic Devices
Optical absorption in semiconductors**,** Light emitting diodes, Laser diode, Stimulated emission and photon amplification, Einstein Coefficients, Solar Energy Spectrum, Solar Cells.

Module VI: Oscillations
Quick review of simple harmonic motion, mechanical and electrical oscillators, vector and complex numbers, Phasor representation, damped oscillations: under, critical and over

damping, forced oscillations, impedance, energy and power supplied by driving force, Q-factor, related numerical/problems.

Text Books:	
1	Semiconductor Physics and Devices (Fourth Edition), Donald A. Neamen, McGraw-Hill 2012.
2	Optoelectronics and Photonics: Principles and Practices by S. O. Kasap, Prentice Hall2001
3	The Physics of Vibrations and Waves (Sixth Edition), H J Pain John-Wiley 2005.

Reference Books:	
1	Physics of Semiconductor Devices, Simon M. Sze, Wiley-Interscience (1981)
2	Semiconductor Device Physics and Design, Umesh K Mishra and Jasprit Singh, Springer2008.

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Semester I	
Course Code: 24HS05PR0103	**Course:** Semiconductor Physics
L: 0Hrs, **P**:2 Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** BSC

Course Outcomes: After completion of the course, students will be able to	
CO1	Develop skills required for experimentation and verification of physics laws.
CO2	Analyse the results obtained through proper graph plotting and Error analysis.
CO3	Conduct experiments to validate physical behavior of materials/components.
CO4	Analyze the behavior and characteristics of P-N Junction, Zener-Diode and other semiconductor devices.
CO5	Prepare laboratory reports on interpretation of experimental results

List of Experiments:
1.Parameter extraction from V-I characteristics of a diode
2.Resistivity measurement of semiconductor by Four Probe method
3.Performance and analysis of Hall Effect in semiconductor to determine the Hall coefficient and carrier concentration of the majority carriers in the given specimen
4.Estimation of energy gap in semiconductor
5.Characteristics and analysis of solar cells
6.Verification of Ohm's law and error analysis of the data using Linear Least Square Fit (LLSF) method
7.Analysis of energy values and wave function using Mathematica software
8.Verification of Planck's constant.
9.Determination of wavelength of ASER light by diffraction grating
10.To find acceleration due to gravity by Simple Pendulum.

Reference:	
1	Laboratory manual of the Physics Department
2	Principles and Practices by S. O. Kasap, Prentice Hall2001

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Semester I	
Course Code: 24HS03TH0104	**Course:** Differential Calculus and Basics of Statistics
L: 3Hrs, **P**:0 Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** BSC

Course Outcomes: After completion of the course, students will be able to	
CO1	Recognize first order ordinary differential equations that can be solved by each of the four methods –Linear DE, exact DE, reducible to linear DE and reducible to exact differential equations and use the appropriate method to solve them.
CO2	Solve higher order ordinary differential equations with constant and variable coefficients.
CO3	Find best fit curve by method of least square method and calculate correlation, regressions.
CO4	Internalize multivariable calculus and apply it find Jacobean, maxima and minima of function
CO5	Solve partial differential equation by using Variable separable method

Syllabus

Module I: First order ordinary differential equations (07 hours)

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut'stype, Applications of First order Differential Equations.

Module II: Ordinary differential equations of higher orders (08 hours)

Second order linear differential equations with constant and variable coefficients, method of variation of parameters, Cauchy-Euler equation. Applications of Higher order Differential Equations.

Module III: Statistics: (07 hours)

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression – Rank correlation, Multiple regression and correlation and its application in Engineering.

Module IV: Differential Calculus (10 hours)

Taylor's and Maclaurin's series expansions, radius of curvature (Cartesian form), evolutes and involutes, Limit and continuity of functions of several variables and their partial derivatives, Euler's Theorem, chain rule, total derivative, Jacobians, Maxima, minima and saddle points; Method of Lagrange multipliers.

Module V: Partial differential equations (8 hours)

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes.

Text Books/ References	
1	Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley &Sons, 2006.
2	W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and BoundaryValue Problems, 9th Edition, Wiley India, 2009.
3	S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
4	E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice HallIndia, 1995.
5	E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
6	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition,2000.
7	Theory and Problems of probability and statistics : 2nded :J. R. Spiegal ,Schaum series
8	A text book of Applied Mathematics Volume I & II, by P. N. Wartikar and J. N. Wartikar, Pune Vidhyarthi Griha Prakashan, Pune-411030 (India).
9	S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

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Semester I	
Course Code: 24HS03PR0102	**Course:** Computational Mathematics Laboratory
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** BSC

Course Outcomes: After completion of the course, students will be able to	
CO1	Download SageMath and use it as an advance calculator.
CO2	Sketch and analyze function graphs.
CO3	Apply the concepts of differential calculus to find extreme value of continuous functions and analyze solutions of differential equations
CO4	Evaluate improper integrals and its applications to find length, area, volume, centre of gravity and mass.
CO5	Analyze and calculate eigen values, eigen vectors, rank nullity, and solve system of linear equations of a matrix / linear map.
CO6	Analyze the data to find best fit curve.

List of Experiments:	**Mapped COs**
1. To use SageMath as advanced calculator	CO1
2. 2D Plotting with SageMath	CO2
3. 3D Plotting with SageMath	CO2
4. Applied optimization with Sagemath	CO3
5. Analysis of Solutions of differential equations in SageMath	CO3
6. Linear Algebra with various applications	CO5
7. Curve Fitting to identify trends and patterns within dataset by using SageMath	CO6
8. Practical Applications of Integral Calculus with SageMath	CO4

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Semester I	
Course Code: 24EE07TH0101	**Course:** Fundamental of Electrical and Electronics Engineering
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Apply the concept of basic laws for solving the DC circuits.
CO2	Analyse the behavior of single phase and three phase AC circuits.
CO3	Discuss the working principle of transformer and calculate its parameters.
CO4	Comprehend the working of Induction motors and BLDC motor.
CO5	Analyze the Diode characteristics and explore it's various applications.

Syllabus

Module I: DC Circuits (06 Hours)
Circuit elements resistor, inductor and capacitor, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel circuits excited by independent voltage sources; energy sources, dependent sources, star- delta transformation.

Module II: A.C. Circuits (08 Hours)
Generation of sinusoidal voltage, basic terminologies associated with AC quantity, phasor representation of alternating quantities, Real power, reactive power, apparent power and power factor, Analysis of basic series and parallel AC circuit.
Three Phase A.C. Circuits: Basic concepts; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits.

Module III: Single Phase Transformer (08 Hours)
Basic principle and construction of single-phase transformer; Operation under no load and load condition, equivalent circuit, voltage regulation and efficiency.

Module IV: Induction Motors (06 Hours)
Construction, working principle and applications of single-phase motors. Working principle of three phase induction motor; Introduction to BLDC motors: working principle, construction with its applications.

Module V: PN Diode operation (06 Hours)
Forward bias and reverse bias , Volt-Ampere characteristics of p-n diode, Temperature dependence of VI characteristics, Current components in p-n diode, Diode equation, Transition and Diffusion capacitances, Breakdown Mechanisms in Semiconductor diodes, Rectifiers: half wave and full wave, Wave shaping circuits

Module VI: Special Purpose Diodes and their Applications (06 Hours)

Zener diode characteristics and application, Tunnel Diode, LED, LDR, Varactor, Photo diode, PIN diode, Schottky diode, LASER, Applications.

Text Books:	
1	Basic Electrical and Electronics Engineering by S.K.Bhattacharya, Pearson Publications
2	Basic Electrical and Electronics Engineering by D.P. Kothari and I J Nagrath, TMH.

Reference Books:	
1	Basic Electrical Engineering by Fitzerald and Higginbotham, TMH.
2	Basic Electrical Engineering by I.J Nagrath, TMH.
3	Millman's Integrated Electronics: Jacob Millman, Christos Halkias, Chetan Parikh, McGraw Hill

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Semester I	
Course Code: 24EE07PR0101	**Course:** Fundamental of Electrical and Electronics Engineering Lab
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Perform experiments on basic DC and AC electric circuits and make valid conclusions from observed results.
CO2	Evaluate regulation and efficiency of a single phase transformer by performing different tests.
CO3	To study reversal of rotation of three phase induction motor.
CO4	Analysis the V-I characteristics of various types of diodes.
CO5	Calculate the energy bill and verify the same provided by the utility for a specific installation and specific period.
CO6	Write effective reports based on own observations and conclusions

List of Experiments:
1. To verify Kirchhoff's law of DC circuits.
2. To verify Kirchhoff's law for RLC series circuits.
3. To verify Kirchhoff's law for RLC parallel circuits.
4. To study the balanced three phase system for star and delta connected load.
5. Improvement of power factor by using static capacitors.
6. To determine regulation and efficiency of a single- phase transformer using open circuit (O.C.) and short circuit (S.C.) tests
7. To determine regulation and efficiency of a single- phase transformer using Direct Loading test
8. To study reversal of rotation of a three phase induction motor
9. To study V-I characteristics of various types of diode
10. Calculation and verification of energy bill of a house.
11. Open ended experiments.

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Semester I	
Course Code: 24EE07TH0102	**Course:** Digital Circuits
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** ESC

Course Outcomes: After completion of the course, students will be able to	
CO1	Explain number systems, basic logic gates, and Digital codes of logic families.
CO2	Implement Boolean Arithmetic equations and Karnaugh maps to simplify the logical equations in digital circuits.
CO3	Illustrate the working mechanism and design guidelines of different combinational circuits in the digital system.
CO4	Examine the behaviour of sequential circuits like latches, flip flops of digital circuit.
CO5	Design asynchronous and synchronous sequential circuits in digital systems.

Syllabus

Module I:
Basics of Digital Electronics: Motivation for digital systems, Number Systems and Digital Codes (conversion and arithmetic), representation of signed numbers, Boolean algebra, SOP, POS forms, Karnaugh-maps, Introduction to Logic family

Module II
Timing Issues in Digital Circuit: Fan-In, Fan-Out, Propagation Delay, Power dissipation, Noise Margin, Timing issues

Module III
Combinational Circuit Design: Multiplexers, De-multiplexers, Encoders, Decoders, Code Converters, Adders, Subtractor, BCD Adder/Subtractor, comparator.

Module IV
Sequential Circuit: Latches, Flip Flops – RS, D, JK, Master Slave JK, T flip flop, their excitation and truth table, Conversion of one Flip Flop to another, Timing and Clocking issues.

Module V
Sequential circuits Design: Design of asynchronous and synchronous counters, Shift Registers, Application of shift register.

Module VI
Design of synchronous sequential circuit using Mealy model and Moore model: state transition diagram, State encoding techniques, State reduction techniques.

Text Books:	
1	D.V. Hall, “Digital Circuits and Systems”, Tata McGraw Hill, 1989.
2	Modern Digital Electronics: R. P Jain, Tata McGraw Hill, 3rd Edition.

Reference Books:	
1	Digital Logic and Computer Design: Morris Mano, PHI, 3rd Edition.

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Semester I	
Course Code: 24EE07TH0103	**Course:** Fundamentals of Programming
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Compulsory	**Course Type:** ESC

Course Outcomes: After completion of the course, students will be able to	
CO1	Write an algorithms, Flowchart and Pseudo code for solving problems and learn fundamentals of C language.
CO2	Apply the concepts of looping, branching, and decision-making statements for a given problem.
CO3	Implement arrays, string and develop user defined functions using C programs.
CO4	Develop C program using pointers and structures and perform different operations on it.
CO5	Apply the basics of file handling mechanisms.

Syllabus

Module I: Introduction to Programming
Algorithm building, Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. Introduction to C language: Comments, Header files, Keywords, Constant, Variable, data types, constants and variables, operators, Types of Statements, Pre-processor Directives. Control statements, Looping statements and Nesting of control structures.

Module II: Arrays and Functions
Concepts of array, one- and two-dimensional arrays, declaration and initialization of arrays for algorithm building. User defined and Library Functions, Parameter passing in functions, call by value, passing arrays to functions, call by reference, Difference between functions and recursion.

Module III: Pointers and Structures
Basics of pointers, pointer to pointer, pointer and array, pointer to array, array to pointer, function returning pointer. Basics of structure, structure members, accessing structure members, nested structures, array of structures, structure and functions, structures and pointers.

Module IV: File handling
Streams in C, Types of Files, FileInput/output Operations: Modes of file opening, Reading and writing the file, Closing the files.

Text Books:	
1	Programming in ANSIC: E.BalguruswamiMc-GrawHill
2	Mastering C: K. R. Venugopal and S. R. Prasad, Tata Mc-GrawHill

Reference Books:	
1	Programming with C: Byron Gottfried, Schaums Outline Series.
2	Let Us C: YashwantKanetkar, B P B Publication

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Semester I	
Course Code: 24EE07PR0103	**Course:** Fundamentals of Programming Lab
L: 00Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** BSC

Course Outcomes: After completion of the course, students will be able to	
CO1	Develop C program involving decision control statements, loop control statements and case control structures
CO2	Develop C programs making use of arrays, string, user-defined functions, structures and pointers.
CO3	Demonstrate reading and writing data from/to files using C language.
CO4	Analyze correctness in syntax and logic for the program which is developed from algorithm.

Experiments based on:
Control statements, Looping statements and Nesting of control structures
Arrays and Functions
Pointers and Structures
File handling

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Semester I	
Course Code: 24HS02TH0101	**Course:** English for Professional Communication
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Compulsory	**Course Type:** AEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Demonstrate effective use of word power in written as well as oral communication.
CO2	Understand the techniques of listening and apply the techniques of reading comprehension used in professional communication
CO3	Apply the principles of functional grammar in everyday as well as professional communication.
CO4	Effectively implement the comprehensive principles of written communication by applying various writing styles.
CO5	Create precise and accurate written communication products.

Syllabus
Module I: Vocabulary Building 1.1 Importance of using appropriate vocabulary 1.2 Techniques of vocabulary development 1.3 Commonly used power verbs, power adjectives and power adverbs. 1.4 Synonyms, antonyms, phrases & idioms, one-word substitutions and standard abbreviations
Module II: Listening and Reading Comprehension 2.1 Listening Comprehension: active listening, reasons for poor listening, traits of a good listener, and barriers to effective listening 2.2 Reading Comprehension: types and strategies.
Module III: Functional Grammar and Usage 3.1 Identifying Common Errors in use of: articles, prepositions, modifiers, modal auxiliaries, redundancies, and clichés 3.2 Tenses 3.3 Subject-verb agreement, noun-pronoun agreement 3.4 Voice
Module IV: Writing Skills 3.5 Sentence Structures 3.6 Sentence Types

3.7 Paragraph Writing: Principles, Techniques, and Styles
Module V: Writing Practices
5.1 Art of Condensation: Précis, Summary, and Note Making
5.2 Correspondence writing techniques and etiquettes – academic writing
5.3 Essay Writing

Text Books:	
1	Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
2	Practical English Usage. Michael Swan. OUP. 1995.
3	Remedial English Grammar. F.T. Wood. Macmillan.2007
4	On Writing Well. William Zinsser. Harper Resource Book. 2001
5	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

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Semester I	
Course Code: 24HS02PR0101	**Course:** English for Professional Communication Lab
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** AEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Apply effective listening and speaking skills in professional and everyday conversations.
CO2	Demonstrate the techniques of effective Presentation Skills
CO3	Evaluate and apply the effective strategies for Group Discussions
CO4	Analyse and apply the effective strategies for Personal Interviews
CO5	Implement essential language skills- listening, speaking, reading, and writing

List of Experiments:
Computer Assisted + Activity Based Language Learning
Practical 1. Everyday Situations: Conversations and Dialogues – Speaking Skills
Practical 2. Pronunciation, Intonation, Stress, and Rhythm
Practical 3. Everyday Situations: Conversations and Dialogues – Listening Skills
Activity Based Language Learning
Practical 4. Presentation Skills: Orientation & Mock Session
Practical 5. Presentation Skills: Practice
Practical 6. Group Discussions: Orientation & Mock Session
Practical 7. Group Discussions: Practice
Practical 8. Personal Interviews: Orientation & Mock Session
Practical 9. Personal Interviews: Practice

Liberal/Performing Art Basket						
Sr. No.	**Course Code**	**Course Name**	**Sem**	**Hours /week**	**Credits**	**Maximum Marks** (Continuous Evaluation)
1)	24HS02PR0105-01	Fundamentals of Indian Classical Dance: Bharatnatayam	I/II	2	1	50
2)	24HS02PR0105-02	Fundamentals of Indian classical Dance: Kathak	I/II	2	1	50
3)	24HS02PR0105-03	Introduction to Digital Photography	I/II	2	1	50
4)	24HS02PR0105-04	Introduction to Japanese Language and Culture	I/II	2	1	50
5)	24HS02PR0105-05	Art of Theatre	I/II	2	1	50
6)	24HS02PR0105-06	Introduction to French Language	I/II	2	1	50
7)	24HS02PR0105-08	Art of Painting	I/II	2	1	50
8)	24HS02PR0105-09	Art of Drawing	I/II	2	1	50
9)	24HS02PR0105-10	Nature camp	I/II	2	1	50
10)	24HS02PR0105-11	Developing Self Awareness	I/II	2	1	50
11)	24HS02PR0105-12	Art of Poetry	I/II	2	1	50
12)	24HS02PR0105-13	Creative and Content Writing	I/II	2	1	50
13)	24HS02PR0105-14	Science of Life through Bhagwad Gita	I/II	2	1	50

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Semester I	
Course Code: 24HS02PR0105-01	**Course:** Fundamentals of Indian Classical Dance: Bharatnatayam
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the importance of dance and Bharatnataym as an Indian dance form
CO2	Develop skills to perform the dance form at its basic level.
CO3	Evaluate their strengths and interest to take bridge course to give *Pratham* (1st level formal exam of Bharatnatayam).

Syllabus
Practical -1: Orientation in Bharatnatayam
Practical-2: Tattu Adavu till 8, Naatta Adavu 4 Steps, Pakka Adavu 1 step, Metta Adavu 1 Step, Kuditta Metta Adavu 4 Steps,
Practical -3: Practice sessions
Practical-4: Tatta Kuditta Adavu (Metta), Tatta Kuditta Adavu (Metta) 2 Steps, Tirmanam Adavu 3 Steps, Kattu Adav - 3 Steps, Kattu Adav - 3 Steps
Practical-5: Practice sessions
Practical-6: Tiramanam (front) 3 Steps, Repeat of Tiramanam (Overhead) 3 Steps,
Practical-7: practice sessions
Practical–8: final practice sessions and performances.

Recommended reading:	
1	Introduction to Bharata's Natyasastra, Adya Rangacharya, 2011
2	The Natyasastra and the Body in Performance: Essays on the Ancient Text, editedby Sreenath Nair, 2015
3	Bharatanatyam How to ... : A Step-by-step Approach to Learn the Classical Form, Eshwar Jayalakshmi, 2011

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Semester I	
Course Code: 24HS02PR0105-02	**Course:** Fundamentals of Indian Classical Dance: Kathak
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the importance of dance and Kathak as an Indian dance form
CO2	Develop skills to perform the dance form at its basic level.
CO3	Evaluate their strengths and interest to take bridge course to give *Prarambhik* (1^{st} level formal exam of Kathak).

Syllabus
Practical -1: Orientation in Kathak. Correct posture of kathak, Basic Movements andexercise Stepping, Chakkar of 5 count (Bhramari),
Practical -2: practice sessions of practical 1
Practical -3: Hastaks, Hastaks and Steppings, Reciting asamyukta Mudra shloka,Hastak and steppings
Practical -4: practice sessions of practical 3
Practical -5: Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, Ghante Ki Tihai,
Practical -6: practice sessions of practical 5
Practical -7: 2 1 Chakkardar Toda and Ginnti Ki Tihai, 2 Todas and 1 ChakkardarToda, practice sessions
Practical -8**:** Final performances.

Recommended reading:	
1	Kathak Volume1 A "Theoretical & Practical Guide" (Kathak Dance Book),Marami Medhi & Debasish Talukdar, 2022, Anshika Publication (13 September 2022)

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Semester I	
Course Code: 24HS02PR0105-03	**Course:** Introduction to Digital Photography
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Develop an understanding of the technical aspects and aesthetics of Photography.
CO2	Apply the rules of digital photography for creating photographs.
CO3	Develop skills to enhance photographs through post processing.
CO4	Create a portfolio of their photographs in selected genre.

Syllabus
Practical 1: Orientation in digital photography: Genres, camera handling and settings
Practical 2: Rules of Composition
Practical 3: Rules of Composition: practice sessions
Practical 4: Understanding Exposure and Art of Pre-Visualization
Practical 5: Rules of Composition and Art of Pre-Visualization: practice sessions
Practical 6: Post Processing Photographs and Portfolio creation
Practical 7: Post Processing Photographs: practice sessions
Practical 8: Portfolio finalization and presentation in selected genre.

Reference material:	
1	Scott Kelby (2020) *The Digital Photography Book: The Step-by-Step Secrets for howto Make Your Photos Look Like the Pros*, Rocky Nook, USA
2	Larry Hall (2014) *Digital Photography Guide: From Beginner to Intermediate: A Compilation of Important Information in Digital Photography*, Speedy PublishingLLC, Newark
3	J Miotke (2010) *Better Photo Basics: The Absolute Beginner's Guide to TakingPhotos Like a Pro*, AMPHOTO Books, Crown Publishing Group, USA

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Semester I	
Course Code: 24HS02PR0105-04	**Course:**Introduction to Japanese Language and Culture
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Gain a brief understanding about Japan as a country and Japanese culture.
CO2	Develop ability to use vocabulary required for basic level communication in Japanese language.
CO3	Able to write and read the first script in Japanese language.
CO 4	Able to frame simple sentences in Japanese in order to handle everyday conversations
CO5	Able to write in basic Japanese about the topics closely related to the learner.

Syllabus
Practical-1: Orientation about Japan, its language, and its culture
Practical-2: Communication Skills 1: Vocabulary for basic Japanese language
Practical-3: Practice sessions
Practical-4: Writing Skills 1: Reading and writing first script in Japanese
Practical-5: Practice sessions
Practical-6: Communication Skills 2: framing sentences
Practical-7: Practice sessions
Practical-8: Writing Skills 2: Write basic Japanese and practice

Recommended reading:	
1	Marugoto Starter (A1) Rikai - Course Book for Communicative Language Competences, by The Japan Foundation, Goyal Publishers & Distributors Pvt. Ltd (ISBN: 9788183078047)
2	Japanese Kana Script Practice Book – Vol. 1 Hiragana, by Ameya Patki, Daiichi Japanese Language Solutions (ISBN: 9788194562900)

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Semester I	
Course Code: 24HS02PR0105-05	**Course:** Art of Theatre
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand and synthesize the working of the prominent genres of theatre across the world.
CO2	Apply the skill of voice and speech in theatre and public speaking
CO 3	Apply the art of acting and also develop generic skills such as confidence, communication skills, self-responsibility, motivation, commitment, interpersonal skills, problem solving, and self-discipline.
CO4	Apply skills acquired related to technical/production aspects of theatre and also develop problem solving and interpersonal skills.

Syllabus
Practical 1: Orientation in theatre
Practical 2: Voice and Speech training
Practical 3: Voice and Speech training: practice sessions
Practical 4: Art of acting
Practical 5: Art of acting: practice sessions
Practical 6: Art of script writing
Practical 7: Art of script writing: practice sessions
Practical 8: Final performances

Reference books:	
1	Boleslavsky, R. (2022). *Acting: The First Six Lessons* (1st ed., pp. 1-92). Delhi OpenBooks.
2	Shakthi, C. (2017). *No Drama Just Theatre* (1st ed., pp. 1-171). Partridge.
3	Bruder, M., Cohn, L. M., Olnek, M., Pollack, N., Previto, R., & Zigler, S. (1986). *APractical Handbook for the Actor* (1st ed.). Vinatge Books New York.

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Semester I	
Course Code: 24HS02PR0105-06	**Course:** Introduction to French Language
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Demonstrate basic knowledge about France, the culture and similarities/differences between India and France
CO2	Learn to use simple language structures in everyday communication.
CO3	Develop ability to write in basic French about themselves and others.
CO4	Develop ability to understand beginner level texts in French

Syllabus
List of Practicals
Practical-1: Orientation about France, the language, and culture
Practical-2: Communication Skills 1: Vocabulary building for everyday conversations
Practical -3: Practice sessions
Practical-4: Reading and writing Skills : Reading and writing simple text in French
Practical-5: Practice sessions
Practical-6: Communication Skills 2: listening comprehension
Practical-7: Practice sessions
Practical-8: Writing Skills: Write basic French and practice

Recommended reading:	
1	15-minute French by Caroline Lemoine
2	Cours de Langue et de Civilisation Françaises by G. Mauger Vol. 1.1
3	Cosmopolite I by Natalie Hirschsprung, Tony Tricot

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Semester I	
Course Code: 24HS02PR0105-07	**Course:** Introduction to Spanish Language
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Demonstrate basic knowledge about Spain, the culture and similarities/differences between India and France
CO2	Learn to use simple language structures in everyday communication.
CO3	Develop ability to write in basic Spanish about themselves and others.
CO4	Develop ability to read and understand beginner level texts in Spanish

Syllabus
List of Practicals
Practical-1: Orientation about Spain, the language, and culture
Practical-2: Communication Skills 1: Vocabulary building for everyday conversations
Practical -3: Practice sessions
Practical-4: Reading and writing Skills : Reading and writing simple text in Spanish
Practical-5: Practice sessions
Practical-6: Communication Skills 2: listening comprehension
Practical-7: Practice sessions
Practical-8: Writing Skills: Write basic Spanish and practice

Recommended reading:	
1	15-Minute Spanish by Ana Bremon
2	Aula Internacional 1 by Jaime Corpas ,Eva Garcia, Agustin Garmendia.
3	Chicos Chicas Libro del Alumno by María Ángeles Palomino

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Semester I	
Course Code: 24HS02PR0105-08	**Course:** Art of Painting
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Become familiar with the basic methods, techniques & tools of painting.
CO2	Train the eye and hand to develop sense of balance, proportion and rhythm.
CO3	Develop the ability to observe and render simple natural forms.
CO4	Enjoy the challenging and nuanced process of painting.

Syllabus
List of Practicals
Practical 1: Orientation in Painting tools & basics of lines, shapes, light, shadows and textures
Practical 2: The art of observation how to see shapes in drawing
Practical 3: Introduction Water color how to handle water paints
Practical 4: Introduction to acrylic colors how to handle acrylic paints
Practical 5: Explore layering paint and capturing the quality of light with paint.
Practical 6: Create landscape painting
Practical 7: Create Abstract painting
Practical 8: Paint on Canvas (try to recreate any famous painting)

Reference material:	
1	Drawing made easy by Navneet Gala; 2015th edition
2	Alla Prima II Everything I Know about Painting--And More by RichardSchmid with Katie Swatland
3	Daily Painting: Paint Small and Often To Become a More Creative,Productive, and Successful Artist by Carol Marine

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Semester I	
Course Code: 24HS02PR0105-09	**Course:** Art of Drawing
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Become familiar with the basic methods, techniques & tools of drawing.
CO2	Train the eye and hand to develop sense of balance, proportion and rhythm.
CO3	Develop the ability to observe and render simple natural forms.
CO4	Enjoy the challenging and nuanced process of drawing.

Syllabus
List of Practicals
Practical 1: Orientation in Drawing tools & basics of lines, shapes, light, shadowsand textures
Practical 2: The art of observation how to see shapes in drawing
Practical 3: One/two-point basic linear perspective
Practical 4: Nature drawing and landscapes
Practical 5: Gestalt principles of visual composition
Practical 6: Figure drawing: structure and proportions of human body
Practical 7: Gesture drawing: expression and compositions of human figures
Practical 8: Memory drawing: an exercise to combine the techniques learnt

Reference material:	
1	Drawing made easy by Navneet Gala; 2015th edition
2	Perspective Made Easy (Dover Art Instruction) by Ernest R. Norling

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Semester I	
Course Code: 24HS02PR0105-10	**Course:** Nature Camp
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Develop an affinity with nature by observing and understanding it marvels with guidance fromexperts
CO2	Develop an understanding of the challenges and solutions associated with nature and its conservation

Course content
In collaboration with the Forest Department and/or a local NGO working in the field of environment conservation, this course would be conducted in 24 hours. Students will be taken to a tiger reserve in Vidrabha region or Forest fringe villages or work with an NGO from Vidarbha region working on natural resource management. The camps (for 2 days) will cover any one of the following topics as decided by the course coordinator:
1. Awareness about each element of biodiversity (camps on moths, butterflies, birds, other wildlife etc.)
2. Environment management (water, forest, wildlife) – practices of Forest Department in managing atiger reserve, and other aspects of water and forest conservation.
3. Sustainable natural resource management - initiatives by rural communities and local NGOs
4. Man-animal conflict and solutions (socio-economic and technical) – role of local communities andForest Department
5. Traditional practices in environment conservation – role of local communities and local NGOs

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Semester I	
Course Code: 24HS02PR0105-11	**Course:** Developing Self-awareness
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Gain foundational understanding of graphology and through self-analysis will achieve greater awareness about their strengths and weaknesses & areas for personal growth
CO2	Equipped with tools and techniques for continuous self-improvement, using signature analysis and graphotherapy as part of their personal development journey
CO3	Understand how to use Neuro Linguistic Programming (NLP) strategies to set and achieve goals effectively, overcoming mental blocks and limiting beliefs.
CO4	Enhance ability to absorb, retain, and recall information, which can benefit academic and professional performance.

Syllabus
Practical 1: The Power of Handwriting (Handwriting is Brainwriting)
Practical 2: Know yourself through handwriting
Practical 3: The Role of Signature in your life
Practical 4: Graphotherapy to enhance yourself in all ways
Practical 5: Neurolinguistic Programming , S.M.A.R.T Goal
Practical 6: Effective Communication Model, Rapport Building and Anchor
Practical 7: Brain Directives & Linguistic Presuppositions
Practical 8: Neurobics

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Semester I	
Course Code: 24HS02PR0105-12	**Course:** Art of Poetry
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the origin and development of poetry
CO2	Appreciate the art of poetry in life
CO3	Develop aesthetic sense
CO4	Develop holistic perspective to their personality

Syllabus
Practical 1: **Art of poetry – orientation**
Practical 2: **Forms of poetry – orientation**
Practical 3: **Forms of poetry – recitation**
Practical 4: **Application of poetry – orientation**
Practical 5: **Application of poetry – practical session**
Practical 6: **Poetry and aesthetics**
Practical 7: **Writing poetry – orientation**
Practical 8: **Writing poetry – writing sessions**

Text Book:	
1	**The Art of Poetry** 1. Fry, S. (2005). The ode less travelled: Unlocking the poetic mind. HarperCollins. 2. Addonizio, K., & Laux, D. (1997). The poet's companion: A guide to the pleasures of writing poetry. W.W. Norton & Company. 3. Lucy, J. (Ed.). (2001). The art of poetry. Penguin Books.
2	**Understanding and Interpretation of Poetry** 1. Hirsch, E. (1999). How to read a poem: And fall in love with poetry. Harcourt Brace & Company. 2. Pinsky, R. (1998). The sounds of poetry: A brief history. Farrar, Straus and Giroux.

	3. Meyer, M. (2005). Poetry: An introduction. Bedford/St. Martin's.
3	**Writing Poetry** 1. Hugo, R. (1979). The triggering town: Lectures and essays on poetry and writing. W.W. Norton & Company. 2. Bradbury, R. (1990). Zen in the art of writing: Releasing the creative genius within you. Bantam Books. 3. Behn, R., & Twichell, C. (Eds.). (1992). The practice of poetry: Writing exercises from poets who teach. HarperCollins.

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Semester I	
Course Code: 24HS02PR0105-13	**Course:** Creative and Content Writing
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand and apply fundamental concepts and techniques of creative writing.
CO2	Apply storytelling techniques to create engaging narratives.
CO3	Develop and implement effective SEO and digital content strategies
CO4	Create and refine content using various tools and applying diverse writing styles and formats.
CO5	Utilize digital tools to craft multimedia narratives and create a professional portfolio.

Course Content:

Creative Writing
Practical 1: Introduction to Creative and Content Writing
Practical 2: Character and Story Development
Practical 3: Crafting Compelling Narratives

Content Writing
Practical 4: SEO and Digital Content Strategies
Practical 5: Writing for Media
Practical 6: Tools

Content Creation
Practical 7: Digital Storytelling
Practical 8: Creative Portfolio Launch

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Semester I	
Course Code: 24HS02PR0105-14	**Course:** Science of life through Bhagwad Gita
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Elective	**Course Type:** CCA

Course Outcomes: After completion of the course, students will be able to	
CO1	To understand the methodology to correctly interpret and analysis the scripture
CO2	To understand the application of various teaching of the Bhagwad Gita
CO3	Use meditation and breathing techniques for healthy mind and body.

Syllabus:
Practical 1: Introduction to Bhagwad Gita - methodology
Practical 2: Real life application of chapter 1-3
Practical 3: Real life application of chapter 4-6
Practical 4: Real life application of chapter 7-9
Practical 5: Real life application of chapter 10-12
Practical 6: Real life application of chapter 13-15
Practical 7: Real life application of chapter 16-18
Practical 8: Meditation and breathing techniques

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Semester I	
Course Code: 24HS02TH0104	**Course:** Foundational Course in Universal Human Values
L: 1Hrs, **P**:0Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** VEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Develop a holistic perspective of life.
CO2	Better understanding of inter-personal relationships and relationship withsociety and nature.
CO3	An ability to strengthen self-reflection

Syllabus

Module I: Aspirations and concerns
Need for Value Education: Guidelines and content of value education.
Exploring our aspirations and concerns: Knowing yourself, Basic human aspirations Need for a holistic perspective, Role of UHV; Self-Management: harmony in human being

Module II: Health
Harmony of the Self and Body, Mental and physical health; Health for family, friends and society.

Module III: Relationships and Society
Harmony in relationships, Foundational values: Trust, Respect, Reverence for excellence, Gratitude and love; harmony in society; harmony with nature.

Reference Material:	
1	The primary resource material for teaching this course consists of

Text Book:	
1	R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174- 46781-2

Reference books:

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. IvanIllich, 1974, Energy & Equity, The Trinity Press, Worcester, and

HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W.
6. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.
7. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
8. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
9. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
10.A.N Tripathy 2003,Human Values, New Age Internationals Publish

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Semester II	
Course Code: 24HS01TH0203	**Course:** Engineering Chemistry
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Compulsory	**Course Type:** BSC

Course Outcomes: After completion of the course, students will be able to	
CO1	Discuss the unique properties of nano-materials and applications in various field
CO2	Analyze the principles of various spectroscopic techniques and utilize them for qualitative and quantitative analysis.
CO3	Learn the harnessing of energy in various energy storage devices.
CO4	Illustrate the importance of thermodynamic functions and discuss the types and prevention measures for the corrosion.

Course Content:

Module I: Nano-material (07 Hours)

Nano-materials: Introduction, Classification and size dependent properties (surface area, Optical and catalytic properties). Synthesis of nano-materials (Solution combustion and Sol-gel methods).

Carbon nano-materials: Introduction, types, synthesis by modified CVD method, functionalization and applications of CNT and Graphene.

Applications of Nanomaterials

Module II: Material Characterization using different Spectroscopic Techniques (07 Hours)

Spectroscopy: Fundamentals of spectroscopy, Interaction of light with matter, Beer's-Lambert's Laws of absorption.

Electronic Spectroscopy: Types of transitions, Chromophores, auxochrome, different type of absorption shifts, Woodward-Fieser Rule.

Nuclear Magnetic Resonance Spectroscopy: Phenomenon of NMR, important aspects of NMR, Prediction of NMR spectrum.

Module III: Energy Storage and conversion devices (08 Hours)

Battery: Fundamentals of electrochemistry, Introduction to battery, types, characteristics, components/materials, working and applications of Lead acid battery, Lithium-cobalt oxide and metal air batteries, battery aging and battery waste management.

Energy conversion devices: Introduction, characteristics, materials, working and applications of H_2-O_2 fuel cells, amorphous Si and quantum dye sensitized solar cells.

Module IV: Chemical Thermodynamics and Corrosion Science (07 Hours)
Thermodynamic functions: Energy, work, entropy, enthalpy and free energy
Corrosion: Introduction, mechanisms of corrosion, types of corrosion and its prevention.

Text Books	
1	Energy storage and conversion devices: Super capacitors, batteries and hydroelectric cells, Anurag Gaur, A. L. Sharma, Anil Arya. 2021, CRC press, 1st edition, ISBN: 978-1-003-14176-
2	An introduction to nanomaterials and Nano science, A. K. Das and M. Das, CBS Publishers and Distributors.
3	Organic Spectroscopy, William Kemp, Third Edition, Palgrave Publication, 1991.
4	A Textbook of Engineering Chemistry, Dr. Rajshree Khare, published by S. K. Katariya and Sons, New Delhi.

Reference Books	
1	The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C. N. Rao, A Muller and A. K. Cheetam, Wiley-VCH, 2004
2	Electronics properties of materials, Rolf E, Hummel, 2012, Springer Publications New York, 4th Edition, ISBN 9781441981639.

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Semester II	
Course Code: 24HS01PR0203	**Course:** Engineering Chemistry Lab
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** BSC

Laboratory Outcomes
The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.
The students will learn to:
CO1. Apply the fundamental principles of measurement, preparation of solution, handling of hazardous chemicals and also estimate the amount of different elements present in the given samples.
CO2. Measure molecular /system properties such as surface tension, viscosity and other properties of aqueous or other industrially important liquids.
CO3. Analyze the spectral properties for qualitative and quantitative analysis.

List of Experiments for Chemistry Lab (Any eight experiments from the given list)
[1] Demonstration of Handling of hazardous chemicals, MSDS (material safety data sheet), waste minimization strategies and chemical waste disposal
[2] Preparation of different Solutions: Molar solution, Normal solution and percent solution and Determination of concentration in their various forms
[3] Determination of Surface tension of a given liquid/mixture.
[4] Determination of Viscosity of a given liquid/mixture at room temperature and different temperatures using Viscometer.
[5] Estimation of Cu and Zn in a brass sample using iodometric titration method.
[6] Estimation of Chromium ions from e-waste sample.
[7] Determination of the end point of the acid-base titration (Strong acid Vs Strong base and Weak acid Vs Strong base conductometrically.
[8] Estimation of Fe (II) ions spectrophotometrically / calorimetrically.
[9] Estimation of acid value of oil.
[10] Estimation of saponification value of oil.
[11] Predict and Interpret the NMR spectra (Demonstration Experiment).
[12] Spectroscopic/colorimetric determination of wavelength of maximum absorption and determination of unknown concentration by Beers-Lamber Law.

Text Books
1. Experiments and Calculation in Engineering Chemistry by S. S. Dara, S. Chand Publications.

2. Advanced Practical Physical Chemistry by J.B.Yadav, Krishna's Prakashan Media (P) Limited.
Reference Books
College Practical Chemistry by V. K. Ahluwalia, S. Dhingra and A. Gulati, Universities Press Publications.

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Semester II	
Course Code: 24HS03TH0219	**Course**: Linear Algebra and Integral calculus
L: 3Hrs, **P**:0 Hrs per Week	**Total Credits: 0**3
Compulsory/Elective: Compulsory	**Course Type:** BSC

Course Outcomes: After completion of the course, students will be able to	
CO1	Interpret the solutions of system of linear equations and use the concepts of Eigen values, Eigen vectors to find diagonalization of matrices, reduction of quadratic form to canonical form.
CO2	Evaluate definite and improper integrals using Beta, Gamma functions. Also trace cartesian curves.
CO3	Solve multiple integration by change of order, change of variable methods and apply it to find area, volume, mass and center of gravity.
CO4	Understand geometric meaning of gradient, curl, divergence
CO5	Perform line, surface and volume integrals of vector-valued functions.

Syllabus

Module I Linear Algebra: (08 hours)
Rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigen values and eigenvectors; Diagonalization of matrices; Orthogonal transformation and quadratic to canonical forms, Introduction to n-dimensional space, Singular value decomposition and its application in reducing the dimensionality of images and data.

Module II: Integral Calculus: (08 Hours)
Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Tracing of curves (Cartesian form)

Module III: **Multiple Integrals (10 Hours)**
Multiple Integration: Double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: area, mass and volume by double integration, Center of mass and Gravity (basic concepts).

Module IV: Vector Calculus (Differentiation) (07 Hours)
Scalar point function, Vector point function, vector differentiation, gradient, divergence and curl, directional derivatives with their physical interpretations, solenoidal and irrotational motions, Scalar potential function.

Module V: Vector Calculus (Integration) (07 Hours)
Vector integration: Line integrals, work done, conservative fields, surface integrals and volume integrals, Stoke's theorem, Gauss divergence theorem, Green's theorem and their simple applications.

Topics for self-learning	
1	Rolle's theorem, Mean value theorems, Indeterminate forms, Applications of definite integrals to evaluate perimeter, area, surface areas and volumes of revolutions.

Textbooks/References:	
1	Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2	Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
4	Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5	P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).
6	Biomedical Statistics -Shantikumar Yadav , Sompal Singh, Ruchika Gupta
7	Theory and Problems of Probability and Statistics - M.R. Spiegal (Mc Graw Hill) Schaum Series

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Semester II	
Course Code: 24EE07TH0201	**Course:** Electrical Technology
L: 3Hrs, **P**:0Hrs per Week	**Total Credits: 0**3
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze DC magnetic circuits using fundamental concepts and circuit laws
CO2	Analyze the performance of single-phase transformer and discuss the operation of autotransformer
CO3	Demonstrate the construction, working principle and types of DC machine and evaluate its performance.
CO4	Identify different types of wiring system and various safety devices
CO5	Select illumination requirement for different premises.
CO6	Understand single line diagram of Power System and discuss various energy sources

Syllabus

Module I: Magnetic Circuits (05 Hours)
Magnetic circuits: Basic terminologies of magnetic circuits, Analogy between magnetic and Electric circuits, Kirchoff's Laws for magnetic circuits, Types of magnetic circuits (series and parallel), B-H characteristics, leakage flux and fringing.

Module II: Performance and Analysis of Single phase Transformer: **(10 Hours)**
Review of basic concept of single-phase transformer, phasor diagram, percentage resistance, reactance and impedance, All day efficiency ,polarity test, back-to-back test.
Auto-transformer: Construction, comparison with two winding transformers, VA conducted magnetically and electrically.
Accessories of oil immersed transformer (numerical excluded), introduction to dry type transformer, methods of cooling.

Module III: DC Machines (10 Hours)
Basic principle & operation of DC generators and DC motors (separately excited, shunt and series), Induced EMF equation, Characteristics of DC motors, speed control of DC motors, Losses & Efficiency, Application of DC motor.

Module IV: Wiring and Electrical Installations (05 Hours)
Introduction of wiring, selection of wiring, types of wiring, I.E. (Indian Electricity) rules of domestic wiring, testing and installation of domestic wiring, Earthing formats for electrical connections
Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, RCCB and Earthling.

Module V: Illumination (04 Hours) Types of lamps, illumination schemes for domestic, industrial and commercial premises, lumens required for different categories.
Module VI: Introduction to Power System (04 Hours) Sources of Electrical Energy, Block schematic of Hydro-electric, Thermal, Nuclear Wind and Solar Power Plant with their advantages and disadvantages. Single line diagram for generation, transmission and distribution through different voltage levels.

Textbooks/References:	
1	Electrical Wiring Estimating and Costing, S. L. Uppal, Khanna Publishers, 1976
2	A Text Book of Electrical Technology, B. L. Theraja (Vol. I & II), S. Chand, 2005
3	Basic Electrical Engineering, D. C. Kulshreshtha, McGraw Hill, 2009. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, 2010
4	Basic Electrical Engineering: S. B. Bodkhe, N. M. Deshkar, P. P. H. Pvt. Ltd.
5	Electrical Machinery: I. J. Nagrath and D. P. Kothari, Tata McGraw-Hill Education, 2004
6	Electrical Machines, Dr. P.S. Bimbhra, Khanna Publishers, Third Edition,
7	Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Co., Third edition, 2015

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Semester II	
Course Code: 24EE07PR0201	**Course:** Electrical Technology Lab
L: 0Hrs,**P**:2Hrs per Week	**Total Credits:**01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Analysis the B-H characteristics of different magnetic materials.
CO2	Analyze the performance of single phase transformer using various tests
CO3	Analyze the performance of DC motor.
CO4	Understand and select appropriate switchgears, wires and cables for various LT installations.
CO 5:	Understand and draw polar curves for various lamps.
CO 6:	Write effective reports based on observations and conclusions

List of Experiments:
1. To study B-H curve of different magnetic materials.
2. To check the functioning of single phase transformer.
3. To perform a. Polarity marking on two winding transformers. b. Conversion of two-winding transformer into autotransformer.
4. To study speed control of D.C. shunt motor by: a. Armature Voltage Control method. b. Field current control method.
5. To reverse the direction of rotation of DC shunt motor
6. To perform load Test on D.C. shunt motor.
7. To study the different types of switchgears and accessories for LT installations.
8. To study the different types of wires and cables for different applications.
9. To study the symbols of various components used in electrical system and understand simple single line diagrams.
10. To design electrical wiring scheme for residential applications.
11. To verify the quality of earthing by measuring various parameters.
12. To find out the luminous efficacy and polar curve of a light source

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Semester II	
Course Code: 24EE07TH0202	**Course:** Analog Electronic Circuits
L: 2Hrs, **P**:0Hrs per Week	**Total Credits: 0**2
Compulsory/Elective: Compulsory	**Course Type:** ESC

Course Outcomes: After completion of the course, students will be able to	
CO1	Discuss the operation and analyze the characteristics of semiconductor devices like BJT and MOSFET.
CO2	Design and analyze electronic circuits containing non-linear elements such as diodes, BJT & MOSFET using the concepts of biasing, load lines, operating point.
CO3	Analyze inverting and non- inverting configurations of operational amplifier with negative feedback, evaluate performance parameters of operational amplifier.
CO4	Design Op-amp circuits for linear and nonlinear applications.

Syllabus

Module I: (06 Hours)
BJT Circuits: Structure and V-I characteristics of a BJT; BJT as a switch. BJT as an amplifier, biasing circuits; common-emitter, common-base and common-collector amplifiers

Module II: (08 Hours)
MOSFET Circuits: MOSFET structure and V-I characteristics. MOSFET as a switch. MOSFET as an amplifier, biasing circuits and analysis, common-source, common-gate and common-drain amplifiers

Module III: (08 Hours)
Feedback amplifier and Op-amp fundamentals: General Feedback amplifier Structure, Properties of Negative Feedback, Characteristics of operational amplifier, open loop Op-amp, basic inverting and non- inverting Op-amp amplifiers with negative feedback

Module IV: (08 Hours)
Op-amp linear and nonlinear applications: Voltage follower, summing amplifiers, integrators and differentiators, difference amplifiers & instrumentation amplifiers, Clipper, Clamper, Comparators, Schmitt trigger circuits

Textbooks:	
1	Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, "Microelectronics Circuits: Theory and Applications," Seventh Edition, Oxford University Press, 2017.
2	Sergio Franco,"Design with Operational Amplifiers and Analog Integrated Circuits," Fourth Edition, McGraw-Hill Education, 2014.

Reference books:	
1	Donald Neamen, “Electronic Circuits: Analysis and Design,” Third Edition, McGraw-Hill Publication, 2006.
2	Donald Neamen, “Semiconductor Physics and Devices: Basic Principles,” Fourth edition, McGraw-Hill, 2011.
3	Jacob Millman, Christos Halkias, Chetan Parikh, “Millman's Integrated Electronics,” Second edition, McGraw Hill Education, 2017.
4	Ramakant Gayakwad,” OP-AMPS and linear integrated circuits” 4th Edition, PHI
5	D. Roy Choudhary, Shail Jain “Linear Integrated Circuits”, 4th Edition, New Age International

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Semester II	
Course Code: 24EE07PR0202	**Course:** Analog Electronic Circuits Lab
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** ESC

Course Outcomes: After completion of the course, students will be able to	
CO1	Discuss the operation and analyze the characteristics of semiconductor devices like BJT and MOSFET.
CO2	Design and analyze electronic circuits containing non-linear elements such as diodes, BJT & MOSFET using the concepts of biasing, load lines, operating point.
CO3	Analyze inverting and non- inverting configurations of operational amplifier with negative feedback, evaluate performance parameters of operational amplifier.
CO4	Design Op-amp circuits for linear and nonlinear applications.

Syllabus:

Experiments based on Syllabus of Analog Electronic Circuits.

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Semester II	
Course Code: 24EE07TH0203	**Course:** Data Structures and Algorithms
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Compulsory	**Course Type:** ESC

Course Outcomes: After completion of the course, students will be able to	
CO1	Recognize different abstract data structures, their operations and complexities and learn basic techniques of algorithm analysis.
CO2	Apply the different linear data structures (Stack, Queues, Linked list) to problem solutions.
CO3	Apply appropriate searching and sorting algorithms to access elements.
CO4	Apply various traversal methods on binary trees and implement basic operations on it.
CO5	Demonstrate various traversal and path finding algorithms for Graphs.

Syllabus

Module I: Data Structures and Algorithms Basics (06 Hours)
Organizations, data structure operations; abstract data types (ADTs) and their characteristics. Algorithms: definition, characteristics, analysis of an algorithm, asymptotic notations, time and space tradeoffs.

Module II: (08 Hours)
Stacks and Queues: Overview of Array ADT.
Stack ADT: Introduction, Representation of Stacks, Stack Operations and Applications of stacks
Queue ADT: Introduction, Operations on Queue, Types of Queues and Applications of Queues.

Module III: Linked Lists (06 Hours)
Singly Linked Lists: representation in memory, algorithms of several operations: traversing, searching , insertion, deletion, reversal, ordering, etc.

Module IV: Searching and Sorting (08 Hours)
Searching: Linear and Binary Search Methods and complexity analysis of search methods.
Sorting: Different approaches to sorting, Bubble sort, Insertion Sort, Selection Sort, Merge Sort, Quick Sort, Heap Sort and their complexity analysis.

Module V: Trees: (06 Hours)
Introduction, basic terminology, binary tree and operations, binary search tree [BST], expression tree, traversing a binary tree, Operations on Binary Search Tree.

MODULE VI: Graphs (06 Hours):

Introduction, basic terminology, graph traversal algorithm (DFS, BFS) with complexity analysis, shortest path algorithms.

Textbooks:	
1	E Balagurusamy , Data Structures Using C,MC Graw Hill, Nineteenth reprint 2023.
2	Ellis Horowitz, Sartaj Sahni& Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.
3	Mark Allen Weiss; Data Structures and Algorithm Analysis in C; Second Edition;Pearson Education; 2002.
4	G.A.V. Pai; Data Structures and Algorithms: Concepts, Techniques and Application;First Edition; McGraw Hill; 2008.

Reference books:	
1	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein; Introduction to Algorithms; Third Edition; PHI Learning; 2009.
2	Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran; Fundamentals of Computer Algorithms; Second Edition; Universities Press; 2008
3	A. K. Sharma; Data Structures using C, Second Edition, Pearson Education, 2013

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Semester II	
Course Code: 24EE07PR0203	**Course:** Data Structures and Algorithms Lab
L:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** ESC

Course Outcomes: After completion of the course, students will be able to	
CO1	Implement the array, stack, Queue and their applications
CO2	Implement different sorting and searching algorithms
CO3	Implement linked lists and their applications
CO4	Perform basic operations on trees and graphs.

Experiments based on
1. Write a program in C to implement an array
2. Write a program in C to implement PUSH and POP operations on Stack using array.
3. Write a program in C to check nesting of parentheses using a Stack.
4. Write a program in C to evaluate postfix expression using Stack.
5. Write a program in C to implement a Queue and perform its common operations.
6. Write a program in C to implement a linked list and perform its common operations.
7. Write a program in C to implement binary tree traversal using INORDER, PREORDER and POSTORDER techniques
8. Write a program in C to implement searching techniques in array.
9. Write a program in C to implement DFS and BFS graph traversal algorithm.
10. Open ended experiment.

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Semester II	
Course Code: 24HS02TH0203	**Course:** Foundational Literature of Indian Civilization
L: 1 Hrs, **P**:0Hrs per Week	**Total Credits:**01
Compulsory/Elective: Compulsory	**Course Type:** AEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the Indian knowledge system and its scientific approach.
CO2	Get introduced to the Vedic corpus and recognize the multi-faceted nature of the knowledge contained in the Vedic corpus.
CO3	Understand the salient features of the philosophical systems of the Vedic and non-Vedic schools.
CO4	Develop a basic understanding of the ancient wisdom recorded in various Indian literary work

Syllabus

Module I: **Overview of Indian Knowledge System**
Importance of ancient knowledge, defining IKS, IKS classification framework, Historicity of IKS, Some unique aspects of IKS.

Module II: The Vedic corpus
Introduction of Vedas, four Vedas, divisions of four Vedas, six Vedangas, Distinct features of Vedic life.

Module III: Indian Philosophical systems
Development and unique features, Vedic schools of philosophy, Samkhya and Yoga School of philosophy, Nayay and Vaisesika school of philosophy, Purva-mimamsa and Vedanta schools of Philosophy, Non-vedic philosophies: Jainism, Buddhism, and other approaches

Module IV: Indian wisdom through ages
Panchtantras, Purans: contents and issues of interests,
Itihasa: uniqueness of the two epics (Ramayan and Mahabharata),
Key issues and messages from Ramayana, Mahabharata – a source of worldly wisdom;
Indian ancient Sanskrit literature: Kalidas, Vishakadutta, Bhavbhuti, Shudraka*
***any one text as decided by the course teacher**

Reference material	
1	B. Mahadevan, Vinayak Rajat Bhar, Nagendra Pavana R. N., "Introduction to Indian Knowledge System: Concepts and Applications" PHI, 2022
2	S.C. Chatterjee and D.M. Datta, An introduction to Indian Philosophy, University of Calcutta, 1984

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Semester II	
Course Code: 24HS04PR0201	**Course:** Sports-Yoga-Recreation
L: 0Hrs, **T**:0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** CCA

Aim of the Course

The course aims to foster Health and wellness through Healthy and Active Lifestyle and creating awareness about the fundamentals of Physical Education, Sports, Yoga, Recreation and its effectiveness through practical experiences and hands on activities.

Objectives of the Course	
1:	To impart the students with basic concepts of Sports, Yoga and Recreational activities for health and wellness.
2:	To familiarize the students with health-related Exercise and evaluate their Health-related Fitness.
3:	To make Overall growth & development with team spirit, social values and leadership qualities among students through various sports, games and Yogic activities.
4:	To create Environment for better interaction and recreation among students as neutralizer for stress through various minor and recreational games.

Course Outcomes:

After completion of the course, students will be able to

CO1	Understand fundamental skills, basic principle and practices of sports and Yoga.
CO2	Practically learn the principles of implementing general and specific conditioning of physical exercises and yoga.
CO3	Develop Health-related fitness and Body-mind co-ordination through various fitness activities, sports, recreational games and yoga.
CO4	Practice Healthy & active living with reducing Sedentary Life style.

Course Content:

Module I:

- Warm up and Cool Down and Stretching Exercises.
- General and Specific Exercises.
- Calculation of BMI & Resting Pulse Rate.
- General and Specific exercises for strength, Speed, Agility, Cardiovascular Endurance, Flexibility, Coordinative abilities.

- Practice of Fundamental Skills of Volleyball, Table Tennis and Chess, etc.
- Knowledge and practice of the Equipment used in a Gymnasium and its application.

Module II:

- Yoga: Standing, Sitting, Prone & Supine positions.
- Suryanamaskar.
- Pranayama, Meditation and Relaxation Techniques.
- Recreational Games.
- Practice of Fundamental Skills of Basketball, Football, Carrom, etc.
- Health related Physical Fitness Test.

Assessment Type	**Weightage in Marks**	**Total Marks**
Practical	Physical Efficiency Test – 30 Marks Sports/Games skill Activity/Project – 10 Marks Yoga Activities – 10 Marks	50
		Total = 50 Marks

References:

1	Russell, R.P. (1994). Health and Fitness Through Physical Education. USA: Human Kinetics.
2	Uppal, A.K. (1992). Physical Fitness. New Delhi: Friends Publication.
3	AAPHERD “Health related Physical Fitness Test Manual.”1980 Published by Association drive Reston Virginia
4	Kumar, Ajith. (1984) Yoga Pravesha. Bengaluru: Rashtrothanna Prakashana.
5	Dr. Devinder K. Kansal, A Textbook of Test Evaluation, Accreditation, Measurements and Standards (TEAMS ‘Science)

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Semester II	
Course Code:	**Course:** Electrical Maintenance
L: 3Hrs, **T**:0Hrs, **P**:0Hrs per Week	**Total Credits: 0**3
Compulsory/Elective: Exit course	**Course Type:** I Year Exit Course

Course Outcomes: After completion of the course, students will be able to	
CO1	Prepare maintenance schedules for electrical equipment and follow the various maintenance practices
CO2	Test and maintain rotating electrical machines.
CO3	Test and maintain single phase and three phase transformers.
CO4	Test and maintain insulation systems of electrical equipment

Syllabus

Module1: General Introduction

Objectives of particular testing, Significance of ISS, concept of tolerance, routine test, type test, special tests

Method of testing, direct, indirect, distractive and non-distractive testing methods.

Concept of routine, preventive and breakdown maintenance, advantages of preventive Maintenance, introduction to Total productive maintenance [TPM].

Testing Methods: Conceptual understanding to detect the fault by test results of Megger Testing, Resistance Testing, Turns ratio testing, Three phase sequence, Testing.

Module 2: Transformer routine maintenance

Testing: Type, Routine and Special Tests as per IS for Distribution and Power Transformer, Radiator choking, Breather silica jell bad condition, leakages from tank joints, Loose connections at terminals. Conservator top-up need, contamination of transformer oil properties, transformer de-hydration need etc. Effect of each reason on transformer.

Module 3: Rotating Machine/ Motors maintenance

Testing: Needs and Standards, Tolerance, Types: Routine, Special and Supplementary tests,

Methods of Testing: Direct, Indirect and regenerative with advantages and applications,

Induction Motor Testing: Routine Type and Special Test of Single and Three Phase Induction motor as per IS.

Alternator and Synchronous motor Testing: Routine Type and Special Test of Three Phase alternator and Synchronous motor as per IS.

Module 4: Maintenance of Electrical Machine Insulation

Factors affecting life of Insulation material, Measurement of Insulation Resistance and Interpretation of condition of Insulation, Transformer Oil: Properties, contamination agents, tests, Strengthening Insulations: Weakening agents, cleaning, Drying, Re-varnishing, baking impregnation, Filtration.
Module 5: Miscellaneous equipment maintenance Maintenance Solar panel, Battery.

Text Books:	
1	A text book of electrical maintenance, M.A. Choudhary, Publisher: Nirali Prakashan
2	Maintenance of electrical equipment, S. M. Choudhari,: Techknowledge publications
3	Maintenance of electrical equipment, by Sonje Swati M.,Publisher: Tech-Neo
4	Testing, Commissioning, Operation and Maintenance of Electrical Equipments, S.Rao,:Khanna publishers
5	Operation and maintenance of electrical equipment Vol.1 and Vol.2, By :B.V.S.Rao, MediaPromoters and publishers Pvt.Ltd

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Semester II	
Course Code:	**Course:** Electrical Appliances
L: 3Hrs, **T**:0Hrs, **P**:0Hrs per Week	**Total Credits:**3
Compulsory/Elective: Exit course	**Course Type:** I Year Exit Course

Course Outcomes: After completion of the course, students will be able to	
CO1	Discuss the concept of Energy Efficiency of Electrical appliances & types of power supply units used in these appliances.
CO2	Explain working principle & application of different electrical motors.
CO3	Describe working principle of appliances used for heating & cooling purpose.
CO4	Identify the different electrical power supply backup equipment like battery,Inverter, UPS, & photovoltaic system.
CO5	Explain construction & working principle of electrical domestic appliances.
CO6	Test & perform maintenance of Consumer Electrical Appliances.

Syllabus

Module 1: [06 Hours]
Basics of DC & AC systems, voltage-current-power relationships, AC DC sources for appliances, Star rating, Energy efficiency in Electrical appliances, Importance of IS codes, IE codes.

Module 2: [08 Hours]
Introduction to AC/DC Motors for Appliances (FHP Motors) - Single Phase Motors (FHP), DC Motors, BLDC Motors, Universal Motors.

Module 3: [08 Hours]
HVAC Appliances-: Construction, Working Principle, Ratings/Specifications, Control of

a) Resistance heating: Water heaters, Room Heater, Tea/ Coffee Maker, Oven, Toasters, Iron

b) Non Resistive heating: Induction heaters, Microwave oven

c) Cooling Appliances: Construction, Working Principle, Ratings/Specifications, Control of Fans, Desert Coolers, Air conditioner, Refrigerator

Module 4: 08 Hours]
Power supply Equipment: Battery and battery chargers, Switch mode power supply, Inverter, Uninterrupted Power Supply (UPS), Photovoltaic power System

Module 5: [06Hours]
Other Consumer appliances: Construction, Working Principle, Ratings/Specifications, Control Mixer, Grinder, Juicer, Vacuum Cleaner, Air Purifier, Washing Machines, Weighing

scale, Elevator
Module 6: [06 Hours] Illumination-Construction, Working Principle, Ratings/Specifications, Control of LED Lights.

Text Book/ Resources:	
1	Consumer Electronics by S P Bali, Pearson
2	Handbook of Repair & Maintenance of domestic electronics appliances: BPB Publications
3	Literature available through e-resources.

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Semester III	
Course Code: 24HS03TH0304	**Course:** Probability and Transforms
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** ESC

Course Outcomes: After completion of the course, students will be able to	
CO1	Interpret discrete and continuous probability distributions, and analyze real-life situations using expected value and variance.
CO2	Apply Binomial, Poisson, and Normal distributions to compute probabilities and related statistical measures.
CO3	Compute joint, marginal, and conditional probabilities using joint PMFs and PDFs, and analyze relationships between variables.
CO4	Explain the concept of sampling distributions, and apply the principles of hypothesis testing including null and alternative hypotheses, significance levels, and p-values.
CO5	Use Laplace transforms and their properties to solve ordinary and partial differential equations in engineering applications.

Syllabus

Module I: (06 Hours)
Probability spaces, conditional probability, Discrete and continuous random variables, expectation and variance of random variable.

Module II: (06 Hours)
Binomial distribution, Poisson distribution, Normal distribution and their applications, exponential distribution

Module III: (08 Hours)
Joint probability function for discrete and continuous random variables, Marginal probability functions, expectation and variance of multivariate random variables, covariance.

Module IV: (10 Hours)
Small and large sampling, Sampling Distributions, Point and Interval Estimations, Testing of Hypothesis for single mean and proportion for both small and large sample size, Testing of Hypothesis for difference of mean and proportion.

Module V: (08 Hours)
Laplace transforms and its existence, properties of Laplace transform, inverse Laplace transform and application of Laplace Transform to solve differential equations

Text Books:

1	M R. Spiegal , Theory and Problems of probability and statistics :,2nd edition, Schaum series
2	S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
3	B. S. Grewal, Higher Engineering Mathematics, Khanna publishers 43rd edition (2015).

Reference Books:	
1	Maurtis Kaptein, Statistics for data science, An introduction to probability, statistics and Data Analysis, Springer 2022.
2	Jay L Devore, Probability and Statistics for Engineering and sciences, 8th edition, Cenage learning.
3	Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

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Semester III	
Course Code: 24EE07TH0301	**Course:** Signals and Systems
L: 3 Hrs, **P**:0 Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Identify the different types of signals and systems.
CO2	Analyze the differential equation in time domain.
CO3	Apply Fourier transforms for continuous-time and discrete-time signals.
CO4	Apply Z-transform to discrete signals and systems.
CO5	Illustrate the sampling process and its various applications

Syllabus

Module-I: Introduction to Signals and Systems (08 Hours)
Signals and systems as seen in everyday life and in various branches of engineering and science. Different types and properties of signal and systems. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals.

Module-II: Behavior of Continuous and Discrete-Time LTI Systems (07 Hours)
Impulse response and step response, convolution, input-output behaviour with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response

Module-IV: Z-transform (07 Hours)
Z-transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis, various properties of Z-transforms.

Module-III: Fourier Transform (10 Hours)
Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT), the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT).

Module-V: Sampling and Reconstruction (06 Hours)

Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero- order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text Books:	
1	V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2	J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
3	H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
4	S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.AICTE Model Curriculum for Undergraduate degree in Electrical Engineering (Engineering & Technology)

Reference Books:	
1	V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2009.
2	M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.
3	B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009

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Semester III	
Course Code: 24EE07TH0302	**Course:** Electrical Machines
L: **4** Hrs, **P**:0Hrs per Week	**Total Credits:** 04
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Describe the three-phase transformer related aspects, tests and calculate the load sharing during parallel operation.
CO2	Describe the three-phase induction motor related aspects, no load and blocked rotor tests.
CO3	Understand the concepts of starting, speed control and braking of three-phase induction motor.
CO4	Explain the construction and operation of synchronous generator and determine voltage regulation and other unknowns under given conditions. Also explain synchronization and parallel operation of alternators.
CO5	Explain operation of synchronous motor, phasor diagram, starting methods of synchronous motor and analyze the effect of change in field current.
CO6	Explain the construction, working principle and applications of various special motors.

Syllabus

Module I: Three Phase Transformer (08 Hours)

Construction of three phase transformer, connections, OC & SC test on three phase transformers, calculation of regulation and efficiency, all day efficiency, vector groups, clock notation of 3-phase transformer, concept of Inrush current, Tap changer (on load and off load).

Parallel operation of three phase transformer: Conditions for parallel operation and load sharing between parallel connected transformer.

Module II: Three Phase Induction Machine (08 Hours)

Construction,3-phase winding, production of rotating magnetic field, slip, equivalent circuit, phasor diagram, torque equation, power flow, torque-slip characteristic in all three modes of operation (motor, generator and braking), No load and blocked rotor tests**,** calculation of equivalent circuit parameters, losses and efficiency.

Module III: Starting, Speed Control and Braking of 3-Phase Induction Motor (08 Hours)

Starting methods of 3-phase Induction Motor: DOL starting, Auto-transformer starting, Star-Delta starting. Speed control Methods: By change in input voltage, input frequency, V/F method, rotor resistance control and consequent pole changing technique. Braking methods: Plugging, Regenerative braking, DC and AC braking.
Module IV: Synchronous Generator (08 Hours) Construction of cylindrical and salient pole synchronous machines, induced EMF, operation as a generator, voltage equation, phasor diagrams, calculation of voltage regulation by synchronous impedance method, calculation of efficiency, Condition for parallel operation, synchronization with infinite bus.
Module V: Synchronous Motor (08 Hours) Operation as a synchronous motor, starting of synchronous motor, effect of change in field current, calculation of efficiency, types of losses, voltage equation, phasor diagram.
Module V: Introduction to Special Motor (05 hours) Construction, operation and application of Permanent magnet synchronous motor, Brushless DC motor.

Text Books:	
1	Electrical Machines: Dr. P.S. Bimbhra
2	Electrical Machines: Ashfaq Hussain
3	A Text Book of Electrical Technology: B. L. Theraja (Vol. II)
4	Electric Motors and Transformers Theory and Practicals:Dr. S. B. Bodkhe
5	Electric Power Transformer Engineering by Charles W. Johnson,3rd Edition,2012 CRC Press

Reference Books:	
1	Performance & Design of A.C. Machine: M. G. Say
2	Electrical Machines: I.S. Nagrath & Dr. D.P. Kothari.
3	Laboratory Courses in Electrical Engineering: Tarnekar, Kharbanda, Bodkhe & Naik

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Semester III	
Course Code: 24EE07PR0302	**Course:** Electrical Machines Lab
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Evaluate regulation and efficiency of a three-phase transformer by performing OC and SC tests.
CO2	Conduct tests on three-phase induction motors to determine equivalent circuit parameters, analyze torque-slip characteristics, and explore starting, speed control methods.
CO3	Perform experiments on Synchronous Generator and Synchronous motor and make valid conclusions from observed results
CO4	Write effective reports based on own observations and conclusions

List of Experiments:
1. To perform open circuit and short circuit tests on three phase transformers.
2. To perform load test on three phase Induction Motor.
3. To study speed control of three phase Induction Motor by- (i)Frequency control (ii)Rotor resistance control
4. To perform no load and blocked rotor test on three phase Induction Motor to find its parameters.
5. To study load characteristics of an Induction Generator.
6. To determine voltage regulation of three phase alternator by open circuit and short circuit test.
7. To determine voltage regulation of three phase alternator by direct loading.
8. To find Xd and Xq of a salient pole rotor type synchronous machine by slip test.
9. To study the synchronization of alternator with infinite bus.
10. To plot V and inverted V curves of a synchronous motor.

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Semester III	
Course Code: 24EE07TH0303	**Course:** Electrical Measurements and Instrumentation
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Identify suitable bridge for the measurement of passive electrical elements.
CO2	Describe the operating principle and construction of different types of analog instruments.
CO3	Describe the operating principle and construction of digital instruments for the measurement of electrical quantities.
CO4	Calculate different operational parameters of instrument transformers.
CO5	Select and compare different transducers for the measurement of various physical quantities.

Syllabus

Module-I: (09 Hours)
Measurement Systems, classification of different measuring Instruments, D.C bridges (Wheat stone, Kelvin and Kelvin's Double bridge) A.C bridges (Schering Bridge, Maxwell-Inductance- Capacitance Bridge, Hay's bridge, Owen's Bridge and DeSauty's Bridge).

Module-II: (09 Hours)
Analog Measurement Techniques, Principle of permanent magnet moving coil (PMMC) instrument, Moving iron (MI) instrument and Electrodynamometer type instruments. Measurement of three phase and single phase power, loading effect of instruments.

Module-III: (06 Hours)
Digital Measurement Techniques, True RMS measurement, measurement of voltage, Current, Power, Frequency and Energy.

Module-IV: (07 Hours)
Introduction to Instrument transformers and its applications. Working principle of Special Instruments, Insulation Tester, and Earth tester.

Module-V: (09 Hours)
Classification of Transducers, Electromechanical transducers, Potentiometric resistance Transducers, Inductive type transducers, Variable inductance transducer, , Piezoelectric transducer, Strain gauges, Linear variable differential transformer, Capacitive type

transducer, resistance strain gauge, Digital transducers.
Module-VI: (07 Hours) Measurement of various physical quantities like temperature, flow, motion, atmospheric parameters and pressure.

Text Books:	
1	A Course in Electrical and Electronics Measurements and Instrumentation: 11edition, Sawhaney A. K., Dhanpat Rai & Sons, Delhi 1994.
2	Electrical Measurements and Measuring Instruments: 3ed. Golding, E. W., Widdis, F.C.,Wheeler's Student Edition, 1994.
3	Electrical Measurements and Instrumentation: U. A. Bakshi, A.V. Bakshi, Technical Publications, 2009.
4	Electrical and Electronic Measurements and Instrumentation: R.K. Rajput.
5	Instrumentation Measurement and Analysis: B C Nakra, K K Chaudhary

Reference Books:	
1	Electronic Measurements and Instrumentation: 3 ed., Cooper, W.D., Helfrick, A.D., Prentice-Hall of India,New Delhi 1991

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Semester III	
Course Code: 24EE07PR0303	**Course:** Electrical Measurements and Instrumentation Lab
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand and correlate the theoretical knowledge of electrical measurements and instrumentation with laboratory experiments.
CO2	Perform the experiment and analyze the observed data.
CO3	Write practical record with effective presentation.
CO4	Measure different physical and electrical parameters and make valid conclusion.

List of Experiments:
Part-A: Based on Electrical Measurements
1. Measurement of Resistance i. Medium Resistance using Wheatstone Bridge Method ii. Low Resistance using Kelvin's Double Bridge method
2. Measurement of Capacitance using i. De-Sauty's Bridge and Modified De_Sauty's Bridge ii. Schering Bridge
3. Measurement of Inductance using i. Hay's Bridge ii. Maxwell's Bridge
4. Measurement of reactive power by one wattmeter method
5. Measurement of three phase power using two wattmeter method.
6. Measurement of Energy using Digital Energy meter
Part B: Based on Instrumentation
7. Pressure measurement using Piezo Resistive sensor
8. Flow measurement using Rotameter
9. Temperature measurement using Thermocouple
10. Study of Linear Variable Differential Transformer (L.V.D.T.)

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Semester III	
Course Code:	**Course:** Object Oriented Programming
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** MDM

Course Outcomes: After completion of the course, students will be able to	
CO1	Classify the different features of object-oriented programming.
CO2	Implement the features of Develop basic programs for given problems.
CO3	Apply the concepts of Multithreading and Exception handling to develop efficient and error free codes
CO4	Discuss Generics, Collections and multithreading and develop programs using these concepts.

Syllabus

Module I: (08 Hours)

Features of Object-Oriented Programming languages like data encapsulation, inheritance, polymorphism and late binding. Introduction to class and Methods, Access control of members of a class, instantiating a class, Constructors, Garbage Collection, finalize() Method.

Module II: (08 Hours)

Concept of inheritance, methods of derivation, use of super keyword and final keyword in inheritance, run time polymorphism. Abstract classes and methods, interface, implementation of interface, creating packages, importing packages, static and non-static members.

Module III: (09 Hours)

Exceptions, types of exception, use of try catch block, handling multiple exceptions, using finally, throw and throws clause, user defined exceptions, Generics, generic class with two type parameter, bounded generics, Collection classes: Arrays, Vectors, Array list, Linked list, Hash set, Queues, Trees.

Module IV: (09 Hours)

Introduction to streams, byte streams, character streams, file handling in Java, Serialization Multithreading: Java Thread models, creating thread using runnable interface and extending Thread, thread priorities, Thread Synchronization, Inter-thread communications.

Text Books:	
1	JAVA The Complete Reference: Herbert Schildt; Seventh Edition, Tata McGraw- Hill Publishing Company Limited 2007.
2	A programmer's Guide to Java SCJP Certification: A Comprehensive Primer: Khalid A. Mughal and Rolf W.Rasmussen, Third Edition.
3	Java Fundamentals: A Comprehensive Introduction:HerbertSchildt and Dale Skrien; Tata McGraw- Hill Education Private Ltd., 2013.

Reference Books:	
1	Core JAVA Volume-II Advanced Features: Cay S. Horstmann and Gary Cornell; Eighth Edition; Prentice Hall, Sun Microsystems Press, 2008.
2	Java Programming: A Practical Approach: C Xavier; Tata McGraw- Hill Education Private Ltd.,2011.

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Semester III	
Course Code: 24EEOEI07TH0305-1	**Course:** Electrical Engineering: Introduction and Applications
L: 2 Hrs, **P**:0 Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Open Elective	**Course Type:** OE

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze DC circuits and magnetic circuits using fundamental concepts and circuit laws
CO2	Apply the fundamental laws of electrical engineering to solve simple AC circuits
CO3	Analyse three phase circuits using fundamental laws.
CO4	Explain the construction, working principle of single-phase transformer, Induction motor and determine its performance at given operating condition

Syllabus

Module I: DC Circuits and Magnetic Circuits (08 Hours)
Review of fundamental terminologies related to dc circuits, mesh current and node voltage analysis of DC circuits, star-delta and delta-star transformation
Review of fundamental terminologies related to magnetic circuits, analogy with electric circuits, analysis of magnetic circuits, self and mutual inductances

Module II: Single Phase AC Circuits (08 Hours)
Generation of sinusoidal voltage, basic terminologies associated with AC quantity, phasor representation of alternating quantities. Real power, reactive power, apparent power and power factor, Analysis of basic series and parallel AC circuit.

Three Phase A.C. Circuits: Basic concepts; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits.

Module III: Single Phase Transformers (08 Hours)
Basic principle and construction of single-phase transformer; Operation under no load and load condition, equivalent circuit, voltage regulation and efficiency.

Module-IV: Induction Motors (06 Hours)
Construction, working principle and applications of single-phase motors. Working principle of three phase induction motor; Introduction to BLDC motors: working principle, construction with its applications.

Text Books:

1	Fundamentals of Electric Circuits by Charles K Alexander and Matthew N. O. Sadiku, TMH Publication, 5th Edition, 2013.
2	Basic Electrical Engineering by Abhijit Chakrabarti, Sudipta Nath, and Chandan Chanda, TMH Publication, 2013.
3	Electrical Machinery by P.S. Bimbhra, Khanna Publishers, 7th Edition

Reference Books:	
1	Electrical Engineering Fundamentals by Vincent Del Toro, PHI Publication, Second Edition.
2	Electrical Technology by H Cotton, CBS Publishers and Distributors,7th Edition, 2005.

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Semester III	
Course Code: 24EEOEI07TH0305-2	**Course:** Renewable Energy Systems
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Elective	**Course Type:** OE

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the necessity and importance of renewable energy sources.
CO2	Discuss the working principle of solar photovoltaic system and its topologies.
CO3	Discuss the operation of wind energy generation.
CO4	Explain the renewable energy sources like Hydel, Tidal, Biomass, Geothermal, Wave, and Ocean.

Syllabus

Module I: Global and National Energy Scenario (04 Hours)
Over view of conventional & renewable energy sources, need, potential & development of renewable energy sources, Global and Indian Energy scenario, Energy for sustainable development, Global climate change, carbon credits and carbon footprint calculation.

Module II: Solar Energy (08 Hours)
Solar energy system, Solar Radiation, Introduction to photovoltaic solar cell, characteristics and its connections, Different PV topologies.

Module III: Wind Energy (06 Hours)
Wind Energy Conversion, Potential, Nature of the wind, Types of wind turbines, Wind-Electric Generation.

Module IV: Other Renewable Sources (08 Hours)
Introduction to hydel-power generation, tidal energy, biomass energy, geothermal energy

Text Books:	
1	Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH,New Delhi, 3rd Edition.
2	Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis - second edition, 2013.
3	Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers

Reference Books:	
1	Renewable Energy- Edited by Godfrey Boyle, Oxford University Press, 3rd Edition,

	2013.
2	Handbook of Renewable Technology, Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
3	Renewable Energy Technologies, Ramesh & Kumar /Narosa
4	Renewable Energy Technologies, A practical guide for beginners, Chetang Singh Solanki, PHI.
5	Non-conventional Energy Source, B.H. Khan, TMH, 2nd Edition.

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Semester III	
Course Code: 24HS01PR0301	**Course:** Environmental Science
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** VEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Apply the fundamental principles of measurement and skills in preparation and handling of Environmentally hazardous materials and interpret the statistical data related to measurements.
CO2	Use of the computational tools for searching, interpretation of results, etc. and preparation of case study regarding Environmental Issues.

List of Experiments
[1] Demonstration of Handling of hazardous chemicals, MSDS (material safety data sheet), waste minimization strategies and chemical waste disposal.
[2] Preparation of different Solutions: Molar solution, Normal solution and percent solution and Determination of concentration in their various forms.
[3] Basic statistical analysis of results of neutralization of acid against the base and preparing acceptable graphs using software.
[4] Estimation of Copper ions from acid digested PCB solution.
[5] Estimation of Chromium ions from e-waste sample.
[6] Prediction of NMR spectra and analytical data of molecules using Computational Software and its analysis.
[7] Spectroscopic determine of wavelength of maximum absorption of chemical/biological compound in solution and plotting of calibration curves.
[8] Estimation of Fe (II) ions from e-waste rust spectrophotometrically / calorimetrically using 1, 10-Phenanthroline method.
[9] Determination of Free CO2 in the given water sample.
[10] Determination of dissolved oxygen (DO) in the given water sample.
[11] Estimation of Chlorine in water.
[12] Determination of rate of the reaction at room temperature and analysis of experimental data using Computational Software
[13] Determination of AQI of a region.
[14] Use of various open online search tools for Environmental Case Studies.

Text Books:	
1	S. S. Dara, A Textbook on Experiments and Calculations in Engineering Chemistry, S. Chand Publications.
2	J. B. Yadav, Advanced Practical Physical Chemistry, Krishna's Prakashan Media (P)

	Limited.
3	A. J. Elias, Collection of Interesting General Chemistry Experiments, Universities Press Publications.
4	V. K. Ahluwalia, S. Dhingra and A. Gulati, College Practical Chemistry, Universities Press Publications.

Reference Books:	
1	David Young, Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems, Wiley Interscience Publications

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Semester III **Honors in "Electric Vehicle"**	
Course Code: 24EE07HT0301	**Course:** Electric Vehicle Fundamentals
L: 3 Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** Honors

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the evolution and comparison of Electric Vehicles (EVs)
CO2	Describe the various internal combustion engines.
CO3	Analyze vehicle dynamics and performance parameters
CO4	Explain the basic concepts of hybrid and electric traction and analyze various drive train topologies. They will also evaluate power flow control strategies for efficient energy management and performance optimization in hybrid vehicles.

Syllabus

Module I: Environmental Impact and History of Modern Transportation (05 Hours)
Air Pollution, Global Warming, Petroleum Resources, Overview of Electric Vehicles (EVs), Comparison with Internal Combustion Engine (ICE) vehicles, EV Market

Module II: Fundamental of Internal Combustion (IC) Engine (06 Hours)
Introduction of IC Engine, 2S and 4S Engine, Types of Engines, Ignition system and cooling system.

Module III: Vehicle Dynamics and Control (07 Hours)
Fundamentals of vehicle dynamics: Tractive effort, gradeability, and driving cycles, Energy consumption and efficiency analysis, Performance parameters (range, acceleration, top speed).

Module IV: Hybrid Drive-trains (06 Hours)
Basic concept of hybrid traction, introduction to various hybrid drive train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Module V: Electric Vehicle (EV) Drive-trains (06 Hours)
Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. social and environmental importance of EV and HEV.

Text Books:	
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles - Fundamentals, Theory, and Design: M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, CRC Press, 2004.
2	Electric and Hybrid Vehicles Design Fundamentals by Iqbal Husain, CRC Press

Reference Books:	
1	Electric and Hybrid Vehicles: T. Denton, Routledge, 2016

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Semester III **Minors in "E-Mobility"**	
Course Code: 24EE07MT0301	**Course:** Basics of Electrical Engineering and E-Mobility
L: 3 Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** Minors

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze the basics of ac and dc circuits.
CO2	Discuss the construction and operation of transformer, induction motor and DC Motor.
CO3	Compare electric vehicle with conventional vehicle and its impact on energy supplies.
CO4	Discuss the dynamics of vehicle.
CO5	Discuss the architecture and various topologies of EV and HEVs.

Syllabus

Module I: Introduction to Electric Circuits (06 Hours)
Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff's current and voltage laws, analysis of simple circuits with DC excitation.

Module II: Single Phase AC Circuits (06 Hours)
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits.

Module III: Introduction to Electric Machines (06 Hours)
Construction and working principle of transformer and induction motor.

Module IV: Overview of Electric Vehicle (05 Hours)
History of modern transportation, environmental impact and need of EV, comparison with IC engine, general layout of EV and its component, Electric vehicle Market.

Module V: Vehicle Dynamics (08 Hours)
Introduction, tractive efforts: linear and angular acceleration, aerodynamic drag, rolling resistance and uphill resistance. Power and torque to accelerate, dynamic equation, drive cycle and energy used.

Module VI: Drive train of EV and HEVs (05 Hours)
Basic concept of EVs and HEVs, classification, various drive-train topologies and power flow control.

Text Books:	
1	Electrical Technology: B. L. Theraja, S. Chand Publications.
2	Basic Electrical Engineering: S. B. Bodkhe, N. M. Deshkar, P. P. H. Pvt. Ltd.
3	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4	Electric Circuits" James W. Nilsson, Susan Riedel, 9th edition, Prentice hall, 2011
5	Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles."
6	Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals," CRC Press, 2021
7	James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd,

Reference Books:	
1	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
2	V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
3	Electric and Hybrid Vehicles: T. Denton, Routledge, 2016
4	Ali Emadi, "Handbook of Automotive Power Electronics and Drives", CRC publishers, 2012.

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Semester IV	
Course Code: 24EE07TH0401	**Course:** Network Analysis
L: 3 Hrs, **P**:0 Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze the single phase and three phase circuits using basic mathematical tools
CO2	Apply various network theorems for electrical network analysis.
CO3	Apply Laplace transforms and waveform synthesis techniques for electrical circuit analysis.
CO4	Evaluate various network functions and two port electrical network parameters.

Syllabus

Module I: Equilibrium Equations (8 Hours)
Equilibrium equations with Nodal and Mesh Analysis on electrical networks, source transformations, Dot conventions in coupled circuits, Solutions of mutually coupled networks, Duality.
Resonance in series and parallel RLC circuits
Three-phase unbalanced circuits and power calculations.

Module II: Network Theorems (08 Hours)
Superposition, Reciprocity, Thevenin's, Norton's. Maximum Power Transfer, Compensation, Tellegen's theorem as applied to DC and AC circuits.

Module III: Laplace Transform and Applications (08 Hours)
Evaluation of initial and final condition, Concept of complex frequency, Partial fractions, Singularity functions, Waveforms Synthesis, Steady state and transient state analysis of RL, RC, RLC network with initial and final conditions using Laplace Transformation.

Module IV: Network Functions (06 Hours)
Transient Response, Driving points and transfer functions, Poles, Zeros of network function, their properties, Time response from Pole-Zero locations on s-plane, convolution integral solution.

Module V: Two Port Networks (10 Hours)
Network Parameters and Inter-connections, Conditions of Reciprocity and Symmetry, Inter-relations between parameter sets.

Text Books:

1	M. E. Van Valkenburg, “Network Analysis”, Prentice Hall, 2006.
2	D. Roy Choudhury, “Networks and Systems”, New Age International Publications,1998.
3	W. H. Hayt and J. E. Kemmerly, “Engineering Circuit Analysis”, McGraw Hill Education, 2013.
4	C. K. Alexander and M. N. O. Sadiku, “Electric Circuits”, McGraw Hill Education,2004.
5	Chakrabarty, “Circuit Theory (Analysis and Synthesis)”, Dhanpat Rai and Co. 2006

Reference Books:	
1	Allan H. Robbins, Wilhelm C. Miller, “Circuit Analysis Theory and Practice”, Cengage Learning India, 2013.
2	Jegatheesan, R., “Analysis of Electric Circuits,” McGraw Hill, 2015. Joseph A. Edminister, Mahmood Nahri, “Electric circuits”, Schaum's series, McGraw- Hill,New Delhi, 2010.
3	Mahadevan, K., Chitra, C., “Electric Circuits Analysis,” Prentice-Hall of India Pvt Ltd., New Delhi, 2015.
4	Richard C. Dorf and James A. Svoboda, “Introduction to Electric Circuits”, 7th Edition, John Wiley and Sons, Inc. 2015.
5	Sudhakar A and Shyam Mohan SP, “Circuits and Network Analysis and Synthesis”, McGraw Hill, 2015.

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Semester IV	
Course Code: 24EE07PR0401	**Course:** Network Analysis Lab
L: 0 Hrs, **P**:2 Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Apply, analyse and co-relate fundamental principles of Engineering with laboratory experimental work.
CO2	Perform the experiment and analyse the observed data.
CO3	Write practical record with effective presentation.
CO4	Verify experimental results with theoretical analysis and make valid conclusion.

List of Experiments:
1. Verification of Thevenin's Theorem.
2. Verification of Norton's Theorem.
3. Verification of Superposition Theorem.
4. Verification of Maximom Power Transfer Theorem.
5. Verification of Milliman's Theorem.
6. Verification of Reciprocity Theorem.
7 To Find the Voltage Transfer Ratio of a Two Port, Bridged-T Network.
8. To Find Z-Parameters of a Two Port, T -Network.
9. To Study the Resonance of RLC Series/Parallel Network and Plot the Vr Vs F Curve
10. To Verify the Network Theorems using MATLAB Simulation.
11. To Find the Voltage Transfer Ratio using MATLAB Simulation
12.To Find Z-Parameters T-Network using MATLAB Simulation
13.Virtual Laboratory experiments

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Semester IV	
Course Code: 24EE07TH0402	**Course:** Electrical Power System
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Determine per unit values of various power system components.
CO2	Calculate different electrical parameters of transmission line.
CO3	Model different types of transmission line and determine its efficiency and voltage regulation.
CO4	Discuss different types of distribution system and the performance of underground cables.
CO5	Discuss the mechanical design aspects of overhead transmission line.

Syllabus

Module I: Basic Concepts (06 Hours)
Evolution of Power Systems and Present-Day Scenario. Structure of a power system, Transmission and Distribution Systems, Single line diagram, overhead and underground system, AC and DC transmission, Introduction to per-unit system and per-unit calculations.

Module II Transmission Line Parameters (08 Hours)
Transmission line parameters, Electric and Magnetic Fields around conductors, Capacitance and Inductance calculations for symmetrical and unsymmetrical conductor spacing, Transposition of line, Skin and Proximity effect, bundled conductors, Corona.

Module III: Performance of Transmission Line (10 Hours)
Sinusoidal Steady state representation of Lines: Short, medium and long lines. Performance of transmission line and voltage regulation, Real and reactive power flow in transmission line, Surge Impedance Loading.

Module IV: Distribution System and Cables (08 Hours)
Types of distribution system and its topologies, Feeders, distributors and service mains, Quantitative analysis of DC and AC distributor. Types of Cables, Capacitance of single-phase and three-phase Cable, Grading of Cable.

Module V: Mechanical Design of Transmission Line (08 Hours)
Line Supports, Types of towers, Sag Calculation, Effect of Wind and Ice loading, Insulators: Types, Voltage distribution in insulator string, improvement of string efficiency.

Text Books:	
1	Power System Analysis: J. Grainger and W. D. Stevenson, McGraw Hill Education,1994
2	Modern Power System Analysis: *D. P. Kothari and I. J. Nagrath, McGraw Hill Education, 2003.*
3	Electric Power Systems: *C.L. Wadhwa, Wiley Eastern Ltd, New Delhi.*
4	A Course in Power Systems: J.B. Gupta , S.K. Kataria & Sons,2008

Reference Books:	
1	Principles of Power System: V.K. Mehta, S. Chand ,2005
2	Electric Power Systems: M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, Wiley, 2012.

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Semester IV	
Course Code: 24EE07TH0403	**Course:** Microcontroller Programming and Applications
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the architecture and organization of microcontroller.
CO2	Apply embedded C concepts for microcontroller programming.
CO3	Interpret the control registers of different peripherals and initialize them.
CO4	Interface different Input-Output devices with microcontroller.
CO5	Implement microcontroller-based real-time applications.

Syllabus

Module I: Introduction to Microcontrollers (04 Hours)
Microprocessor and Microcontroller, Overview of microcontroller applications and major families; Microcontroller architecture.

Module II: (08 Hours)
Instruction Set Introduction: Addressing modes and Instruction set of a **ATMEL AVR microcontroller,** Microcontroller hardware connection; Interfacing with parallel I/O ports.

Module III: Peripheral Programming (10 Hours)
Timer programming, Analog to digital Conversion, Interfacing of I/O devices; Interrupt programming, working with memories: SRAM, EEPROM, Flash

Module IV: Serial Communication (06 Hours)
Serial communication using USART, Introduction to synchronous transmission**.**

Module V: Embedded C Programming (06 Hours)
C language programming of microcontroller using open source /proprietary software packages in Integrated Development Environment.

Module VI: Application Development (06 Hours)
Introduction to various interactive applications using microcontroller and peripherals, LCD interfacing.

Text Books:	
1	The AVR microcontroller and Embedded systems using assembly and C, Muhammad Ali Mazdi, Sarmad Naimi and Sepher Naimi 2011, Prentice Hall.
2	Embedded C Programming and the Atmel AVR, Second Edition Richard Barnett, Larry O'Cull and Sarah Cox, Delmar, Cengage Learning
3	Go Embedded, Second Edition Asang Dani,, Yeshwant Kanetkar, B.P.B. Publication.

Reference Books:	
1	Programming And Customizing The AVR Microcontroller by Dhananjay Gadre, Tata McGraw-Hill Educatio
2	Product Datasheets

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Semester IV	
Course Code: 24EE07PR0403	**Course:** Microcontroller Programming and Applications Lab
L: 0Hrs, **P**:02Hrs Per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Use open source or proprietary development environment and microcontroller development board for Microcontroller programming.
CO2	Implement control algorithm using Embedded C.
CO3	Setup the circuit on microcontroller development board for testing of program.
CO4	Debug the program to remove the syntax and logical errors.
CO5	Implement simple real-time applications.

Microcontroller Programming and applications Laboratory Assignments			
Sr. No	**Assignment**	**Details**	**Concept Covered**
1.	LED Interfacing	This Assignment demonstrates the LEDs ON-OFF, Blinking and Scrolling operation.	I/O PORTs, Delay function, Control loops
2.	LED and Switches interfacing	This assignment demonstrates LED and Switch interfacing operation.	I/O PORTs, Key Interfacing Control loops
3.	Seven Segment Display interfacing	This assignment demonstrates Multiplexed Seven Segment Display interfacing using BCD to 7segment Decoder 74LS47.	Multiplexed Seven Segment Display(SSD) interfacing Control loops
4.	Electromechanical Relay and Buzzer interfacing	This assignment demonstrates Electromechanical Relay and Buzzer interfacing.	I/O PORTs, Key Interfacing Control loops
5.	LCD interfacing	This assignment demonstrates the 16x2 LCD operation in 4 bit mode.	LCD Interfacing, C Functions
6	ADC interfacing	ADC interfacing with different Sensors	ADC Interface, Interrupts
7	Timer Interfacing	This Assignment demonstrates the Timer initialization in different modes and use of Timer for generation of PWM signals	Timer/Counter, Interrupts, PWM signal generation
8	Serial Communication with PC using UART	This Assignment demonstrates simple Serial communication operation with PC.	Serial communication protocols

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Semester IV	
Course Code:	**Course:** Programming for Machine Learning
L: 3Hrs, **P**:0Hrs Per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** MDM

Course Outcomes: After completion of the course, students will be able to	
CO1	Develop and execute simple Python programs using conditionals and looping for solving problems.
CO2	Develop python program to manipulate lists, tuples, dictionaries and sets for given purpose.
CO3	Use python built-in functions and develop relevant user defined function for the given purpose. Also, able to read and write data from/to files in Python programs.
CO4	Use matplotlib and seaborn to create data visualization in python.
CO5	Utilize libraries such as NumPy, Pandas etc. for data processing and visualization.

Syllabus

MODULE I: INTRODUCTION TO PYTHON (06 Hours)

Python Basics: Python as scripting Language, Python's building blocks- Identifiers, Keywords, Variables, Constants, Indentation, Comments in python, Data Types, Input and Output statements in python Operators in Python, Operator precedence and Associativity.

Types of Control Statements : Decision Making Statements: - if, if…. else, else-if ladder, nested if and switch statement; Looping statement: - while loop, for loop, nested loop Manipulating Loops- use of break, continue and pass statements.

MODULE II: LISTS, TUPLES, DICTIONARIES, SETS (07 Hours)

Lists: create, access, slicing, negative indices, list comprehension

Tuples: create, indexing and slicing, operation on tuple

Dictionaries: create, add and replace values ;Sets: Create and operations

MODULE III: STRINGS, FUNCTIONS, FILES (07 Hours)

Strings: Comparison, formatting, slicing, splitting, stripping, string matching, search and replace

Functions: Parameters and arguments: positional argument, keyword argument, parameters with default values-local and global scope of variable, recursive function, lamda function

Files and exception: create, open, read, write, append and close, errors and exceptions handling

MODULE IV: MODULES, PACKAGES and DATA VISUALIZATION (06 Hours)

Modules - Defining Modules and importing modules; Packages - Defining packages, importing packages; Standard Packages - Using standard packages/libraries Matplotlib & Seaborn **:** Introduction to Data Visualization, Histograms, Line Plots, scatter plots, Heatmaps.
MODULE V: ESSENTIAL PYTHON LIBRARIES FOR MACHINE LEARNING: NUMPY (06 Hours) Introduction to NumPy-Arrays, Indexing, Advanced array manipulation, Broadcasting, Mathematical Operations.
MODULE VI: ESSENTIAL PYTHON LIBRARIES FOR MACHINE LEARNING: PANDAS (06 Hours) Introduction to Pandas: Data Frames, Data loading, Data cleaning preparation, Data wrangling, Exploratory data analysis.

Text Books:	
1	Martin C. Brown, "Python: The Complete Reference"-Graw Hill, 4th Edition, 2018
2	Mark Lutz , "Learning Python", O'Reilly, 5th Edition, 2013
3	Magnus Lie Hetland, "Beginning Python: From Novice to Professional ", Apress, Edition: 4th Edition, 2024.
4	Reema Thareja, "Python Programming: Using Problem Solving Approach", Oxford University Press, 2nd Edition.

Reference Books:	
1	Hands-On Exploratory Data Analysis with Python, Suresh Kumar Mukhiya, Packt Publishing.
2	Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly Media, 2nd Edition.
3	Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", O'Reilly Media, 2nd Edition.

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Semester IV	
Course Code: 24EEOEI07TH0405-1	**Course:** Electrical Appliances
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Elective	**Course Type:** OE

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand concept of energy efficiency of electrical appliances and types of power supply used in various appliances.
CO2	Explain the working principle and application of different electrical motors.
CO3	Explain the working principle of appliances used for heating and cooling purpose.
CO4	Describe the construction and working principle of electrical domestic appliances.
CO5	Discuss the illumination system used for domestic and commercial lighting

Syllabus

Module I: (06 Hours)
Basics of DC & AC systems, voltage-current-power relationships, AC- DC sources for appliances, Star rating,Energy efficiency in Electrical appliances, Importance of IS codes, IE codes.

Module II: (08 Hours)
Introduction to AC/DC Motors for Appliances (FHP Motors) - Single Phase Motors (FHP), DC Motors, BLDC Motors, Universal Motors

Module III: (08 Hours)
HVAC Appliances-: Construction, Working Principle, Ratings/Specifications and Control of
a) Resistance heating: Water heaters, Room Heater, Tea/ Coffee Maker, Oven, Toasters, Iron
b) Non Resistive heating: Induction heaters, Microwave oven
c) Cooling Appliances: Fans, Desert Coolers, Air conditioner, Refrigerator

Module IV: (06 Hours)
Other Consumer appliances: Construction, Working Principle, Ratings/Specifications, Control of Mixer, Grinder,Juicer, Vacuum Cleaner, Air Purifier, Washing Machines, Weighing scale.

Module V: (06 Hours)
Illumination: Construction, Working Principle, Ratings/Specifications, Control of LED

Lights

Text Books:	
1	Consumer Electronics by S P Bali, Pearson
2	Handbook of Repair & Maintenance of domestic electronics appliances: BPB Publications
3	Literature available through e-resources

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Semester IV	
Course Code: 24EEOEI07TH0405-2	**Course:** Energy Storage Systems
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Elective	**Course Type:** Open Elective

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze the characteristics of energy from various sources that need for storage system.
CO2	Study of energy management system of battery depends upon properties.
CO3	Identify, formulate, and solve problems related to fuel cell technology keeping in mind economic viability.
CO4	Analyze different hybrid storage system as per applications in electric vehicles.

Syllabus

Module I: Introduction (06 Hours)
Energy availability, Demand and storage, Need for energy storage, Different types of energy storage.

Module II: Battery technology (08 Hours)
Battery definitions, terms and terminology, Lithium ion battery types and their properties, battery management system, SoC estimation techniques, applications in EV.

Module E III: Fuel Cells (05 Hours)
Introduction to fuel cells, components of fuel cells, Types of fuel cells, working principle of fuel cell, efficiency of fuel cell, fuel cell stack, fuel cell cars and buses.

Module IV: Supercapacitor (06 Hours)
Construction, working principle, types, advantages and disadvantages, application in electric vehicle.
Introduction to Advanced Flywheel, Introduction to Hybrid Energy storage systems: configurations and applications.

Text Books:	
1	A. R. Pendse, “Energy Storage Science and Technology”, SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN – 13:9789380090122), 2011.
2	Rahn C. D. and Wang C., Battery Systems Engineering, First Edition, Wiley (2013)

Reference Books:	
1	Narayan R. and Viswanathan B., Chemical and Electrochemical Energy System, Universities Press (1998)
2	Lithium-ion Batteries Fundamentals and Applications. by Wu, Yuping, CRC Press, Taylor and Francis.
3	Lithium-Ion Batteries Basics and Applications by Reiner Korthauer, Springer.
4	O'hayre, S.W. Cha, W.G. Colella, F.B. Prinz, Fuel Cell Fundamentals, 3rd edition, Wiley publisher.
5	R. P. Deshpande, Ultracapacitors: Future of Energy Storage, McGraw-Hill Education, 2014
6	Genta, G, Kinetic Energy Storage: Theory and Practice of *Advanced Flywheel* Systems eBook

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Semester IV	
Course Code: 24EEOEI07TH0405-3	**Course:** Solar Photovoltaic Systems
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Elective	**Course Type:** Open Elective

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the terms related to solar radiations and calculate the average monthly solar insolation from given data
CO2	Discuss the equivalent circuit of PV cell and interpret I-V & P-V curves under different operating conditions.
CO3	Apply the algorithms used for the maximum power point tracking of PV array.
CO4	Describe the principle of power conversions used in PV system
CO5	Design PV system by estimating the load, sizing and selecting the batteries, sizing and selecting the PV modules and other components

Syllabus

Module I: Introduction (03 Hours)
Fossil fuel energy usage and global warming, role of renewable energy in sustainable development, renewable energy sources; global potential for solar electrical energy systems.

Module II: Solar Radiation (06 Hours)
Extra-terrestrial and terrestrial solar spectrum; clear sky direct-beam radiation; total clear sky insulation on a collecting surface; radiation on the collector in tracking systems; calculation of average monthly insolation from measured data.

Module III: PV Cells and Modules (06 Hours)
Photovoltaic cell and its simple model; I-V and P-V characteristics; PV modules and arrays; effect of shading, use of bypass and blocking diodes; influence of temperature; types of solar cells and their performance.

Module IV: Maximum Power Point Tracking (05 Hours)
Concept of Maximum Power Point Tracking (MPPT), Tracking algorithms, Charge controller: types and function.

Module V: Power Converters in Photovoltaic System (04 Hours)
DC - DC converter: Buck Converter, Boost converter, Buck Boost Converter

Module VI: PV System Design and Applications (04 Hours)

Introduction to batteries and its parameters, Design of PV-powered DC load, Design of stand-alone system with Battery and AC or DC load.

Text Books:	
1	Solar Photovoltaic: Fundamentals, Technologies and Applications: Solanki, PHI Learning Pvt Ltd, 2009

Reference Books:	
1	Renewable and Efficient Electric Power Systems: Gilbert M. Masters, John Wiley & Sons, 2004
2	Photovoltaic Systems Engineering: Roger A. Messenger & Jerry Ventre, CRC Press, 2004, 2nd edition.

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Semester IV	
Course Code: 24HS02TH0401	**Course:** Constitution of India
L: 2Hrs, **P**:0Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Compulsory	**Course Type:** Open Elective

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the role of constitution in democratic India.
CO2	Understand constitutional rights and duties to become responsible citizens.
CO3	Understand the functioning of the three organs of government and accordingly adopt the constitutional values in personal and professional behaviour.
CO4	Understand and evaluate different case laws so as to develop clear understanding of dynamic nature of Indian society in consonance with constitutional spirit.
CO5	Understand various systems/levels of governance for effective participation

Syllabus

Module I: Introduction to the Constitution (04 Hours)
Meaning of the constitution law and constitutionalism
Historical perspective of the Constitution of India
Salient features and characteristics of the Constitution of India.

Module II: Constitutional Rights and Duties (04 Hours)
Scheme of the Fundamental Rights
The scheme of the Fundamental Duties and its legal status
The Directive Principles of State Policy –Its importance and implementation

Module III: Federalism in Indian Constitution(08 Hours)
Federal structure and distribution of legislative and financial powers between the Union and the States.
Parliamentary Form of Government in India – The constitution powers and status of the President of India.
Emergency Provisions: National Emergency, President Rule, Financial Emergency
Union Executive: structure, functions.
Judiciary: Structure, role with special reference to PIL, writ petitions, strengthening of democracy & social Justice.

Module IV: Amendments and their procedure in the Constitution (06 Hours)
Amendment of the Constitutional Powers and Procedure.
Major and latest amendments in the constitution based on case laws (any 10 amendments can be taken for the discussion).

Module V: Bureaucracy and Local Self-governance (04 Hours) Local Self Government – Constitutional Scheme in India Provisions of civil services: Characteristics, functions, merits and demerits

Text Books:	
1	Durga Das Basu, Introduction to the Constitution of India, Lexis Nexis, 20th Edn, 2011.
2	M. V. Pylee, An Introduction to Constitution of India, Vikas Publishing,2002.

Reference Books:	
1	Arora & Mukherji, Federalism in India, Origin and Developments, Vikas Publishing House, New Delhi, 1992.
2	D.C. Gupta, Indian Government and Politics, Vikas publishing House, NewDelhi,1975.
3	K B Merunandan, Bharatada Samvidhana Ondu Parichaya, Bangalore, Meragu Publications, 2015
4	K. Sharma, Introduction to the Constitution of India, Prentice Hall of India, New Delhi, 2002.
5	Merunandan, "Multiple Choice Questions on Constitution of India", 2nd Edition, Meraga publication,2007.
6	Shubham Singles, Charles E. Haries and Et al, Constitution of India and Professional Ethics, Cengage Learning India Private Limited, Latest Edition, 2018.
7	S.N. Jha, Indian Political System: Historical Developments, Ganga Kaveri Publishing House, Varanasi, 2005
8	P.M Bakshi, Constitution of India, Universal Law Publishing House, New Delhi, 1999.

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Semester IV	
Course Code: 24ID27TH0408	**Course:** Creativity, Innovation and Design Thinking
L: 1Hrs, **P**:0Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** SEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Practice thinking as a tool for solving problems and generating ideas
CO2	Apply logical thinking in professional and quasi situations
CO3	Transduce the ideas into practically feasible inventions.
CO4	Incorporate design innovation in the product/processes
CO5	Understand the importance of intellectual property

Syllabus

Module I: Thinking Miracles and Ideation (03 Hours)
Making a case for creativity, Creative thinking as a skill, Valuing diversity in thinking: Thinking preferences, Creativity styles, Creativity in problem solving, Thinking differently, Lateral thinking, Mind stimulation: games, brain-twisters and puzzles, Idea-collection processes, Brainstorming/Brain-writing, Metaphoric thinking, Outrageous thinking, Mapping thoughts, Attitudes and its types.

Module II: Logical Thinking (03 Hours)
Using Math and Science, Systematic logical thinking, Using math concepts, Eight-Dimensional (8D) Approach to Ideation: Uniqueness, Dimensionality, Directionality, Consolidation, Segmentation, Modification, Similarity, Experimentation.

Module III: Inventive Thinking (03 Hours)
Systematic inventive thinking, Levels of Inventions, The TRIZ methodology, Decision and Evaluation: Focused thinking framework, Six thinking hats, Ethical considerations.

MODULE IV: Design for Innovation (03 Hours)
Introduction to design for interaction, nine lessons for innovation, difference in creativity and innovation, Building blocks for innovation, The SCAMPER methods.

Module V: Intellectual Property (03 Hours)
Introduction to intellectual property: Patents, Copyrights, Trademarks, Trade Secret, Unfair Competition

Text/ Reference Books:	
1	Creative Problem Solving for Managers - Tony Proctor - Routledge Taylor & Francis Group
2	101 Activities for Teaching creativity and Problem Solving - By Arthur B Vangundy - Pfeiffer
3	H. S. Fogler and S.E. LeBlanc, Strategies for Creative Problem Solving, Prentice Hall
4	E. Lumsdaine and M. Lumsdaine, Creative Problem Solving, McGraw Hill,
5	J. Goldenberg and D. Mazursky, Creativity in product innovation. Cambridge University Press, 2002.

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Semester IV	
Course Code: 24SM07TH0401	**Course:** Innovation and Entrepreneurship
L: 1Hrs, **P**:0Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** HSSM

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the fundamental concepts of innovation and entrepreneurship.
CO2	Learn about business idea generation, startup processes, and financial planning

Syllabus

Module I: Fundamentals of Innovation and Entrepreneurship
Definition, importance, and scope of entrepreneurship**,** mindset and characteristics of entrepreneurs**,** Innovation: Types, sources, and the innovation process**,** Role of technology and digital transformation in entrepreneurship.

Module II: Business Idea, Financial Planning, and Growth Strategies
Identifying and evaluating business opportunities**,** Business model Canvas, Market research and customer validation**,** Funding sources (venture capital, angel investment, government schemes)**,** Business sustainability and growth strategies.

Text Books:	
1	Innovation and Entrepreneurship" – Peter F. Drucker (HarperBusiness)

Reference Books:	
1	Robert D. Hisrich - Entrepreneurship, Tata McGraw-Hill
2	Vasant Desai - Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House
3	S.S. Khanka - Entrepreneurial Development, S. Chand & Co.
4	Paul Trott - Innovation Management and New Product Development, Pearson

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Semester IV	
Course Code: 24SM07PR0401	**Course:** Innovation and Entrepreneurship Lab
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** HSSM

Course Outcomes: After completion of the course, students will be able to	
CO1	Apply innovation and entrepreneurship principles through hands-on projects.
CO2	Develop problem-solving and business idea implementation skills.

Syllabus
Ideation and Prototyping Brainstorming and idea generation exercises**,** Design thinking methodology for problem-solving**,** Creating a prototype or minimum viable product (MVP)**,** Validating business ideas through customer feedback
Startup Execution and Market Strategies: Business model canvas workshop, Digital marketing and branding basics for startups, Pitching an idea to investors or stakeholders, Developing an innovation-driven business strategy

Text Books:	
1	Innovation and Entrepreneurship" – Peter F. Drucker (HarperBusiness)

Reference Books:	
1	Robert D. Hisrich - Entrepreneurship, Tata McGraw-Hill
2	Vasant Desai - Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House
3	S.S. Khanka - Entrepreneurial Development, S. Chand & Co.
4	Paul Trott - Innovation Management and New Product Development, Pearson

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Semester IV **Honors in "Electric Vehicle Technology"**	
Course Code: 24EE07HT0401	**Course:** Electric Vehicle: Components and Systems
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** Honors

Course Outcomes: After completion of the course, students will be able to	
CO1	Differentiate the different sensors in EV
CO2	Describe about in –vehicle networking
CO3	Explain the different network and communication protocol.
CO4	Gain knowledge of DC-DC converters, AC-DC converters, DC-AC inverters.

Syllabus

Module I: Sensors And Instrumentation (06 Hours)
Introduction, Architecture of Electronic Control Units, Voltage and Current Measurement, Temperature, Acceleration, Pressure, Velocity, Position, and Displacement Other Sensors, Reliability Constraints in Automotive Environment.

Module II: Basics of In-Vehicle Networking (06 Hours)
Overview of Data communication and networking –need for In-Vehicle networking – layers of OSI reference model –multiplexing and de-multiplexing concepts –vehicle buses.

Module III: Networks And Protocols (06 Hours)
Overview of general-purpose networks and protocols -Ethernet, TCP, UDP, IP, ARP, RARP - LIN standard overview –workflow concept-applications –LIN protocol specification – signals - Frame transfer –Frame types –Schedule tables –Task behaviour model –Network management –status management - overview of CAN –fundamentals –Message transfer – frame types-Error handling –fault confinement-Bit time requirements.

Module IV: DC-DC Converter for EV (06 Hours)

Non-isolated converter: Buck, Boost and Buck-Boost, Isolated converter.

Module V: AC-DC and DC-AC Converter for EV (06 Hours)

Single phase and three-phase AC to DC and DC to AC converter.

Text Books:

1	J. Gabrielleen," Automotive In-Vehicle Networks", John Wiley & Sons, Limited, 2008
2	Robert Bosch," Bosch Automotive Networking", Bentley publishers, 2007
3	Society of Automotive Engineers," In-Vehicle Networks", 2002
4	Electric and Hybrid Vehicles Design Fundamentals by Iqbal Husain, CRC Press
5	Power Electronics: Converters, Applications, and Design by Ned Mohan, Tore M. Undeland, and William P. Robbins,3rd Edition **2**002.

Reference Books:	
1	Electric and Hybrid Vehicles: T. Denton, Routledge, 2016.
2	Ronald K Jurgen, "Automotive Electronics Handbook", McGraw-Hill Inc. 1999

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Semester IV **Minors in E-mobility**	
Course Code: 24EE07MT0401	**Course:** Energy Storage Systems for EV applications
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** Minor

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze the characteristics of energy sources used for storage system.
CO2	Estimate different battery parameters (SoC, SoH and SoE).
CO3	Compare different types of lithium ion battery used in electric vehicles
CO4	Understand the working, types and safety related issues of fuel cell.
CO5	Analyze the characteristics of supercapacitors and estimate its parameters.
CO6	Analyze different hybrid storage system as per applications

Syllabus

Module I:: Introduction (06 Hour)
Energy availability, Demand and storage, Need for energy storage, Different types of energy storage, Comparison of energy storage technologies.

Module II: Battery Technology (**08 Hour**)
Overview, Battery definitions, terms and terminology, types and their properties, SoC, SoH, SoE estimation techniques.

Module III: Lithium Ion Battery (**07 Hour**)
Introduction, Components, functions, advantages and disadvantages, Safety, Lifetime, Types to lithium ion battery & their comparison, applications in EV, SoC, SoH, SoE estimation techniques.

Module IV: Fuel Cells (**07 Hour**)
Introduction to fuel cells, components of fuel cells, Types of fuel cells, working principle of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, fuel cell cars and buses.

Module V: Supercapacitor (**08 Hour**)
Construction, working principle, types, advantages and disadvantages, SoC, SoH estimation techniques, application in electric vehicle.
Introduction to Advanced Flywheel, Introduction to Hybrid Energy storage systems: configurations and EV and smart grid applications

Text Books:	
1	A. R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN – 13:9789380090122), 2011.
2	Rahn C. D. and Wang C., Battery Systems Engineering, First Edition, Wiley (2013)
3	Narayan R. and Viswanathan B., Chemical and Electrochemical Energy System, Universities Press (1998)
4	Lithium-Ion Batteries Basics and Applications by Reiner Korthauer, Springer.
5	Lithium-ion Batteries Fundamentals and Applications. by Wu, Yuping, CRC Press, Taylor and Francis.
6	O'hayre, S.W. Cha, W.G. Colella, F.B. Prinz, Fuel Cell Fundamentals, 3rd edition, Wiley publisher.
7	R. P. Deshpande, Ultracapacitors: Future of Energy Storage, McGraw-Hill Education, 2014
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Multidisciplinary Minor (MDM) Courses offered by Electrical Department "Renewable Energy and E-Mobility"

Sem	Course Code	Course Name	L	P	C	Continuous Assessment	End Semester/ Internal evaluation	Total	Duration of End Semester (Hrs)
III	24EE07TH0309	Introductions to Renewable Energy Sources	3	0	3	50	50	100	3
IV	24EE07TH0409	EV Architecture and Components	3	0	3	50	50	100	3
V	24EE07TH0509	Energy Storage Systems in E-Mobility	3	0	3	50	50	100	3
VI	24EE07TH0609	Autonomous Vehicle	3	0	3	50	50	100	3
TOTAL			**12**	**00**	**12**				

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Semester III	
Course Code: 24EE07TH0309	**Course:** Introductions to Renewable Energy Sources
L: 3 Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** MDM

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the necessity and importance of renewable energy sources.
CO2	Discuss the working principle of solar photovoltaic system and its topologies.
CO3	Discuss the operation of wind energy generation.
CO4	Explain the renewable energy sources like Hydel, Tidal, Biomass, Geothermal, Wave, and Ocean.

Syllabus

Module I: Global and National Energy Scenario (04 Hours)
Over view of conventional & renewable energy sources, need, potential & development of renewable energy sources, Global and Indian Energy scenario, Energy for sustainable development, Global climate change, carbon credits and carbon footprint calculation.

Module II: Solar Energy (06 Hours)
Global and Indian solar energy potential, Types of solar energy: Thermal and Photovoltaic, Basic principles of solar radiation, Solar constant, solar spectrum, Extraterrestrial and terrestrial radiation, Solar time, solar angle, sun-path diagrams, Tilt angle, tracking systems, Solar radiation data and modeling

Module III : Solar PV Fundaments (08 Hours) Introduction to photovoltaic solar cell, characteristics and its connections, Concept of Maximum Power Point tracking, Different PV topologies.

Module III: Wind Energy (06 Hours)
Wind Energy Conversion, Potential, Nature of the wind, Types of wind turbines, Wind-Electric Generation.

Module IV: Other Renewable Sources (08 Hours)
Introduction to hydel-power generation, tidal energy, biomass energy, geothermal energy, Other renewable Energy Sources

Text Books:	
1	Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH,New Delhi, 3rd Edition.
2	Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis - second edition, 2013.
3	Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers

Reference Books:	
1	Renewable Energy- Edited by Godfrey Boyle, Oxford University Press, 3rd Edition, 2013.
2	Handbook of Renewable Technology, Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
3	Renewable Energy Technologies, Ramesh & Kumar /Narosa
4	Renewable Energy Technologies, A practical guide for beginners, Chetang Singh Solanki, PHI.
5	Non-conventional Energy Source, B.H. Khan, TMH, 2nd Edition.

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Semester IV	
Course Code: 24EE07TH0409	**Course:** EV Architecture and Components
L: 3 Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** MDM

Course Outcomes: After completion of the course, students will be able to	
CO1	Understand the evolution and comparison of Electric Vehicles (EVs)
CO2	Describe the various internal combustion engines.
CO3	Analyze vehicle dynamics and performance parameters
CO4	Explain the basic concepts of hybrid and electric traction and analyze various drive train topologies. They will also evaluate power flow control strategies for efficient energy management and performance optimization in hybrid vehicles.

Syllabus

Module I: Environmental Impact and History of Modern Transportation (05 Hours)
Air Pollution, Global Warming, Petroleum Resources, Overview of Electric Vehicles (EVs), Comparison with Internal Combustion Engine (ICE) vehicles, EV Market

Module II: Vehicle Dynamics and Control (07 Hours)
Fundamentals of vehicle dynamics: Tractive effort, gradeability, and driving cycles, Energy consumption and efficiency analysis, Performance parameters (range, acceleration, top speed).

Module III: Hybrid Drive-trains (06 Hours)
Basic concept of hybrid traction, introduction to various hybrid drive train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Module IV: Electric Vehicle (EV) Drive-trains (06 Hours)
Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Modules V: Electric Vehicle Components
Overview of electric motor types, Introduction to Energy Storage Systems, Auxiliary and Support Systems

Text Books:	
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles - Fundamentals, Theory, and Design: M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, CRC Press, 2004.
2	Electric and Hybrid Vehicles Design Fundamentals by Iqbal Husain, CRC Press
Reference Books:	
1	Electric and Hybrid Vehicles: T. Denton, Routledge, 2016