RBU

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 Artificial Intelligence and Applications

(For 2024-25 admitted batch)

Program Educational Objectives

PEO 1: Our graduates will be able to plan, design and develop AI based solutions and practice in electrical systems.

PEO 2: Our graduates will be able to work in multidisciplinary environments including IT applications and adapt themselves as per the emerging technological needs of Industry.

PEO 3: 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 knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Programme Specific Outcomes

PSO1: Analyze, design, and develop electrical engineering systems by integrating core electrical concepts with Artificial Intelligence techniques for applications in power systems, control, renewable energy, electric vehicle and industrial automation.

PSO2: Apply AI tools, data analytics, machine learning, and computational techniques to solve complex electrical engineering problems in various domains of electrical engineering.

Ramdeobaba University, Nagpur
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Department of Electrical Engineering
Teaching and Evaluation Scheme
B. Tech Electrical Engineering Specialization Artificial Intelligence and Applications

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	24CS01TH0305-2	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	24CS01TH0407-2	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	Automation with PLC	3	0	3	50	50	100	3
4	PCC	24EE07PR0502	Automation with PLC 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	24CS01TH0507-2	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**				

Program Elective-I

V Sem	I	Electromagnetic Fields 24HS05TH0501	Electrical Energy Conservation and Audit 24EE07TH0504-2	Utilization of Electrical Energy 24EE07TH0504-3	Biology for Engineers 24EE07TH0504-4	Renewable Energy Sources 24EE07TH0504-5

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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	Control Systems	3	0	3	50	50	100	3
5	PCC	24EE07PR0604	Control Systems Lab	0	2	1	25	25	50	--
6	MDM	24CS01TH0605-2	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

Program Elective – II and III

Sem	Program Elective	Track I	Track II	Track III
6	II	Optimization Techniques 24EE07TH0606-1	Power Plant Engineering 24EE07TH0606-2	Electric Drives and Control 24EE07TH0606-3
	III	Data Analytics* 24EE07TH0607-1	Smart Grid Technology and Cyber Security 24EE07TH0607-2	Solar Photovoltaic Engineering 24EE07TH0607-3

*** Credit transfer through equivalent global certification with prior approval by the department**

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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

Program Elective – IV

Sem	Program Elective	Track I	Track II	Track III
7	IV	Robotics and Automation 24EE07TH0704-1	High Voltage Engineering 24EE07TH0704-2	Electric Vehicle 24EE07TH0704-3

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**				

Program Elective – V and VI

Sem	Program Elective	Track I	Track II	Track III
8	V	Digital Signal Processing 24EE07TH0801-1	Power Quality 24EE07TH0801-2	Power Semiconductor Based Drives 24EE07TH0801-3
	VI	Deep Learning* 24EE07TH0802-1	Power Management in Data Centers 24EE07TH0802-2	Energy Storage Systems 24EE07TH0802-3

*** Credit transfer through equivalent global certification with prior approval by the department**

Basket of Program Elective Courses

Sem	**Program Elective**					
5	I	Electromagnetic Fields 24HS05TH0501	Electrical Energy Conservation and Audit 24EE07TH0504-2	Utilization of Electrical Energy 24EE07TH0504-3	Biology for Engineers 24EE07TH0504-4	Renewable Energy Sources 24EE07TH0504-5
		Track I	**Track II**		**Track III**	
6	II	Optimization Techniques 24EE07TH0606-1	Power Plant Engineering 24EE07TH0606-2		Electric Drives and Control 24EE07TH0606-3	
	III	Data Analytics 24EE07TH0607-1	Smart Grid and Cyber Security 24EE07TH0607-2		Solar Photovoltaic Engineering 24EE07TH0607-3	
7	IV	Robotics and Automation 24EE07TH0704-1	High Voltage Engineering 24EE07TH0704-2		Electric Vehicle 24EE07TH0704-3	
8	V	Digital Signal Processing 24EE07TH0801-1	Power Quality 24EE07TH0801-2		Power Semiconductor Based Drives 24EE07TH0801-3	
	VI	Deep Learning 24EE07TH0802-1	Power Management in Data Centers 24EE07TH0802-2		Energy Storage Systems 24EE07TH0802-3	

*** Credit transfer through equivalent global certification with prior approval by the department**

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	Battery Storage and Charging System	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	24EE07HP0701	Project	0	8	4	50	50	100	
			TOTAL	**14**	**08**	**18**	250	250	500	

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	

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**				

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	24EE07MP0701	Project	0	8	4	50	50	100	
			TOTAL	**14**	**08**	**18**				

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							

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.

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

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.

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

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

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.

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.

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

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

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

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

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, MettaAdavu 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

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* (1st 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)

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

Ramdeobaba University, Nagpur
School of Electrical and Electronics Engineering
Department of Electrical Engineering
B.Tech Electrical Engineering Specialization Artificial Intelligence and Applications

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)

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.

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

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

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

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

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

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

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.

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

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

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

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.

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.

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

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

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

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

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.

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

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.

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

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)

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

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.

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, 8^{th} edition, Cenage learning.
3	Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

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

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

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.

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

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.)

Semester III	
Course Code: 24CS01TH0305-2	**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.

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.

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.

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

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

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.

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.

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

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.

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

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

Semester IV	
Course Code: 24CS01TH0407-2	**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, 4thEdition, 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.

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

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

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.

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.

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.

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

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

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

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
8	Genta, G, Kinetic Energy Storage: Theory and Practice of *Advanced Flywheel* Systems eBook

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**				

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.

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

Semester V	
Course Code: 24EE07TH0501	**Course:** Power Electronics
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After the completion of this course, students will be able to	
CO1	Discuss the operation, characteristics, ratings, protection and switching behavior of line commutated devices.
CO2	Discuss the operation, characteristics and ratings of static controllable switches
CO3	Analyse the operation and control of DC–DC converters.
CO4	Analyse the operation, performance and control of DC–AC converters.
CO5	Analyse the performance of AC–DC converters under different operating conditions

Syllabus

Module I: Power switching devices (08 Hours)
Concept of Power Electronics, Scope and Applications, Types of Power Converters, SCR and its characteristics, Ratings, and Gate Drive Circuits, Switching and Conduction Losses, Thyristor protection, Series and Parallel connections of SCRs. Basic Operation of TRAIC and its Characteristics.

Module II: Static Controllable Switches (06 Hours)
Principles of Operation and V-I Characteristic of Power MOSFET, Insulated Gate Bipolar Transistor (IGBT) and Gate turn off thyristor(GTO), Ratings**.**

Module III: DC-DC Converters (08 Hours)
Introduction, Basic Principles of Buck, Boost and Buck-Boost converters. Concept of isolated and non-isolated converters, CCM, DCM mode of Operations, Application of DC-DC converters.

Module IV: DC-AC Converters (08 Hours)
Single Phase and Three Phase Bridge Inverters, Output Voltage Control, Harmonics in Output Voltage Waveform, Harmonics Attenuation by Filters, Harmonic Reduction by PWM techniques, Applications of Inverters.

Module V: AC to DC Converters (07 Hours)
Working of Single Phase, Three Phase Bridge Converters with R, RL and RLE –Load, Effect of Source Inductance in Converters.

Text Books:	
1	Power Electronics: *M. Rashid, Pearson Education India, 2004.*
2	Power Electronics: Converters, Applications and Design: *N. Mohan and T. M. Undeland,2012, John Willey, 3rd edition.*
3	Industrial Power Electronics: *Deodatta Shingare, First Edition, Electrotech Publication Pune, 2009*
4	Power Electronics: *M.D. Singh, K.B. Khanchandani, Tata McGraw Hill.*

Reference Books:	
1	Power Electronics: *C.Y. Lander., Third Edition, 1993, McGraw Hill International*.
2	Principles of Power Electronics: *Joseph Vithyathil, First Edition, 2010,Tata McGraw Hill.*
3	Fundamentals of Power Electronics: *R. W. Erickson and D. Maksimovic, Springer Science & Business Media, 2007.*
4	Power Electronics: *L. Umanand, Essentials and Applications", Wiley India, 2009.*

Semester V	
Course Code: 24EE07PR0501	**Course:** Power Electronics Lab
L: 0Hrs, **P**:02Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of this course, students should be able to	
CO1	Apply, analyze and co-relate fundamental principles of science & Engineering with laboratory experimental work
CO2	Analyze characteristics of different types of power electronics switches
CO3	Analyze the operation of rectifiers, choppers and inverters
CO4	Design SIMULINK circuit for verification of various power electronics circuit behavior using Software.
CO5	Analyze and prepare the technical report on the experiments carried out.

Experiment List	
1	Study and plot V-I characteristics of SCR, MOSFET and IGBT
2	To Study the Operation of UJT as a Pulse Generation Circuit.
3	AC Voltage Controller for Single Phase Load Part A : Using TRIAC-DIAC Part B: Using Anti Parallel Thyristor
4	Single Phase Half Controlled bridge converter with R load
5	To Study Buck Converter using PWM Technique
6	To Study Boost Converter using PWM Technique
7	To Study Single Phase Bridge Inverter using Power MOSFET
8	To Study Three Phase Bridge Inverter, 180º and 120º mode of operation using IGBT
9	Open ended experiments.

Semester V	
Course Code: 24EE07TH0502	**Course:** Automation with PLC
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	Discuss PLC and SCADA architecture.
CO2	Interface various automation components to PLC
CO3	Develop ladder logic programs for industrial control.
CO4	Apply different communication protocols for industrial automation.
CO5	Design PLC–SCADA based automation solutions

Syllabus

MODULE-I: (04 Hours) Introduction to PLC: Technical definition, advantages, chronological evolution, types of PLCs, PLC vs PC, block diagram, processor and executive software.

MODULE -II: (06 Hours) Ladder Diagram Fundamentals & Control Components: Basic components and symbols, relay and contactor logic, PCC, MCC, control desk, NO/NC switches, limit switches, timers, solenoid valves, electro-hydraulic & pneumatic control, sensor selection, fundamentals of ladder diagrams.

MODULE -III: (08 Hours) **Fundamental PLC Programming:**
Physical components vs program components, ladder diagram structure, multiple rung logic, practical programming examples.

MODULE -IV: (08 Hours) Advanced PLC Programming & Addressing
Addressing data files, logical addressing formats, PLC input/output modules and power supply, advanced instructions such as timers, counters, and comparison operations.

MODULE -V: (06 Hours) Industrial Communication & Networking:
Evolution of industrial communication, communication interfaces and protocols, synchronization and timing, introduction to Modbus, Ethernet, and fieldbus systems.

MODULE -VI: (04 Hours) Introduction to SCADA & Industrial Automation:
Industrial automation components, smart sensors, PLC, DCS overview, SCADA architecture and functions, examples of automated systems.

Text Books:	
1	Madhuchchanda Mitra, Samarjit Sengupta, Programmable Logic Controllers and Industrial Automation: An Introduction, 2nd Edition.
2	W. Bolton, Programmable Logic Controllers, 6th Edition.

Reference Books:	
1	PLC manuals and user guides (Siemens, Allen Bradley, etc.)

Semester V	
Course Code: 24EE07PR0502	**Course:** Automation with PLC 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	Understand the automation tools & its components with PLC software
CO2	Develop the logic with ladder diagram for the industry application.
CO3	Select and interface sensors and actuators for automation.
CO4	Communicate PLC with HMI and other measuring devices.

List of Experiments:

1. Simple ON-OFF operation of Lamp using Toggle or push Button
2. Combinational Logic design and implantation on PLC
3. Power ON Delay using PLC
4. Power OFF Delay using PLC
5. Sequential operation using PLC
6. Study of timers from PLC
7. Proxy sensing using PLC (Inductive & Optical)
8. Use of Limit Switch
9. Use of magnetic read sensing
10. Level sensing using Magnetic float switch
11. Temperature measurement using PLC
12. Heater Actuation with Temperature sensing (Temp Control)
13. Actuation of solenoid valve using PLC
14. Motor ON-OFF and Forward/Reverse operation using PLC
15. Counting applications using PLC

Text Books:	
1	Programmable Logic Controllers by John Hacworth and Frederick D. Hackworth Jr, Pearson publisher
2	Programmable Logic Controllers by W. Bolton , Newnes an imprint of Elesevier, 6th edition.

Reference Books:	
1	PLC manuals and user guides (Siemens, Allen Bradley, etc.)

Semester V	
Course Code: 24EE07TH0503	**Course:** Artificial Intelligence
L: 3 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 3
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Explain fundamental concepts of Artificial Intelligence and its applications in electrical engineering.
CO2	Apply basic search algorithms to solve engineering problem-solving tasks.
CO3	Apply heuristic and local search techniques for solving optimization problems in electrical engineering.
CO4	Apply optimization techniques including evolutionary and gradient-based methods for improving system performance.
CO5	Apply basic logic and probabilistic models for reasoning and decision-making in electrical engineering applications.

Syllabus

MODULE-I: Basics of Artificial Intelligence (7 Hours)
Introduction to Artificial Intelligence: concept, history, and scope. Overview of Machine Learning and Deep Learning. Role of AI in modern Electrical Engineering applications such as smart grids, electric vehicles, renewable energy systems, predictive maintenance, and industrial automation. Representation of engineering problems in AI. Introduction to ethical and responsible use of AI in electrical systems.

MODULE -II: Search Techniques and Problem Solving (07 Hours)
Concept of intelligent search and problem-solving methods. Breadth First Search (BFS) and Depth First Search (DFS). Uniform Cost Search and Iterative Deepening Search. Introduction to Applications of search methods in electrical engineering such as power system restoration, fault location, and optimal switching operations.

MODULE -III: **Heuristic and Intelligent Search Methods (07 Hours)**
Concept and importance of heuristics in engineering optimization. Greedy Best First Search and A* Search. Introduction to local search methods. Hill Climbing and Simulated Annealing techniques. Introduction to applications in electrical engineering including shortest transmission path selection, maximum power point tracking.

MODULE -IV: Optimization Techniques (7 Hours)
Introduction to optimization in electrical systems. Genetic Algorithms and their application in minimizing power losses and economic load dispatch. Particle Swarm Optimization (PSO) Ant Colony Optimization (ACO) for network routing and scheduling problems. Introduction to Gradient Descent Optimization method and engineering applications.

MODULE -V: Logic & Simple Probability Models (7 Hours) Introduction to propositional logic and logical reasoning. Basic inference rules and knowledge representation. Overview of First Order Logic and its engineering relevance. Introduction to probability concepts in AI. Bayes Rule and simple probabilistic decision-making. Applications in fault diagnosis, condition monitoring, and intelligent decision support systems in electrical engineering.

Text Books:	
1	Artificial Intelligence: A Modern Approach, "Stuart Russell and Peter Norvig", 4th Edition, Pearson Education, 2020.
2	Artificial Intelligence: Foundations of Computational Agents, "David L. Poole and Alan K. Mackworth", 3rd Edition, Cambridge University Press, 2023.
3	Machine Learning: A Probabilistic Perspective, "Kevin P. Murphy", 1st Edition, MIT Press, 2012.
4	Reinforcement Learning: An Introduction, "Richard S. Sutton and Andrew G. Barto", 2nd Edition, MIT Press, 2018.

Reference Books:	
1	Artificial Intelligence, "Elaine Rich, Kevin Knight and Shivashankar B. Nair", 3rd Edition, Tata McGraw Hill, 2014.
2	Artificial Intelligence: A Guide to Intelligent Systems, "Michael Negnevitsky", 3rd Edition, Pearson Education, 2011.
3	Artificial Intelligence By Example, "Denis Rothman", 2nd Edition, Packt Publishing, 2020.

Semester V	
Course Code: 24EE07PR0503	**Course:** Artificial Intelligence Lab
L: 0 Hrs, **P**: 2 Hrs per Week	**Total Credits:** 1
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Implement basic AI problem representations and uninformed search algorithms using Python.
CO2	Apply heuristic and local search techniques to solve optimization problems related to Electrical Engineering systems.
CO3	Develop simple game-playing, constraint satisfaction, and reinforcement learning models.
CO4	Implement logic-based inference and probabilistic models for decision-making and fault diagnosis applications.

Syllabus
Assignment 1 Implementation of state space representation and Breadth First Search (BFS) and Depth First Search (DFS) for solving a simple path-finding problem.
Assignment 2 Implementation of Uniform Cost Search and Iterative Deepening Search for shortest path problem (e.g., simple electrical wiring network).
Assignment 3 Implementation of Greedy Best-First Search and A* Search algorithm for route optimization.
Assignment 4 Implementation of Hill Climbing and Simulated Annealing for optimization problem
Assignment 5 Implementation of Genetic Algorithm for simple parameter optimization
Assignment 6 Implementation of Min-Max algorithm with Alpha-Beta pruning for a simple two-player game

Assignment 7 Implementation of Constraint Satisfaction Problem (CSP) using Backtracking
Assignment 8 Implementation of basic Q-Learning algorithm for simple decision-making problem (e.g., voltage adjustment or grid control simulation).

Text Books:	
1	Artificial Intelligence: A Modern Approach, "Stuart Russell and Peter Norvig", 4th Edition, Pearson Education, 2020.
2	Artificial Intelligence: Foundations of Computational Agents, "David L. Poole and Alan K. Mackworth", 3rd Edition, Cambridge University Press, 2023.
3	Machine Learning: A Probabilistic Perspective, "Kevin P. Murphy", 1st Edition, MIT Press, 2012.
4	Reinforcement Learning: An Introduction, "Richard S. Sutton and Andrew G. Barto", 2nd Edition, MIT Press, 2018.

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1	Artificial Intelligence, "Elaine Rich, Kevin Knight and Shivashankar B. Nair", 3rd Edition, Tata McGraw Hill, 2014.
2	Artificial Intelligence: A Guide to Intelligent Systems, "Michael Negnevitsky", 3rd Edition, Pearson Education, 2011.
3	Artificial Intelligence By Example, "Denis Rothman", 2nd Edition, Packt Publishing, 2020.

Semester V	
Course Code: 24HS05TH0501	**Course**: Electromagnetic Fields
L: 03 Hrs, P: 0 Hrs per Week	**Total Credits**: 03
Compulsory/Elective: Elective	**Course Type**: PEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Work with vector and scalars conversion for different coordinate system like conversion of Cartesian to Cylindrical, Spherical coordinate system and vice versa.
CO2	Apply Coulomb's law, Gauss law, Divergence theorem to electric field intensity due to the field of 'n' point charges, volume charge and a line charge.
CO3	Apply the concepts of potential difference and potential of a point charge to current, current density, dielectrics and capacitances and metallic conductors employing Poisson's and Laplace equations.
CO4	Apply Biot Savorts law, Ampere's circuital law and Stroke's theorem to study steady magnetic fields and forces and to the behavior of magnetic materials.
CO5	Correlate the basic principles of electromagnetic waves in building time varying and steady state Maxwell's equations.

Syllabus

MODULE-I: Vector Analysis (06 Hours)
Idea of Vector & Scalars, Vector Algebra, Vector addition, vector subtraction, Dot product, Scalar product in Cartesian coordinate system, conversion of variables from Cartesian to cylindrical, Cartesian to spherical and vice versa.

MODULE -II: (06Hours)
Coulomb's law, Electrical field intensity and electric flux density: Coulomb's law, electric field intensity, field of 'n' point charges, field due to continuous volume charge distribution, field of line charge, field of sheet charges concept of flux density

MODULE -III: (08Hours)
Gauss's law, Energy and Potential of charge system: Gauss's law, Application of Gauss's law, divergence theorem, definition of potential difference and potential, potential of a point charges, potential field of system of charge, potential gradient.

MODULE -IV: (10 Hours)
Conductors, Dielectric and Capacitance and Poisson's and Laplace's Equations: Current and current density, Boundary conditions, conductor properties and, Nature of Dielectric materials, Capacitance of parallel plate capacitor, Poissons and Laplace equations.

MODULE -V: (10Hours)

The Steady Magnetic Field and Magnetic Forces: Biot Savarts law, Ampere's Circuital Law, Strokes theorem, Magnetic flux density, Scalar and Vector Magnetic potentials, force on moving charge, nature of Magnetic materials.
MODULE 6: (02 Hours) Maxwell's equations, Elementary ideas of Electromagnetic waves and their propagation.

Text Books:	
1	Engineering Electromagnetic:3rd Ed., Mc-Graw Hill, W. H. Hayt 1974
2	Introduction to Electrodynamics — Author: David J. Griffiths; Publisher: Cambridge University Press; Year: 2023 (5th ed.)

Reference Books:	
1	Electromagnetic, Joseph A. Administer
2	Field and Wave Electromagnetics — Author: David K. Cheng; Publisher: Addison-Wesley; Year: 1989
3	The Feynman Lectures on Physics Vol. II — Authors: Richard P. Feynman, Leighton, Sands; Publisher: Addison-Wesley; Year: 1964

Semester V	
Course Code: 24EE07TH0504-2	**Course:** Electrical Energy Conservation and Audit
L: 3Hrs, **T**:0Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After completion of the course, students will be able to	
CO 1:	Illustrate the basics of energy with material and energy balance.
CO 2:	Analyze the different financial options of investment and their terminology.
CO 3:	Classify the different energy saving opportunities in electric motors.
CO 4:	Evaluate the performance of Compressed Air System and Heating, Ventilation & Air Conditioning (HVAC)
CO 5:	Find out the energy saving opportunities in Pumps, Pumping System and Cooling Towers.
CO 6:	Correlate the energy and its effect on environment.

Syllabus

Module-I: Energy Scenario (08 Hours)

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

Energy Audit: Definition, need, types of energy audit, energy audit instruments.

Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Module-II: Financial Management (08 Hours)

: Investment-need, appraisal and criteria, financial analysis techniques - simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs).

Module-III (Teaching Hours: 08)

Electric Motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Energy efficient motors, soft starters with energy saver, variable speed drives. Different IS Codes related to induction motor efficiency and energy consumption.

Module-IV: HVAC & Fans (08 Hours)

Compressed Air System and (HVAC):
Types of air compressors, compressor efficiency, efficient compressor operation, Heating, ventilation, air conditioning and Refrigeration System:
Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities, pressure drop calculation.

Module-V: Pumps & Cooling Tower (08 Hours)
Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Energy conservation in boiler feed water pump, pumping systems for municipal drinking water, and sewerage, agriculture pump sets.
Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities assessment of cooling towers.

Module VI: Energy, Environment and Climate Change (06 Hours)
Energy and environment, air pollution, climate change United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM, Prototype Carbon Fund (PCF). Energy conservation in Buildings and Energy Conservation Building Codes (ECBC): About Energy Conservation Building Codes (ECBC), building envelope, insulation, lighting, Heating, ventilation, air conditioning (HVAC), fenestrations, water pumping, inverter and energy storage/captive generation, elevators and escalators, star labeling for existing buildings, Energy Service Companies based case studies.

Text Books:	
1	Archie, W Culp. Principles of Energy Conservation: McGraw Hill, 1991.
2	P. O'Callaghan : Energy Management: McGraw Hill Book Company, 1993.
3	Handbook of Energy Engineering: Thuman A and Mehta D Paul, the Fairmount Press.Reference

Reference Books:	
1	Handbook on Energy Audits and Management: Amit Kumar Tyagi.
2	Energy Efficient Buildings: Majumder Milli, TERI.
3	Energy Management: Paul O'Callagh, McGraw Hill.
4	Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.

Semester V	
Course Code: 24EE07TH0504-3	**Course:** Utilization of Electrical Energy
L: 3Hrs, T: 0Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After the successful completion of the course the students will be able to	
CO1	Discuss the process and application of different types Electric Heating and Welding equipments.
CO2	Design illumination systems for lighting design by applying the basics of illumination.
CO3	Discuss Electric Traction system with its power supply structure.
CO4	Explain the working principles and applications for various electrolytic processes for industrial applications
CO5	Discuss the operation of refrigeration and air conditioning.

Syllabus

MODULE I: Electric Heating and Welding

Electric Heating: Types and methods of electrical heating, advantages of electrically produced heat, types & application of electric heating equipment

Electric Welding: Importance, Advantages & Disadvantages of welding, classification of welding processes, Resistance welding, Electric arc welding, Ultrasonic welding, electron beam welding, laser beam welding.

MODULE II: Illumination and Lighting Systems

Nature of light, terms used in illumination, laws of illumination, polar curves, Different types of lamps-their working and construction, classification of light fittings and luminaries, factors affecting the design of indoor lighting installations, total lumen method of calculation, Lighting design for indoor applications. General ideas about street lighting, flood lighting. factory lightning etc.

MODULE III: Electric Traction Supply system

Features of an Ideal Traction System, Advantages and Disadvantages of Electric Traction, System of Traction, Traction Supply System, Transmission system for Traction substation, Feeding and Distribution System on an AC Traction, System of Current Collection, Booster Transformer.

MODULE IV: Electrolytic Processes

Fundamental principles, laws of electrolysis, Extraction & Refining of metals, Electro-deposition, Electro plating, Anodizing, manufacture of chemicals, Power supply for electrolytic processes.

MODULE V: Refrigeration and Air Conditioning
Introduction, Applications of refrigeration, Refrigeration systems, Water coolers, Refrigerants. Principle of air conditioning, Air-conditioning cycle, Load Estimation.

Text Books:	
1	Utilisation of Electrical Power: R. K. Rajput, Laxmi Publications, 3rd Edition, 2023
2	Utilization of Electric Power & Electric Traction: J.B. Gupta, Kataria & Sons
3	Art and Science of Utilization of Electrical Energy: H Partap, Dhanpat Rai & Sons, Delhi

Reference Books:	
1	Utilization of Electric Energy: E. Open shaw Taylor, Orient Longman.
2	Utilisation of Electrical Energy and Electric Traction: J. B. Gupta, S. K. Kataria and Sons, 10th Edition, 1990.

Semester V	
Course Code: 24EE07TH0504-4	**Course:** Biology for Engineers
L: 3Hrs, T: 0Hrs,**P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: Upon the completion of this course students will be able to	
CO1	Understand the basics of biology regarding the life structures and process.
CO2	Comprehend Biomolecules and Enzymes as basic building block of all forms of life
CO3	Understand the principles of energy transaction in living systems.
CO4	Identify DNA as a genetic material in the molecular basis of information transfer
CO5	Realize generation of bioelectric signals and understand fundaments of Biosensor and devices.

Syllabus

Module I:
Engineering perspective and analogies of Biological Sciences, Fundamental differences between science and Engineering- case studies; Hierarchy and classification of life forms, Levels of organization of life- cell, tissues, organs, system and organism, Anatomy and physiology.

Module II: Biomolecules and Enzymes
Biomolecules as basic building block of all forms of life, structure and function of carbohydrates, proteins and Amino acids, Lipids, Nucleic acids, Vitamins and Minerals, Enzymology- Introduction, classification and mechanism of action.

Module III: Metabolism /Bioenergetics
Fundamental principles of energy transactions (Thermodynamics) as applied to biology, Entropy changes in biological systems, free energy, equilibrium, process of synthesis and breakdown of glucose in human body.

Module IV: Genetics
Introduction to Genetics, genetic codes, Expression and Transmission of genetic Information, concept of DNA cloning, single gene disorders in humans.

Module V: Bioelectric signals and devices
Resting and action potential, propagation of bioelectric signals, various bioelectric signals- ECG, EEG, EMG. Human nervous system as complex electric network.

Module VI: Biosensors

Introduction to Biosensors, transducers, amplifiers.
Overview of Bio Imaging-Brief introduction to medical imaging and different medical Imaging modalities; Electro Physiological Signal Analysis. Diagnostic Devices- Overview of Radiography, Nuclear Medical Imaging, Magnetic Resonance Imaging, Ultrasound Imaging. Therapeutic Devices- Overview of Diagnostic application of LASERs, High frequency heat therapy, Automatic Drug delivery Systems.

Text Books:	
1	Biology: A Global Approach: Campbell, N.A.;Reece, J.B;Urry,Lisa; Cain,M,L; Wasserman, S.A.; Minorsky, P.V.; Jackson, R.B.Pearson Education Ltd.
2	Eggins BR. (1006) Biosensors: An Introduction. John Wiley & Sons Publishers.
3	Biology for Engineers, SOHONI SINGH, Vayu Education, ISBN 9789383758265
4	Biology for Engineers ,Wiley India, Wiley Editorial, ISBN 9788126576340

Reference Books:	
1	Molecular Cell Biology. W.H.Freeman.: Lodish H, Berk A, Zipursky SL, et al. (2000)
2	Principles of Biochemistry: Lehninger, A.L., Nelson, D.L., & Cox, M.M (2000). Newyork; Worth Publishers
3	Genes VII: Lewin B.(2000). Oxford University Press.th
4	Medical Instrumentation Application and Design :John G. Webster, ,4 edition, Wiley India,2015
5	Biology for Engineers by G. K. Suraish kumar, Oxford University Press, 1st Ed.

Semester V	
Course Code: 24EE07TH0504-5	**Course:** Renewable Energy Sources
L: 03Hrs, ,**P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: At the end of this course the students will be able to	
CO1	Analyze the working principles of solar energy and its radiation, solar **energy collection and storage systems,** including flat plate collectors, concentrating collectors,.
CO2	Describe the operating principles and performance characteristics of wind energy systems.
CO3	Explain the principles of biomass energy conversion, types of biogas plants and their practical applications.
CO4	Discuss the basic working principles, resources, and potential in India of geothermal and ocean energy systems.
CO5	Explain the concept of Direct Energy Conversion (DEC) and describe the working principles and applications of thermoelectric generators, MHD generation, and fuel cells.

Syllabus

MODULE I: Principles of Solar Radiation (10 Hours)
Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.
Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.
Solar Energy Storage and Applications: Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

MODULE II: Wind Energy (06 Hours)
Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

MODULE III: Bio-Mass (06 Hours)
Principles of Bio-Conversion, Anaerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

MODULE IV: Geothermal Energy (04 Hours)
Resources, types of wells, methods of harnessing the energy, potential in India.

MODULE V: Ocean Energy (04 Hours) OTEC, Principles utilization, setting of OTEC plants, Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants.
MODULE VI: Direct Energy Conversion (06 Hours) Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

Text Books:	
1	Non-Conventional Energy Sources /G.D. Rai
2	Renewable Energy Technologies /Ramesh & Kumar /Narosa

Reference Books:	
1	Renewable energy resources/ Tiwari and Ghosal/ Narosa.
2	Non-Conventional Energy / Ashok V Desai /Wiley Eastern.
3	Non-Conventional Energy Systems / K Mittal /Wheeler
4	Solar Energy / Sukhame

Course Code:	**Course:** Database Management Systems
L: 3Hrs, T: 0Hrs,**P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** MDM

Course Outcomes: Upon the completion of this course students will be able to	
CO1	Explain fundamental concepts of database systems using various data models and integrity constraints.
CO2	Design and implement relational databases using SQL queries and relational algebra for engineering applications.
CO3	Apply database design principles such as ER modeling, normalization, indexing, and file organization techniques to develop efficient database schemas.
CO4	Analyze transaction processing, concurrency control mechanisms, and security techniques to ensure database consistency and reliability in real-world systems.

Syllabus

MODULE I: Database Fundamentals
Introduction to Data & Database Systems, Overview of DBMS, Data Models, Three Schema architecture and General Database Architecture, Relational Model Concepts, Keys & Various Constraints.

MODULE II: Basics of SQL
DDL, DML, DCL, structure – creation, alteration, defining constraints – Primary key, foreign key, unique, not null, check, IN operator, aggregate functions, Built-in functions –numeric, date, string functions, set operations, sub-queries, correlated sub-queries, join, Exist, Any, All , views, Relational Algebra.

MODULE III: Database Design & Normalization
ER Model**,** ER Diagram for Engineering Systems, Conversion of ER to Relational Model, Functional Dependencies, Normalization (1NF, 2NF, 3NF & BCNF)

MODULE IV: Implementation Techniques
Redundant Array of Independent Disks (RAID), File Organization, Indexing and Hashing - Ordered Indices, B+ tree Index Files, Query Processing Overview.

Unit V: Transactions, Concurrency & Security
Introduction to Transaction Processing & Schedules, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Two-Phase Locking Techniques for Concurrency Control.

Text Books:	
1	Database System Concepts, A. Silberschatz, and Henry. F. Korth, S. Sudarshan, McGraw Hill Education(India) Private Limited l, 6th edition, 2011

2	Database Management Systems, Raghu Ramakrishnan, Johannes Gehrke, McGraw Hill Education (India) Private Limited, 3rd Edition, 2003
3	Fundamental of Database Systems, Ramez Elmasri, Shamkant B.Navathe, Pearson Education, 6th edition, 2011

Reference Books:	
1	Database Systems Design, Implementation, and Management, Peter Rob & Carlos Coronel, 7th Ed., 2011.
2	Principles of Distributed Database Systems, Ozsu, Pearson Publication, 2011
3	Distributed Database Management Systems, Rahimi & Haug, Wiley, 2010

Semester V	
Course Code: 24EEOEI07TH0505-2	**Course:** Automation with PLC
L: 2 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 02
Compulsory/Elective: Elective	**Course Type:** OE

Course Outcomes: After completion of the course, students will be able to	
CO1	Explain automation concepts and industrial applications.
CO2	Identify and select sensors, actuators, and control components.
CO3	Understand PLC architecture, I/O addressing, and ladder logic.
CO4	Develop PLC programs for basic industrial automation systems.

Syllabus

MODULE I: Introduction to Automation (04 Hours): Definition and role of automation in industry, History and evolution of automation, Types of automation: Fixed, Programmable, Flexible, Benefits and limitations of automation

MODULE II: Automation Components (06 Hours): Relays: concept, wiring, and relay logic, Logic gates using relays, Switches: types and applications, Sensors: types and selection criteria, Actuators and control devices: - Contactors, Timers, Solenoid valves, Hydraulic & pneumatic systems

MODULE III: Programmable Logic Controller (05 Hours)
Introduction to PLC and its need, PLC architecture and block diagram, PLC I/O modules and addressing, Ladder diagram fundamentals, Components of ladder logic

MODULE IV: Advanced PLC Instructions & Communication (05 Hours)
Timer and counter instructions, Interfacing sensors and actuators with PLC, PLC communication: Modbus, Ethernet, RTU communication

MODULE V: Applications of PLC in Automation (04 Hours)
Conveyor belt automation, Induction motor starting using PLC, Water level control and management system, Case studies of industrial automation

Text Books:	
1	William Bolton, Programmable Logic Controllers, 4th Edition, Elsevier.
2	Programmable Logic Controllers by W. Bolton , Newnes an imprint of Elesevier, 6th edition

Reference Books:	
1	PLC manuals and user guides (Siemens, Allen Bradley, etc.)

Semester V	
Course Code: 24EEOEI07TH0505-3	**Course:** Electric Vehicles
L:02 Hrs, **P**: 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	Explain the need, components, and market aspects of electric vehicles and compare them with IC engines.
CO2	Analyze tractive effort components, vehicle dynamics, power and torque requirements, and energy consumption under different drive cycles.
CO3	Describe the basic concepts, classifications, drive-train topologies, and power flow control of EVs and HEVs.
CO4	Explain battery technologies, battery pack design and architecture, cell-to-pack technology, cell arrangement, and types of batteries used in electric vehicles.

Syllabus

MODULE-I: (06 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 -II: (06 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 -III: (06 Hours)
Basic concept of EVs and HEVs, classification, various drive-train topologies and power flow control.

MODULE -IV: (06 Hours)
Introduction to Battery Technology, Battery Pack Design and architecture,Cell to Pack Technology,Cell Arrangement,types of batteries.

Text Books:	
1	Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles.”
2	Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals,” CRC Press, 2021
3	James Larminie, John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2003.

Reference Books:	
1	Electric and Hybrid Vehicles: T. Denton, Routledge, 2016
2	Ali Emadi, "Handbook of Automotive Power Electronics and Drives", CRC publishers, 2012.

Semester V	
Course Code: 24HS02TH0501	**Course:** Business Communication
L: 1Hrs, **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	
CO 1:	Analyse communication processes and models to apply appropriate strategies in formal and informal workplace interactions.
CO 2:	Apply and demonstrate structured writing strategies and AI-assisted techniques to create effective business correspondence.
CO 3:	Develop and present structured business reports and visual content by integrating data visualization and AI tools effectively.
CO 4:	Apply interpersonal and persuasive communication, emotional intelligence, persuasion, negotiation, and leadership strategies to participate effectively in teamwork, conflict resolution, and employment processes.
CO 5:	Create and demonstrate professional communication across meetings, employment processes, and digital platforms by integrating AI tools ethically and effectively.

Syllabus

MODULE I: Fundamentals of Business Communication (04 Hours)
Introduction to Communication: Nature and Purpose
Communication Models: SBAR Framework (Situation, Background, Assessment, Recommendation), Schramm's Interactive Model, Transactional Model (case-based)

MODULE II: Business Correspondence (04 Hours)
Communication Planning and AI Integration: Planning Business Messages, Language and sensitivity to various audiences, Chat communication etiquette, Human-AI collaboration, Ethical use of AI
Routine Correspondence and prompt engineering: Internal Communication emails, Client emails, Escalation emails, Follow-up emails, Status update emails, Action confirmation emails, Use of AI Prompts for email drafting

MODULE III: Business Reports (04 Hours)
Fundamentals of Business Reports: purpose, structure, and standard formats
Types of Reports and Professional Documents: feasibility, progress, and project reports; agenda, notices, minutes of meetings, and organizational announcements; writing a business case
AI-Assisted Report Writing: Use of AI prompts for planning, drafting, and structuring reports

MODULE IV: Employment and Workplace Tools (03 Hours)

Employment Communication: job descriptions, effective use of job portals (LinkedIn, Indeed, etc.), and AI in hiring **Workplace Etiquette and Ethics:** professional and communication etiquette, ethical practices in organizational context **Workplace and AI Tools:** use of collaboration tools (Slack, Teams, Signal App) and AI tools (Grammarly, Claude) for professional communication

Text Books:	
1	Courtland L Bovee, John V Thill and Roshan Lal Raina "Business Communication Today", 14th edition Pearson
2	P.D. Chaturvedi and Mukesh Chaturvedi, Fundamentals of Business Communication, Pearson Publications, 2012.

Reference Books:	
1	Shalini Verma, Business Communication, Vikas Publishing House Pvt. Ltd., 2015.
2	Sanjay Kumar, Pushpa Lata, Communication Skills, 2nd Edition, Oxford Publication, 2018
3	Sharon Gerson, Steven Gerson, "Technical Communication: Process and Product", 2018, Pearson
4	*The AI Prompt Handbook for Business Writing: 50+ Prompts for Professionals, Managers & Entrepreneurs (The AI Prompt Handbook Series)*, Maxwell Striling, 2026
5	Chris Duffey, Prompt Engineering for Business, Wiley 2024
6	Taner Mostafa, AI Prompts for Business Writing, 2023 https://txwes.pressbooks.pub/bcomm/

Semester V	
Course Code: 24HS02PR0501	**Course:** Business Communication Lab
L: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** AEC

Syllabus (Practical)

Practical 1: Verbal Communication- Formal
Topics covered: **Channels-** Formal and Informal: Vertical, Horizontal, Diagonal, Formal discussion, Types of meetings (SCRUM, status, planning, problem-solving, brainstorming), Giving and receiving feedback, communicating ideas when not assigned to a project
***Suggested Activities*:** Client Call Simulations, Meeting and Feedback Exchange Role Plays.

Practical 2: Verbal Communication- Informal
Topics covered: Grapevine communication, Informal discussions, Art of Small Talk, Self-Introduction (succinct manner)
Suggested Activities: Speed networking, Small Talk Circles.

Practical 3: Emotional Intelligence
Topics covered: Application of Transactional Analysis in workplace contexts (particularly in team and client interactions)
Suggested Activities: PAC Role Play, Reframing negative communication

Practical 4: Persuasive Communication
Topics covered: Persuasion vs. Manipulation, ARGU strategy, Rhetorical Principle, Strategies
Suggested Activities: Product Pitch, Business Storytelling

Practical 5: Negotiation and Conflict Management
Topics covered: Types of Conflicts, Causes of Conflicts, Concept of BATNA, Negotiation strategies, Understanding the Non-Disclosure Agreement
Suggested Activities: Negotiation and Conflict Resolution Case Scenarios, Diplomacy in Action

Practical 6: Group Dynamics and Leadership Skills
Topics covered: Stages of Group formation, Roles in teams, Leadership Styles, Strategies to be an effective leader
Suggested Activities: Role Plays on Leadership Styles, Role-based Team Discussions, Decision-Making Tasks

Practical 7: Visual Communication
Topics covered: Data Visualization (selecting visuals for presenting data) and Data Verbalisation
Suggested Activities: Data to Visual Task

Practical 8: Employment and Workplace communication

Topics covered: Types of Resumes, Keyword Optimization, ATS-friendly resumes, Interview Questions, Answering structure, Body Language, Strategies for Effective Interviews

Suggested Activities: Resume Review, Mock Interviews *(involvement of industry also)*, LinkedIn Optimization

Semester V	
Course Code: 24EE07HT0501	**Course:** Battery Storage and Charging System
L: 04 Hrs, **P**: Hrs per Week	**Total Credits:** 4
Compulsory/Elective: Elective	**Course Type:** Honors

Course Outcomes: After completion of the course, students will be able to	
CO1	Explain battery fundamentals, types including lithium-ion variants, sodium-ion batteries, and construction forms like cylindrical, prismatic, pouch.
CO2	Describe battery parameters, terminology, characteristics, and evaluate State of Charge and State of Health concepts.
CO3	Analyze battery pack modelling using equivalent circuits, physics-based models, and vehicle dynamics for range estimation.
CO4	Apply state and health estimation methods including OCV, Kalman filtering, Coulomb counting, and impedance spectroscopy techniques.
CO5	Evaluate battery management systems, cell balancing methods, and EV charging technologies including converter topologies and V2G concepts.

Syllabus:
Module -I: Battery Basics: Introduction of battery, Types of batteries; Lithium-ion: Lithium Nickel Cobalt Oxide (NCA) or lithium cobalt oxide (LCO), batteries of the cylindrical, prismatic, and pouch varieties, Sodium ion batteries.
Module -II : Introduction to Battery Parameters Battery technology: Overview, Battery definitions, terms and terminology, types and their properties, State of Charge (SoC), State of Health (SoH) concepts.
Module-III: Modelling of Battery Packs: Equivalent-circuit models, physics-based models, equations of vehicle dynamics, vehicle range calculations.
Module -IV: State and Health Estimation methods: SoC, SoH, Open Circuit Voltage, Kalman filtering, Coulomb counting, impedance spectroscopy
Module-V: BMS and Cell Balancing: Functionality of BMS, Battery pack sensing: current, voltage and temperature, isolation and thermal control, protection, and interface, SoC, energy and power estimation requirement. Causes of imbalance, Design choices when implementing balancing, Circuits for

balancing (1): Passive (2): Active, capacitive (3): Active, inductive and dc-dc
MODULE -VI: Battery Charging Technologies Fundamentals of EV battery charging methods including constant current–constant voltage (CC–CV), pulse and fast charging techniques. AC and DC charging infrastructure, charging levels, Introduction to Power electronic converter topologies, wireless charging, and bidirectional charging concepts such as Vehicle-to-Grid (V2G).

Text Books:	
1	Gregory L Plett, Battery Modelling Volume I: (Power Engineering) (2015).
2	Gregory Plett, Battery Management Systems, Volume II: Equivalent-Circuit Methods, Artech (2015).

Reference Books:	
1	Phil Weicker, A Systems Approach to Lithium-Ion Battery Management (Power Engineering), Artech (2013
2	Handbook on Battery Energy Storage System, Asian Development Bank (2018).

Semester V	
Course Code: 24EE07TH0509	**Course:** Energy Storage Systems in E- Mobility
L: 03 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 3
Compulsory/Elective: Compulsory	**Course Type:** MDM

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	Compare different types of batteries as per application in EV.
CO3	Calculate SoC, SoH, SoE estimation of battery depends upon properties.
CO4	Understand the need and functions of a Battery Management System (BMS) in electric vehicles.
CO5	Explain advanced and hybrid energy storage systems.
CO6	Understand and analyze EV charging technologies, including charging infrastructure,

Syllabus

MODULE-I: Introduction to E-Mobility and Energy Storage (07 Hours)
Overview of electric vehicle architecture and energy flow, comparison with conventional fuel-based vehicles, need for energy storage in e-mobility, comparison with IC engine vehicles, types of energy storage systems (electrochemical, mechanical, electrical), basic performance parameters (energy density, power density, efficiency, lifecycle)

MODULE -II: Battery Technologies for EVs (07 Hours)
Types of batteries used in EVs: Lead-acid, Nickel-Metal Hydride (NiMH), Lithium-ion, Solid-state batteries, construction, working principle, characteristics, advantages and limitations, comparison of battery technologies for EV applications.

MODULE -III: Battery Characteristics and Performance Parameters (07 Hours)
Energy density and power density, state of charge and state of health, depth of discharge, C-rate and charging time, efficiency and cycle life, factors affecting battery performance.

MODULE -IV: Battery Management System and Charging Methods (07 Hours)
Need and functions of battery management system, monitoring of voltage, current and temperature, cell balancing techniques, protection mechanisms such as overcharge over-discharge and thermal protection, basics of thermal management.

MODULE -V: Advanced and Hybrid Energy Storage Systems (07 Hours)
Supercapacitors, fuel cells, hybrid energy storage systems, second-life batteries, recycling and sustainability, future trends in EV energy storage

MODULE -VI: MODULE -IV: EV Charging Technologies (07Hours)
Overview of charging standards and infrastructure, Types of EV charging (AC/DC charging), charging levels, onboard and offboard chargers, fast charging technologies, charging standards (CCS, CHAdeMO, Bharat EV standards),

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	Lithium-Ion Batteries Basics and Applications by Reiner Korthauer, Springer.
4	Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", 3rd Edition, CRC Press, 2021.

Reference Books:	
1	R. P. Deshpande, Ultracapacitors: Future of Energy Storage, McGraw-Hill Education, 2014
2	Lithium-ion Batteries Fundamentals and Applications. by Wu, Yuping, CRC Press, Taylor and Francis
3	O'hayre, S.W. Cha, W.G. Colella, F.B. Prinz, Fuel Cell Fundamentals, 3rd edition, Wiley publisher.

Semester VI	
Course Code: 24EE07TH0602	**Course:** Machine Learning
L: 3 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 3
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Discuss fundamental concepts and learning paradigms of machine learning with applications in electrical engineering.
CO2	Apply supervised and unsupervised learning algorithms for prediction, classification, and clustering tasks.
CO3	Evaluate machine learning models using appropriate validation techniques and performance metrics.
CO4	Apply feature engineering, dimensionality reduction, and kernel-based methods to improve model performance.
CO5	Implement probabilistic models and imbalance handling techniques and outline basic model deployment concepts.

Syllabus

MODULE-I: Foundations of Machine Learning and Model Evaluation (7 Hours)
Introduction to Machine Learning concepts and types: supervised, unsupervised, and reinforcement learning. Applications of Machine Learning in Electrical Engineering such as load forecasting, fault diagnosis, predictive maintenance, renewable energy systems, and smart grids. Basic data preprocessing techniques. Model underfitting and overfitting. Basic validation techniques. Introduction to regression methods: Simple Linear Regression and Multiple Linear Regression for engineering data analysis.

MODULE-II: Supervised Learning and Ensemble Methods (07 Hours)
Introduction to supervised learning techniques for engineering applications. Logistic Regression. K-Nearest Neighbors (KNN) method for classification and pattern recognition. Basics of Decision Trees and their use in fault classification and condition monitoring. Introduction to ensemble methods such as Random Forest and boosting concepts. Basic idea of model interpretation and performance evaluation in electrical engineering applications.

MODULE-III: Unsupervised Learning for Clustering (07 Hours)
Introduction to Unsupervised Machine Learning Tasks. Concept of Hard and Soft clustering. K-Means clustering method. Fuzy C-Means Clustering method. Introduction to anomaly detection.

MODULE-IV: Feature Engineering, Kernel Methods and Statistical Learning (07 Hours) Feature engineering techniques. Curse of Dimensionality. Dimensionality reduction using PCA and LDA. Introduction to Support Vector Machines. Idea of kernel trick, types of kernels: linear, polynomial, RBF (Gaussian). Statistical Learning Basics: Mean, variance, Probability concepts, Bias–variance tradeoff.
MODULE-V: Probabilistic Machine Learning, Imbalance Data Handling and Modern Model Deployment Basics (07 Hours) Naïve Bayes algorithm. Imbalance Data Handling Technique: Synthetic Minority Over-sampling Technique (SMOTE), Adaptive Synthetic Sampling (ADASYN), Generative Adversarial Networks (GAN). Introduction to MLOps concepts.

Text Books:	
1	Understanding Machine Learning: From Theory to Algorithms, “Shai Shalev-Shwartz and Shai Ben-David”, 1st Edition, Cambridge University Press, 2014.
2	Pattern Recognition and Machine Learning, “Christopher M. Bishop”, 1st Edition, Springer, 2006.
3	Machine Learning: A Probabilistic Perspective, “Kevin P. Murphy”, 1st Edition, MIT Press, 2012.
4	Introduction to Machine Learning, “Ethem Alpaydin”, 3rd Edition, PHI Learning, 2020.
5	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, “Aurélien Géron”, 3rd Edition, O’Reilly Media, 2022.

Reference Books:	
1	Tom Mitchell, Machine Learning, “Tom M. Mitchell”, 1st Edition, McGraw-Hill, 1997.
2	Introduction to Machine Learning, “Ethem Alpaydin”, 3rd Edition, PHI Learning, 2020.
3	Pattern Recognition and Machine Learning, “Christopher M. Bishop”, 1st Edition, Springer, 2006.

Semester VI	
Course Code: 24EE07PR0602	**Course:** Machine Learning Lab
L: 0 Hrs, **P**: 2 Hrs per Week	**Total Credits:** 1
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Apply various preprocessing techniques before solving the problems
CO2	Apply supervised machine learning techniques to solve different problems.
CO3	Apply probability based models to solve different problems.
CO4	Apply un-supervised machine learning techniques to solve different problems

Syllabus
Assignment 1 To study and apply Data Preprocessing techniques on a sample labeled dataset.
Assignment 2 Design and develop a machine learning regression model on sample labeled dataset.
Assignment 3 Develop a machine learning classification model to classify machine on a sample labeled dataset.
Assignment 4 Train an Artificial Neural Network (ANN) using the MNIST dataset to recognize handwritten digits. Algorithms: Multilayer Perceptron model.
Assignment 5 Develop a machine learning model using ensemble learning techniques on a sample labeled dataset. Algorithms: Random Forest algorithm, AdaBoost.
Assignment 6 Develop a machine learning model on a sample labeled dataset with 30-50 features. Algorithms: Naïve Bayes classifier, Support Vector Machine (SVM).
Assignment 7 Develop a machine learning model on a sample unlabeled dataset for implementation of clustering applications. Algorithms: K-Means clustering, Determine optimal number of clusters (Elbow Method).
Assignment 8 Mini Project: Select a dataset of choice. Apply classification algorithms: Logistic Regression, Naïve Bayes, SVM, KNN, Decision Tree, Random Forest, AdaBoost.

Text Books:	
1	Artificial Intelligence: A Modern Approach, “Stuart Russell and Peter Norvig”, 4th

	Edition, Pearson Education, 2020.
2	Artificial Intelligence: Foundations of Computational Agents, "David L. Poole and Alan K. Mackworth", 3rd Edition, Cambridge University Press, 2023.
3	Machine Learning: A Probabilistic Perspective, "Kevin P. Murphy", 1st Edition, MIT Press, 2012.
4	Reinforcement Learning: An Introduction, "Richard S. Sutton and Andrew G. Barto", 2nd Edition, MIT Press, 2018.

Reference Books:	
1	Artificial Intelligence, "Elaine Rich, Kevin Knight and Shivashankar B. Nair", 3rd Edition, Tata McGraw Hill, 2014.
2	Artificial Intelligence: A Guide to Intelligent Systems, "Michael Negnevitsky", 3rd Edition, Pearson Education, 2011.
3	Artificial Intelligence By Example, "Denis Rothman", 2nd Edition, Packt Publishing, 2020.

Semester VI	
Course Code: 24EE07TH0603	**Course:** Power System Analysis
L: 3Hrs, **P**: 0Hrs per Week	**Total Credits:**3
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze symmetrical faults in power systems and determine circuit breaker ratings and current limiting methods.
CO2	Apply symmetrical component theory for unbalanced systems and sequence impedances.
CO3	Evaluate unsymmetrical faults using symmetrical components.
CO4	Analyze power system stability using swing equation and equal area criterion.
CO5	Evaluate power system operation with load scheduling and load flow.

Syllabus

MODULE-I: (8 Hours)
Symmetrical Fault: Symmetrical fault analysis without and with pre-fault load currents, selection of circuit Breakers ratings, current limiting reactors

MODULE -II: (8 Hours)
Symmetrical Component: Symmetrical Component transformation, Three phase power in unbalanced circuit in terms of symmetrical component, Sequence impedances of Generator, Transformer, Transmission line and Passive loads,

MODULE -III: (8 Hours)
Unsymmetrical Fault : Unsymmetrical Fault Analysis L-G, L-L-G, L-L, Open Conductors faults analysis using symmetrical components

MODULE -IV: (10 Hours)
Power System Stability: Swing Equations of a synchronous machine connected to an infinite bus, Power angle curve, Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three-phase fault, Transient Analysis using the Equal Area Criterion,.

MODULE -V: (6 Hours)
Operation of Power System: Distribution of load between units within the plant, Optimum generation scheduling with and without considering transmission losses. Load flow studies

Text Books:	
1	J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education,

	1994
2	O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3	A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
4	D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.

Reference Books:	
1	B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.

Semester VI	
Course Code: 24EE07TH0604	**Course:** Control Systems
L: 3Hrs, T: 0Hrs,**P**:0Hrs per Week	**Total Credits:** 3
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: After completion of the course, students will be able to	
CO1	Develop mathematical models of physical systems and analyze them using block diagrams, signal flow graphs, and transfer functions.
CO2	Assess transient response characteristics and enhance system stability and performance.
CO3	Determine system stability using Routh–Hurwitz criterion and root locus analysis.
CO4	Use frequency response techniques to analyze control.
CO5	Formulate state-space representations for system modeling and stability analysis.

Syllabus

Module I: (10 Hours)
Introduction: Introduction to automation and automatic control, Broad spectrum of the control system applications, Mathematical modelling of physical systems, Classification, Relative merits and demerits of open and closed loop systems, Linear and non-linear systems, Transfer function of linear time invariant systems , Block diagrams and signal flow graphs, Benefits of feedback, servomechanism.

Module II: Time Response Analysis (05 Hours)
Standard test signals, Time response of first and second order systems for standard test inputs, Concept of system type and time constants, Design specifications for second order systems based on the time response, introduction to P, PI and PID controller.

Module III: Control System stability (03 Hours)
Concept of Stability, Stability types, Routh's and Hurwitz Criteria, Relative and conditional stability analysis.

Module IV: Root Locus Techniques (06 Hours)
Concept and use of root locus, Magnitude and angle criteria, Construction of root loci, effect of addition and poles and zeros on root loci

Module V: Frequency Response Analysis (10 Hours)
Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion, Relative stability using Nyquist criterion gain and phase margin, Closed-loop frequency response, Introduction to lag, lead, lag-lead compensation

Module VI: State Variable Analysis (04 Hours) Concepts of state variables, State space model. Diagonalization of State Matrix, State model in canonical and phase variable form, eigenvalues and Stability Analysis, Finding transfer function from state model

Text Books:	
1	Control Systems: Principles and Design: M. Gopal, McGraw Hill Education, 1997.
2	Modern Control Engineering: K. Ogata, Prentice Hall, 1991.
3	Control Systems Engineering: I. J. Nagrath and M. Gopal, New Age International,2009

Reference Books:	
1	Automatic Control System: B. C. Kuo, Prentice Hall, 1995.

Semester VI	
Course Code: 24EE07PR0604	**Course:** Control System Lab
L: 0Hrs, T: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** PCC

Course Outcomes: Upon successful completion of the course, the student shall be able to	
CO1	Co-relate, analyze and apply the fundamental principles of Control System Engineering to understand the laboratory experimental work.
CO2	Perform the experiment, Analyze the observed data & make valid conclusion
CO3	Write Journal with effective presentation of diagrams and characteristics.
CO4	Use the modern software like MATLAB for plotting and analysing time response and frequency response and obtain optimal system design

Text Books:	
1	Control Systems Engineering: Nagrath and Gopal, New Age International Publisher

Reference Books:	
1	Modern Control Theory: M.Gopal, John Wiley & Sons, 2nd edition, 1993
2	Automatic Control Systems: B.C.Kuo, PHI, 9th edition, 2014
3	Linear System Design: D'azzo and Houpis (M.H.), 4th edition

Semester VI	
Course Code:	**Course:** Internet of Things
L: 3Hrs, T: 0Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Compulsory	**Course Type:** MDM

Course Outcomes: After the successful completion of the course the students will be able to	
CO1	Discuss the resources and their constricts used in IoT system
CO2	Apply the understanding in identifying the resource to be used an element in IoT
CO3	Analyse the suitability of selected element for implementation of the IoT reference
CO4	Suggest the devices to be used different layers
CO5	Discuss the performance of different device at perception network and application layer

Syllabus

Module I:
Introduction to Internet of Things Network and IoT layered architecture

Module II:
Perception layer devices types and their roles as sensors, nodes, controllers. Different sensing elements for real world parameters like temperature, pressure, humidity, light intensity, magnetic flux, current etc.

Module III:
Introduction to Network layer device and their role as Gateways. Actuators at the application of user interface.

Module IV:
Monitoring real world parameters like temperature, pressure, humidity, light intensity, magnetic flux, current etc,

Module V:
Use cases of different sensing element and their actuation, data acquisition, processing at sensors/node

Text Books:	
1	Internet of Things Principles and Paradigms, Rajkumar Buyya Amir Vahid Dastjerdi, Morgan Kaufman, Elsevier 2016 1st Edition

Reference Books:	
1	Internet of Things Principles, Paradigms and Application of IoT, Joseph Kofi Wireko, Kaml Hiran, BPB Publications 2020 1st Edition
2	Application Notes of Microchip MCP9700, Dallas 18DS20, TMP102, TMP35/36/37
3	Application Notes of BM280, BF350, HX710B MPS20N0040D
4	Application Notes of PIR, Inductive Capacitive Sensors, IN122 Current Sensor
5	Microchip SAM-IoT Application notes
6	Arduino NanoBLE/ Nano 33IoT Application notes
7	Espressif Application notes ESP32/ESP8266/Node MCU
8	Raspberry Pi- PICO application notes

Semester VI	
Course Code: 24EE07TH0606-1	**Course:** Optimization Techniques
L: 3 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 3
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Formulate optimization problems for electrical engineering systems.
CO2	Solve linear and non-linear optimization problems using classical techniques.
CO3	Apply optimization techniques in power systems and control engineering
CO4	Implement numerical optimization algorithms using computational tools
CO5	Apply AI-based optimization techniques to real-world engineering problems

Syllabus

MODULE-I: Introduction & Linear Optimization (7 Hours)
Basics of optimization: objective function, constraints. Types: Linear, Non-linear, Integer Formulation of engineering problems, Linear Programming Problem (LPP), Graphical method (2 variables), Simplex method (numerical), Applications: Economic load dispatch (basic concept), Resource allocation in power systems

MODULE -II: Non-Linear Optimization (7 Hours)
Need for search in Single variable optimization. Unconstrained optimization: Exhaustive search, Golden section method. Multivariable optimization: Gradient method, Steepest descent. Constrained optimization: Lagrange multipliers. Applications: Minimizing power loss in transmission lines, Parameter tuning in control system

MODULE -III: Integer & Dynamic Programming (7 Hours)
Integer Programming (IP), Branch and Bound method, Knapsack problem. Dynamic Programming: Principle of optimality, Stage-wise optimization. Applications: Unit commitment in power systems, Scheduling problems, Energy storage optimization

MODULE -IV: Modern Optimization Techniques (7 Hours)
Introduction to heuristic optimization, Genetic Algorithm (GA): Selection, crossover, mutation. Particle Swarm Optimization (PSO), Simulated Annealing. Applications: Optimal placement of sensors, Load forecasting optimization, Renewable energy optimization.

MODULE -V: Optimization in AI & Electrical Systems (7 Hours)
Optimization in Machine Learning: Loss functions, Gradient descent. Neural network weight optimization. Optimization in smart grids: Demand response, Economic dispatch (advanced). Multi-objective optimization. Applications: EV charging optimization, Smart grid scheduling, AI-based energy management.

Text Books:	
1	Introduction to Operations Research, "Frederick S. Hillier and Gerald J. Lieberman", 10th Edition, McGraw-Hill Education, 2015.
2	Engineering Optimization: Theory and Practice, "Singiresu S. Rao", 5th Edition, Wiley, 2019.
3	Optimization for Engineering Design: Algorithms and Examples, "Kalyanmoy Deb", 2nd Edition, PHI Learning, 2012.

Reference Books:	
1	Convex Optimization, "Stephen Boyd and Lieven Vandenberghe", 1st Edition, Cambridge University Press, 2004.
2	Numerical Optimization, "Jorge Nocedal and Stephen J. Wright", 2nd Edition, Springer, 2006.
3	Genetic Algorithms in Search, Optimization and Machine Learning, "David E. Goldberg", 1st Edition, Addison-Wesley, 1989.
4	Optimization of Power System Operation, "Jizhong Zhu", 2nd Edition, Wiley-IEEE Press, 2015.

Semester VI	
Course Code: 24EE07TH0606-2	**Course:** Power Plant Engineering
L: 03 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Discuss the various sources of electrical energy and evaluate generating station performance using load factors and load curves.
CO2	Evaluate plant capacity and key economic factors for economical power plant operation.
CO3	Explain different types of tariffs and their impact on consumers.
CO4	Describe the layout, operation, and performance of thermal, hydro, and nuclear power plants.
CO5	Explain voltage control of AC generators and AVR operation.

Syllabus

Module-I: Sources of Electrical Energy (06 Hours)
Coal, oil and natural gas, water power, nuclear fission and fusion. Recent development in power generation.
Electrical Load & Curves: Different factors connected with a generating station, connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity and utilization factor, load curve, load duration curve, load survey, base load and peak load station, advantages of interconnection. load forecasting.

Module -II: Plant Capacity & Economics (06 Hours)
Choice of site, size and number of units, Cost of electrical energy, Depreciation of plant, Effect of Load Factor, Tariff: different consideration of Flat & two part economical choice.

Module -III: Thermal Power Station (06 Hours)
General layout, major equipment, essential and non- essential auxiliaries, electric supply to auxiliaries, cost of generation, effect of different factor on costs. Treatment on water, Tests on coal, Automatic control of different system. Advantages and disadvantages.

Module -IV: Hydro Power station (06 Hours)
Hydrology, stream flow, flow duration curve, power duration curve, mass curve and reservoir capacity, type of hydro plants and their field of use, pumped storages plants and their utility, surge tanks, governing characteristics of turbine and hydro generators. Advantages and disadvantage.

Module -V: Nuclear station (06 Hours)
Principle of Nuclear energy, materials, types of nuclear reactors, breeder reactors, location, material for moderator and control rods, cost economics.

Module -VI: Voltage control of A.C. generators (06 Hours) Voltage control of A.C. generators: Methods of stabilizing exciter voltage, Automatic Voltage regulator action. Captive & Cogeneration.

Text Books:	
1	Modern Power Station Practice: Turbines, Generators and Associated Plant Vol C, Publisher: Pergamon; 3rd Revised edition E,dition (31 December 1992)
2	Generation of Electrical Energy: Dr. B. R. Gupta, Publisher: S Chand (1 December 2010)
3	Power Plant Engineering: P. C. Sharma, Publisher: Kataria, S. K., & Sons (2004)

Reference Books:	
1	Electrical Power Station Control: H.P. Young..Vol-XI, Publisher: Chapman and Hall Ltd, London.
2	Elements of Power Station Design: M.V.Deshpande. Edition:Reprint, Publisher: PHI Learning, Pvt. Ltd., 2009.
3	Electric Power Generation the Changing Dimensions: Digambar M. Tagare, Publication by John Wiley & Sons, Inc IEEE Press.
4	Power Plant Engineering: P. K. Nag, Publisher: Tata Mc Graw - Hill Education, Edition: 2nd, 2001.

Semester VI	
Course Code: 24EE07TH0606-3	**Course:** Electric Drives and Control
L: 3 Hrs, **P**:0 Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Analyze the factors governing the selection, starting, braking, and speed control of electric motors for industrial drive applications.
CO2	Calculate and determine the appropriate size and rating of motors for continuous and intermittent duty cycles using load characteristics and thermal considerations.
CO3	Analyze the construction, operation, and control circuits of AC/DC contactors and relays used in motor control.
CO4	Apply principles of traction motor control to compute starting, speed control, braking, and series-parallel control parameter.
CO5	Develop PLC programs for control and automation of electrical drives in industrial applications.

Syllabus

MODULE-I: (07 Hours) Industrial Application of Electric Motors: - Factors governing selection of Electric Motors, Types of Drives and types of load, starting of electric motors, Speed control of Electric motors. Definition classification and speed torque characteristics of common drive motors and their characteristics under starting, running, Electric Braking, Types of enclosures.

MODULE -II: (07 Hours) **Selection of Motors: Size & Rating: -** Insulating materials, Temperature rise in Electrical machines, Duty cycles, Power capacity for continuous and intermittent periodic duties, Load equalization and flywheel effect. Brief idea about drives commonly used in industries.

MODULE -III: (07 Hours) **Contactors: -** Control devices for industrial motors, AC and DC contactors and relays: Lock out contactors, magnetic structure, operation, arc interruption, contactor rating, and H.V. contactors. Control circuits for automatic starting and braking of DC motor and three phase induction motor.

MODULE -IV: (07 Hours) Motors for Electric Traction: - Different systems of Traction. Train movement and energy consumption. Traction Motors: Motors used in AC/DC traction, their performance and desirable characteristics, requirements and suitability of motor for traction duty.

MODULE -V: (08 Hours) Control of Electric Traction Motors: - Traction motor control – Starting and speed control traction motors. Series parallel control with numerical. Starting and speed control of 3-phase induction motors. Braking of traction motor

Text Books:	
1	Utilization of Electric Power and Electric Traction: *J. B. Gupta, Volume IV, S. K. Kataria & Sons publisher*
2	A textbook of Electrical Technology: *B. L. Theraja & A. K. Theraja, Volume III, S. Chand Publication*

Reference Books:	
1	A textbook on Power System Engineering: *A. Chkrabarti, M.L. Soni, P.V. Gupta & U. S. Bhatanagar, Dhanpat Rai & Co. Publisher.*
2	Magnetic Control of Industrial Motor: *Heumann.*

Semester VI	
Course Code: 24EE07TH0607-1	**Course:** Data Analytics
L: 3 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 3
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Interpret data analytics lifecycle and basic preprocessing techniques.
CO2	Apply regression and association techniques for pattern discovery.
CO3	Implement classification and clustering methods for data analysis.
CO4	Apply basic time series models for forecasting problems.
CO5	Create effective data visualizations and simple data stories.

Syllabus

MODULE-I: Introduction and Overview (07 Hours)
Importance of data analytics. Basic data preprocessing and cleaning. Simple exploratory data analysis techniques. Overview of analytics lifecycle phases.

MODULE -II: Association Rules and Regression (07 Hours)
Basic concept of association rules and Apriori algorithm. Frequent itemsets and rule evaluation. Introduction to Linear and Logistic Regression. Model selection basics.

MODULE -III: Classification and Clustering (07 Hours)
Introduction to clustering and classification. K-Means clustering method. Decision Trees and Naïve Bayes basics. Basic model evaluation techniques.

MODULE -IV: Time Series Analysis Time Series Analysis (07 Hours)
Introduction to time series data. Basic ARIMA model concept. Simple forecasting techniques. Model selection basics.

MODULE -V: Data Visualization and Storytelling (07 Hours)
Principles of good data visualization. Common charts for distributions, comparisons, and trends. Basic visualization tools and file formats. Introduction to data storytelling concepts. Reader-driven and author-driven narratives. Best practices in presenting data insights.

Text Books:	
1	Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, "David Dietrich, Barry Heller and Beibel Yang", 1st Edition, John Wiley & Sons (EMC Education Services), 2015.
2	An Introduction to Statistical Learning with Applications in Python, "Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani", 2nd Edition, Springer, 2023.

3	Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, "Claus O. Wilke", 1st Edition, O'Reilly Media, 2019.
4	Time Series Analysis and Its Applications, "Robert H. Shumway and David S. Stoffer", 4th Edition, Springer, 2017.

Reference Books:	
1	Data Mining: Concepts and Techniques, "Jiawei Han, Micheline Kamber and Jian Pei", 3rd Edition, Morgan Kaufmann Publishers, 2011.
2	Pattern Recognition and Machine Learning, "Christopher M. Bishop", 1st Edition, Springer, 2006.
3	Applied Predictive Modeling, "Max Kuhn and Kjell Johnson", 1st Edition, Springer, 2013.
4	Storytelling with Data: A Data Visualization Guide for Business Professionals, "Cole Nussbaumer Knaflic", 1st Edition, Wiley, 2015.
5	Forecasting: Principles and Practice, "Rob J Hyndman and George Athanasopoulos", 3rd Edition, OTexts, 2021.

Semester VI	
Course Code: 24EE07TH0607-2	**Course:** Smart Grid and Cyber Security
L: 03 Hrs, **P**: 0 Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After completion of the course, students will be able to	
CO1	Explain distributed generation, microgrid concepts, configurations, advantages, challenges, and grid integration.
CO2	Describe smart grid architecture, components, AMI, and transmission and distribution automation.
CO3	Explain smart grid concepts, structure, features, challenges, and developments in India.
CO4	Analyze communication technologies, PMUs, WAMS, IoT applications, and cybersecurity in smart grids.
CO5	Apply smart grid planning, operation, control, and demand-side management techniques effectively.

Syllabus

Module I: Distributed Generation – Introduction, Integration of distributed generation to Grid, Concepts of Micro Grid, Typical Microgrid configurations, AC and DC micro grids, Interconnection of Microgrids, Technical and economic advantages of Microgrid, Challenges and disadvantages of Microgrid development.

Module-II: Smart Grid Architecture:
Components and Architecture of Smart Grid Design, Review of the proposed architectures for Smart Grid, Advanced metering infrastructure, The fundamental components of Smart Grid designs –Transmission Automation –Distribution Automation –Renewable Integration.

Module-III: Introduction to Smart Grid:
Introduction, Definition of smart grid, Concept of smart grid structure, Conventional grid Vs. Smart grid, Opportunities & Barriers of Smart Grid, Enablers of smart grid, Smart-grid activities in India, Key Challenges for Smart Grid.

Module-IV: Communication Technologies and Smart Grid:
Introduction to Communication Technology – Two way digital communications paradigm, Introduction to Synchro-Phasor Measurement Units (PMUs), Wide Area Measurement Systems (WAMS), Applications of IOT in Smart Grid, Cyber Security for Smart Grid.

Module-V: Smart Grid Planning
Planning aspects of smart grid, Operation and control of AC, DC & hybrid smart grid,.

Module VI: Introduction to Demand Side Management:
Smart energy efficient end use devices- Smart distributed energy resources- Load Curves- Load Shaping Objectives- Methodologies - Peak load shaving - Energy Management-Role of technology in demand response- Demand Side Management.

Text Books:	
1	James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley
2	Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 1st edition, 2012.

Reference Books:	
1	Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, iley
2	J. A. Momoh, "Smart Grid: Fundamentals of Design and Analysis," Wiley-IEEE Press, 1st Edition, March 2012.

Semester VI	
Course Code: 24EE07TH0607-3	**Course:** Solar Photovoltaic Engineering
L: 3Hrs, **P**:0Hrs per Week	**Total Credits:** 03
Compulsory/Elective: Elective	**Course Type:** PEC

Course Outcomes: After the completion of this course, student will be able to	
CO1	Explain the global energy scenario, importance of renewable energy, solar radiation fundamentals, and estimation of solar resource for photovoltaic applications.
CO2	Analyse the operation, characteristics, and performance of PV cells, modules, and arrays under varying environmental conditions.
CO3	Explain and evaluate Maximum Power Point Tracking (MPPT) techniques and charge controller functions in PV systems.
CO4	Analyse the role of DC–DC and DC–AC converters in photovoltaic systems and classify different types of solar PV systems.
CO5	Design basic stand-alone and hybrid photovoltaic systems including battery sizing and load estimation for DC and AC applications.

Syllabus

Module I: (10 Hours)

Introduction: Fossil fuel energy usage and global warming; role of renewable energy in sustainable development; renewable energy sources; global potential for solar electrical energy systems.

Solar Radiation: - Extra-terrestrial and terrestrial solar spectrum, Sun-Earth movement, Angles of sunrays on Solar Collector, Sun Tracking, Estimating Solar radiation empirically.

Module II: PV Cells and Modules (10 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; Effect of radiation and temperature; Types of solar cells and their performance.

Module III: Maximum Power Point Tracking (06 Hours)

Concept of Maximum Power Point Tracking (MPPT) , Tracking algorithms; Charge controller: types and function.

Module IV: Power converters in Photovoltaic system (06 Hours)

DC - DC converter, DC - AC converter; Types of Solar PV systems.

Module V: Photovoltaic System Design and Application (08 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; Introduction to Hybrid PV system.

Text Books:	
1	Solar Photovoltaic: Fundamentals, Technologies and Applications: Chetan Singh Solanki, PHI Learning Pvt Ltd, 2009
2	Solar Photovoltaic Technology and Systems: Chetan Singh Solanki, PHI learning Pvt. Ltd.,2014

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.
3	Renewable Energy Technologies: Sanjay Agrawal and Rajeev Mishra, AICTE, March 2023

Semester VI	
Course Code: 24EE07PR0609	**Course:** Simulation Lab
L: 0Hrs, T: 0Hrs, **P**:2Hrs per Week	**Total Credits:** 01
Compulsory/Elective: Compulsory	**Course Type:** SEC

Course Outcomes: After the completion of this course, student will be able to,	
CO1	Design and simulate the Electrical Machine/ Power System/Power Electronics circuit using MATLAB Simulink / P-Sim / ETAP Softwares / Power World Simulator/ Open source software
CO2	Analyze the results of simulated circuit/system.
CO3	Write MATLAB programme in M-file for given complex electrical engineering based numerical problems.
CO4	Analyze and compare the results with theoretical calculations.

Contents:
The practical is based on electrical engineering applications using following softwares.
1. MATLAB/ Simulink
2. ETAP Power Station,
3. P-Sim
4. Power World Simulator
5. Open source software

Text/Reference Books:	
1	Industrial Power Electronics: Deodatta Shingare, First Edition, Electrotech Publication Pune, 2009
2	Hadi Saadat, "Power System Stability", TMH, New Delhi, 2010.
3	S.G. Tarnekar, P.K. Kharbanda, S. B. Bodkhe, S. D. Naik, D.J. Dahigaonkar "A Textbook of Laboratory Courses in Electrical Engineering", S. Chand & Co., New Delhi, 2009.
4	MATLAB Manual from MATHWORKS Inc.
5	Manual, ETAP Software
6	Manual, P-Sim software

Semester VI	
Course Code: 24EE07HT0601	**Course:** Electric Vehicle Drives and Control
L: 04 Hrs, **P**: Hrs per Week	**Total Credits:** 4
Compulsory/Elective: Elective	**Course Type:** Honors

Course Outcomes: After completion of the course, students will be able to	
CO1	Explain constructional features, operating principles, and classifications of stepper, SRM, BLDC, and PMSM drives.
CO2	Analyze torque production mechanisms, EMF equations, magnetic circuits, and steady-state performance characteristics of electric drives.
CO3	Evaluate linear analysis, characteristics, and torque prediction methods for stepper motors and switched reluctance motors.
CO4	Design and assess power converter circuits, drive controllers, and closed-loop control strategies for modern motor drives.
CO5	Apply concepts of lead angle, sensor less control, and digital controllers in industrial and automotive drive applications.

Syllabus
Stepper Motors: Constructional features, Principle of operation, Types, Torque predictions, Linear Analysis, Characteristics, Drive circuits, Closed loop control, Concept of lead angle, Applications.
Switched Reluctance Motors (SRM): Constructional features, Principle of operation, Torque prediction, Characteristics, Steady-state performance prediction, Analytical Method, Power controllers, Control of SRM drive, Sensor less operation of SRM, Applications.
Brushless D.C. Motors: Fundamentals of Permanent Magnets, Types, Principle of operation, Magnetic circuit analysis, EMF and Torque equations, Power Converter Circuits and their controllers, Characteristics and control, Applications.
Permanent Magnet Synchronous Motors (PMSM): Constructional features, Principle of operation, EMF and Torque equations, Sine wave motor with practical windings, Phasor diagram, Power controllers, Performance characteristics, Digital controllers, Applications.

Text Books:	
1	K. Venkataratnam, Special Electrical Machines, Universities Press (India) Private Limited (2008).

2	E.G. Janardanan, Special Electrical machines, PHI learning Private Limited, Delhi, (2014).

Reference Books:	
1	R. Krishnan, Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, (2001).
2	

Semester VI	
Course Code: 24EE07TH0609	**Course:** Autonomous Vehicle
L: 3Hrs, **T**:0Hrs, **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	
CO 1:	Explain the fundamentals, evolution, and applications of autonomous vehicles.
CO 2:	Analyse different types of sensors and perception systems used in autonomous driving.
CO 2:	Select which communication protocols to be used by autonomous vehicles
CO 3:	Illustrate the architecture of autonomous vehicle
CO 4:	Evaluate communication technologies, system architectures, and safety challenges in autonomous vehicle systems.
CO 5:	Apply artificial intelligence and machine learning techniques for decision making and control in autonomous driving.

Syllabus

Module-I: Principles of Autonomy & Decision Making (08 Hours)
Why we need self-driving vehicles, the new business models, Transportation & Non-transportation use cases, Autonomous driving regulations, and policies, an overview of current state-of-the-art systems, Localization, Mapping, Simultaneous Localization & Mapping, Object Detection.

Module-II: Sensors (08 Hours)
Key considerations. Different types of sensors and their use in driving safety and car performance management, Radar, Lidar, Ultrasonic Sensors, Cameras, Global Navigation Satellite Systems, Inertial Measurement Units, Odometry Sensors, Object detection and environment perception, Computing Platform, Actuator Interface.

Module-III: Architecture (08 Hours)
Functional Architecture: Perception, Planning, Vehicle Control, System Architecture: Hardware, Middleware, Firmware Layer, Putting it all together: Preparation, Development, Prediction, Routing, Testing.

Module-IV: Communication Technology (08 Hours)
In-vehicle communication system, Vehicle to everything communication, why is V2X important, V2X standard, V2X uses cases, challenges, Back-end systems, Functional Safety, Cyber security.

Module-V: AI & Self Diving Cars (07 Hours)
Role of Artificial Intelligence in autonomous driving, Machine learning techniques in perception, Deep learning for object detection and scene understanding, Reinforcement learning for decision making, Autonomous vehicle control strategies, Future trends in autonomous mobility

Text Books:	
1	Shaoshan Liu, Lijun Li, Jie Tang, *Creating Autonomous Vehicle Systems*, Morgan & Claypool Publishers.
2	Raj Rajkumar, Dionisio de Niz, Mark Klein, *Cyber-Physical Systems: Foundations, Principles and Applications*, Morgan Kaufmann.
3	Steven Waslander, *Autonomous Driving: Technical, Legal and Social Aspects*, Springer.

Reference Books:	
1	Liu, et. al., Creating Autonomous Vehicles – Synthesis Lectures in Computer Science, Morgan Claypool – e1 - 2017, e2 – 2020.
2	Michael E McGrath, Autonomous Vehicles: Opportunities, Strategies and Disruptions, 2e, Independent, 2019.
3	Hanky Sjafrie, Introduction to Self-Driving Vehicle Technology, Routledge (T&F), 2019
4	Ranjan & Senthamilarasu, Applied Deep Learning and Computer Vision for Self-Driving Cars, Packt Publishing; 1st edition, 2020