Gurugram University Gurugram

DEPARTMENTOF ENGINEERING & TECHNOLOGY
(FACULTY OF SCIENCES & TECHNOLOGY)

SCHEME & CURRICULUM

for

BACHELOR OF TECHNOLOGYUG DEGREE PROGRAMME

in

ELECTRICAL ENGINEERING (Electrical Vehicles)

(Session 2025-2026)

DEPARTMENTOF ENGINEERING & TECHNOLOGY
(FACULTY OF SCIENCES & TECHNOLOGY)
Gurugram University Gurugram

VISION

Gurugram University aspires to be a front runner in global education; role model for institutional excellence, trans-cultural quality learning, intellectual growth, contemporary research, capacity building and nurturing socially and morally responsible disciples through a learner- centric approach. The university seeks to ensure a journey from studentship to epitome of discipleship by working on academic, professional, technical, industry and life skillsof its students.

MISSION

1. **To become a socially conscious center of knowledge and advancement equipped to take up the challenges of the global change as well as committed to empower its teachers for the development of the students.**
2. **To move up through international alliances and collaborative initiatives to achieve global excellence.**
3. **To create rigorous academic and research environment for creation of knowledge and its perpetual advancement.**
4. **To attract and build people in a rewarding and inspiring environment by fostering freedom, empowerment, creativity, scientific zeal and innovation.**

VISION

To become center of quality education, research with innovation in the field of Electrical Engineering and be recognized at National and International level for serving society.

MISSION

- To provide quality education to aspiring young minds for improving their scientific knowledge and technical skills in the area of Electrical Engineering
- To produce socially committed trained professionals who can contribute effectively to the advancement of their organization and society through their scientific knowledge.
- To foster innovation in Electrical & Electronics Engineering and allied areas by collaborating with industryand other R&D organizations.

ABOUT THE PROGRAM

The Bachelor of Technology (B.Tech.) program in Electrical Engineering offers students a comprehensive education in integrated circuit design, combining theoretical knowledge with practical skills. Students learn fundamental concepts in Electrical Engineering, Vehicle Technology, digital logic design, analog and digital electronics, and semiconductor physics, while gaining expertise in Electrical Vehicles, and Hybrid technology. The program emphasizes hands-on experience with industry-standard tools and real-world projects, preparing graduates for careers in a rapidly expanding field that supports diverse applications from consumer electronics to advanced technologies like AI and Hybrid Technology. With a focus on both technical proficiency and innovation, this program addresses the growing demand for skilled engineers and positions students for significant contributions to technological advancements and economic growth..

NOTE:

- The scheme will be applicable from Academic Session 2024-25 onwards.
- The scheme will also be applicable to the students who are admitted in 2024-25academic session and are transiting in 3rd Semester of their program.

Electrical Engineering (Electrical Vehicles)

PROGRAM EDUCATION OBJECTIVES

PEO1	Graduates will possess a strong foundation in science and engineering fundamentals, along with analytical skills to effectively solve real-world problems.
PEO2	Graduates will gain technical proficiency in Electronic Engineering fields and scale new heights in the profession through lifelong learning.
PEO3	Graduates will embrace professionalism; ethical conduct at all levels and constantly evolves in a multidisciplinary approach leading towards sustainability.
PEO4	Graduates will leverage their engineering knowledge, effective communication skills, leadership qualities, and teamwork spirit to serve society and contribute positively to their community.

PROGRAM OUTCOMES

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyzecomplex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needswith appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complexengineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequentresponsibilities relevant to the professional engineering practice.

PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

PSO1	Demonstrate proficiency in development, design, and analysis of electrical and electronic systems using cutting-edge hardware and software tools, with a focus on Electrical Vehicles & Hybrid Technology.
PSO2	Deploy traditional and innovative techniques / tools in diverse domains of Electrical Engineering to contribute to societal advancements and improvements.

GENERAL COURSE STRUCTURE & CREDIT DISTRIBUTION

STRUCTURE OF UNDERGRADUATE ENGINEERING PROGRAM

S.No.	Category	Breakup of Credits (Total 169)
1	Humanities and Social Sciences including Management courses	12
2	Basic Science courses	20
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	30
4	Professional core courses	68
5	Professional Elective courses relevant to chosen specialization/branch	12
6	Open subjects – Electives from other technical and /or emerging subjects	12
7	Project work, seminar and internship in industry or elsewhere	15
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge]	Non-credit
9	**Total**	**169**

SEMESTER WISE SUMMARY OF THE PROGRAM

S.No.	Semester	No. of Contact Hours	Marks	Credits
1.	I	26	800	20
2.	II	26	900	21
3.	III	36	1000	24
4.	IV	28	1000	22
5.	V	25	900	21
6.	VI	26	1100	23
7.	VII	28	900	23
8.	VIII	40	600	15
	Total	235	7200	169

COURSE CODE AND DEFINITIONS

Course Code	Definitions
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
OEC	Open Elective courses
LC	Laboratory course
MC	Mandatory courses
PROJ	Project

MANDATORY INDUCTION PROGRAM (3-WEEKS DURATION)

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. A 3-week long induction program for the UG students entering the institution, right at the start, has to be planned. Normal classes will start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

Tentative activities which can be planned in this Induction Programme are as follows:

- Physical Activity
- Creative Arts
- Universal Human Values
- Literary
- Proficiency Modules
- Lectures by Eminent People
- Visits to Local Area
- Familiarization to Dept./Branch & Innovations

CREDIT DISTRIBUTION IN THE FIRST YEAR OF UNDERGRADUATE ENGINEERING PROGRAM

Sr. No.	Course Code	Subject	Lecture (L)	Tutorial (T)	Laboratory/ Practical (P)	credit (C)
1.	HSM-101	Communication Skills in English	2	0	0	2
2.	BSC-103	Mathematics-I	3	1	0	4
3.	BSC-03/ ESC-103	Physics OR Basic of ElectricalEngineering	3 3	1 0	0 0	4 3
4.	ESC-101	Programming for problem solving using C	3	0	0	3
5.	ENV-101	Basics of Environmental Science	2	0	0	2
6.	HSM-101P	Communication Skills in English (P).	0	0	2	1
7.	BSC-103P ESC-103P	Physics (P) OR Basic of ElectricalEngineering (P)	0 0	0 0	2 2	1 1
8.	ESC-101P	Programming for problem solving using C (P)	0	0	2	1
9.	ESC-102P	Workshop Practice (P)	1	0	2	2
10.	HSM-101	Sports (Audit Course) Compulsory	0	0	2	0
11.	BSC-104	Mathematics-II	3	1	0	4
12.	HSM-102	Human Value & Soft Skills	2	0	2	3
13.	BSC-101	Chemistry	3	0	0	3
14.	HSM-101	Design Thinking	1	0	2	2
15.	ESC-102	Electronics Engineering – I	3	0	0	3
16.	HSM-101	IDEA Lab Workshop	0	0	2	1
17.	ESC-102P	Electronics Engineering- I (P)	0	0	2	1
Total Credits						**41**

1st Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	HSM-101	Communication Skills in English	2	0	0	2	30	70	100
2	BSC-103	Mathematics-I	3	1	0	4	30	70	100
3	BSC-103	Physics	3	1	0	4	30	70	100
4	ESC-101	Electronics Engineering – I	3	0	0	3	30	70	100
5	HSM-101	Basics of Environmental Science	2	0	0	2	50	50	100
6	HSM-101P	Communication Skills in English (P).	0	0	2	1	50	50	100
7	BSC-103P	Physics (P)	0	0	2	1	50	50	100
8	ESC-101P	Electronics Engineering – I (P)	0	0	2	1	50	50	100
9	ESC-102P	Workshop Practices (P)	1	0	2	2	50	50	100
10	HSM-101	Sports (Audit Course) Compulsory*	0	0	2	0			
		Total Credits				20			800

2nd Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	BSC-104	Mathematics-II	3	1	0	4	30	70	100
2	ESC-103	Basic of Electrical Engineering	3	0	0	3	30	70	100
3	BSC-101	Chemistry	3	0	0	3	30	70	100
4	ESE-102	Programming for problem solving using C	3	0	0	3	30	70	100
5	HSM-101	Design Thinking	1	0	2	2	30	70	100
6	ESC-103P	Programming for problem solving using C(P)	0	0	2	1	50	50	100
7	ESC-102P	Electronics Engineering- I (P)	0	0	2	1	50	50	100
8	ESC-101	IDEA Lab Workshop	0	0	2	1	50	50	100
9	HSM-102	Human Value & Soft Skills	2	0	2	3	50	50	100
		Total Credits				21			900

CREDIT DISTRIBUTION IN THE SECOND YEAR OF UNDERGRADUATE ENGINEERING PROGRAM

3rd Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC301	Electrical Circuit Analysis	3	1	0	30	70	100	4
2	ESC302	Analog Electronics Circuits	3	0	0	30	70	100	3
3	ESC303	Electrical Machines-1	3	0	0	30	70	100	3
4	ESC304	Electromagnetic Fields	3	1	0	30	70	100	4
5	BSC305	Mathematics-III	3	1	0	30	70	100	4
6	ESC-306	Python	2	0	2	50	50	100	3
7		Mandatory Course*	2	0	0	100	0	100	0
8	ESC302P	Analog Electronics Circuit Lab	0	0	2	50	50	100	1
9	ESC303P	Electrical Machines Lab -1	0	0	2	50	50	100	1
10	ESC307	Project-1	0	0	2	50	50	100	1
		Total	**20**	**4**	**12**			**1000**	**24**

***Non Credit Course**

	Course Code	Course Title
Mandatory Course	MC-01 (Common to all)	Indian Constitution
	MC-02 (Common to all)	Essence of Indian Traditional Knowledge

4th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC401	Digital Electronics	3	1	0	30	70	100	4
2	ESC402	Electrical Machines – II	3	0	0	30	70	100	3
3	ESC403	Power Electronics	3	1	0	30	70	100	4
4	ESC404	Signal and Systems	3	1	0	30	70	100	4
5		Program Elective –I	3	0	0	30	70	100	3
6	MC-03	Environmental Sciences	2	0	0	100	0	100	0
7	ESC401P	Digital Electronics Lab	0	0	2	50	50	100	1
8	ESC402P	Electrical Machines Lab–II	0	0	2	50	50	100	1
9	ESC403P	Power Electronics Lab	0	0	2	50	50	100	1
10	ESC405	Project-2	0	0	2	50	50	100	1
		Total	**17**	**3**	**8**	**240**	**660**	**1000**	**22**

*** Non Credit Course**

	Course Code	Course Title
Program Elective -1	EPE406	Design and Engineering
	EPE407	Transducer and IOT
	EPE408	Introduction to Electrical Vehicles

5^{th} Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	End Sem	Total	Cr.
			L	T	P				
1	ESC501	Power Systems – I	3	0	0	30	70	100	3
2	ESC502	Control Systems	3	1	0	30	70	100	4
3	ESC503	Microprocessors	3	1	0	30	70	100	4
4		Program Elective –II	3	0	0	30	70	100	3
5		Open Elective –I	3	0	0	30	70	100	3
6	ESC501P	Power Systems Lab-1	0	0	2	50	50	50	1
7	ESC502P	Control Systems Lab	0	0	2	50	50	50	1
8	ESC503P	Microprocessors Lab	0	0	2	50	50	50	1
9	ESC504	Project-3	0	0	2	50	50	50	1
		Total	**15**	**2**	**8**			**900**	**21**

	Course Code	Course Title
Program Elective –II	EPE505	Electric Vehicles Architecture
	EPE506	Electrical Machine Design
	EPE507	Digital Control
Open Elective –I	EOE508	Artificial Intelligence
	EOE509	Computational Electromagnetics
	EOE510	Energy Management

6th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC601	Power System-II	3	0	0	30	70	100	3
2	ESC602	Electrical Measurements and Instrumentation	3	0	0	30	70	100	3
3	ESC603	Electronics Design	3	0	0	30	70	100	3
4		Program Elective-III	3	0	0	30	70	100	3
5		Program Elective-IV	3	0	0	30	70	100	3
6		Open Elective –II	3	0	0	30	70	100	3
7	ESC601P	Power System Lab –II	0	0	2	50	50	100	1
8	ESC602P	Electrical Measurements and Instrumentation Lab	0	0	2	50	50	100	1
9	ESC603P	Electronics Design Lab	0	0	2	50	50	100	1
10	ESC604	Project-4	0	0	2	50	50	100	1
11	ELV605	Social Work*	-	-	-	100		100	1
		Total	**18**	**0**	**8**			**1100**	**23**

	Course Code	Course Title
Open Elective -II	EOC612	Sensors & Actuators
	EOC613	Renewable Energy
	EOC614	Remote Sensing and GIS
Program Elective –III	EPE606	Fuel cell Electrical Vehicles and Hydrogen Technology
	EPE607	Electrical and Hybrid Vehicles
	EPE608	Digital Signal Processing
Program Elective –IV	EPE609	Wind and Solar Energy System
	EPE610	Electrical Vehicles controls and Drives
	EPE611	Digital Control Systems

* At least one day in fortnight

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7th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC701	High Voltage Engineering	3	0	0	30	70	100	3
2	ESC702	Energy Storage and Management for Electric Vehicles	3	0	0	30	70	100	3
3		Program Elective -V	3	0	0	30	70	100	3
4		Program Elective -VI	3	0	0	30	70	100	3
5		Open Elective –III	3	0	0	30	70	100	3
6		Open Elective –IV	3	0	0	30	70	100	3
7	ESC703	Major Project	0	0	6	50	50	100	3
8	ESC704P	Introduction to Scilab and its applications	0	0	2	50	50	100	1
9	ESC702P	Energy Storage and Management for Electric Vehicles Lab	0	0	2	50	50	100	1
		Total	**18**	**0**	**10**			**900**	**23**

	Course Code	Course Title
Program Elective –V	EPE705	Materials for Electric and Hybrid Electric Vehicles
	EPE 706	HVDC Transmission Systems
	EPE 707	Power Quality and FACTS
Program Elective –VI	EPE 708	High Voltage Engineering
	EPE 709	Electric Vehicle Testing and Certification
	EPE 710	Control Systems Design
	EPE 711	Power System Dynamics and Control

	Course Code	Course Title
Open Elective-III	EOE 712	Organizational Behavior
	EOE 713	Finance & Accounting
	EOE 714	Basics of Operation Research
Open Elective-IV	EOE 715	Materials Science and Engineering
	EOE 716	Artificial Intelligence
	EOE 717	Computational Fluid Dynamics

8th Semester

Sr. No.	Category	Course Code	Course Title	Hours Per Week			Sessional Marks	Final Marks	Total	Credits
				L	T	P				
1	PROJ/SEC	ESE801	Industrial Training	8 Hrs per Day			400	200	600	15

A) Procedure For Annual Examination And Marks		
Project Evaluation	50 Marks	Total 200 Marks
Project Seminar	50 Marks	
Project Viva	100 Marks	
B) Continuous Assessment Marks		
Assessment By Institute Faculty	200 Marks.	Total 400 Marks
Assessment By Industrial Guide	100 Marks.	
Conduct Marks	100 Marks.	
		Total 600 Marks

15/4/25
Dr Sumit Choudhary

Dr Bhoop Singh

Dr Vijay Kr Lamba 15/4

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Electrical Engineering (Electrical Vehicles)

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- Physical Activity
- Creative Arts
- Universal Human Values
- Literary
- Proficiency Modules
- Lectures by Eminent People
- Visits to Local Area
- Familiarization to Dept./Branch & Innovations

1st Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	HSM-101	Communication Skills in English	2	0	0	2	30	70	100
2	BSC-103	Mathematics-I	3	1	0	4	30	70	100
3	BSC-103	Physics	3	1	0	4	30	70	100
4	ESC-101	Electronics Engineering – I	3	0	0	3	30	70	100
5	HSM-101	Basics of Environmental Science	2	0	0	2	50	50	100
6	HSM-101P	Communication Skills in English (P).	0	0	2	1	50	50	100
7	BSC-103P	Physics (P)	0	0	2	1	50	50	100
8	ESC-101P	Electronics Engineering – I (P)	0	0	2	1	50	50	100
9	ESC-102P	Workshop Practices (P)	1	0	2	2	50	50	100
10	HSM-101	Sports (Audit Course) Compulsory*	0	0	2	0			
Total Credits						20			800

2nd Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	BSC-104	Mathematics-II	3	1	0	4	30	70	100
2	ESC-103	Basic of Electrical Engineering	3	0	0	3	30	70	100
3	BSC-101	Chemistry	3	0	0	3	30	70	100
4	ESE-102	Programming for problem solving using C	3	0	0	3	30	70	100
5	HSM-101	Design Thinking	1	0	2	2	30	70	100
6	ESC-103P	Programming for problem solving using C(P)	0	0	2	1	50	50	100
7	ESC-102P	Basic of Electrical Engineering - I (P)	0	0	2	1	50	50	100
8	ESC-101	IDEA Lab Workshop	0	0	2	1	50	50	100
9	HSM-102	Human Value & Soft Skills	2	0	2	3	50	50	100
Total Credits						21			900

3rd Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC301	Electrical Circuit Analysis	3	1	0	30	70	100	4
2	ESC302	Analog Electronics Circuits	3	0	0	30	70	100	3
3	ESC303	Electrical Machines-1	3	0	0	30	70	100	3
4	ESC304	Electromagnetic Fields	3	1	0	30	70	100	4
5	BSC305	Mathematics-III	3	1	0	30	70	100	4
6	ESC-306	Python	2	0	2	50	50	100	3
7		Mandatory Course*	2	0	0	100	0	100	0
8	ESC302P	Analog Electronics Circuit Lab	0	0	2	50	50	100	1
9	ESC303P	Electrical Machines Lab -1	0	0	2	50	50	100	1
10	ESC307	Project-1	0	0	2	50	50	100	1
		Total	**20**	**4**	**12**			**1000**	**24**

***Non Credit Course**

	Course Code	**Course Title**
Mandatory Course	MC-01 (Common to all)	Indian Constitution
	MC-02 (Common to all)	Essence of Indian Traditional Knowledge

4th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC401	Digital Electronics	3	1	0	30	70	100	4
2	ESC402	Electrical Machines – II	3	0	0	30	70	100	3
3	ESC403	Power Electronics	3	1	0	30	70	100	4
4	ESC404	Signal and Systems	3	1	0	30	70	100	4
5		Program Elective –I	3	0	0	30	70	100	3
6	MC-03	Environmental Sciences	2	0	0	100	0	100	0
7	ESC401P	Digital Electronics Lab	0	0	2	50	50	100	1
8	ESC402P	Electrical Machines Lab–II	0	0	2	50	50	100	1
9	ESC403P	Power Electronics Lab	0	0	2	50	50	100	1
10	ESC405	Project-2	0	0	2	50	50	100	1
		Total	**17**	**3**	**8**	**240**	**660**	**1000**	**22**

*** Non Credit Course**

	Course Code	**Course Title**
Program Elective -1	EPE406	Design and Engineering
	EPE407	Transducer and IOT
	EPE408	Introduction to Electrical Vehicles

5th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	End Sem	Total	Cr.
			L	T	P				
1	ESC501	Power Systems – I	3	0	0	30	70	100	3
2	ESC502	Control Systems	3	1	0	30	70	100	4
3	ESC503	Microprocessors	3	1	0	30	70	100	4
4		Program Elective –II	3	0	0	30	70	100	3
5		Open Elective –I	3	0	0	30	70	100	3
6	ESC501P	Power Systems Lab-1	0	0	2	50	50	50	1
7	ESC502P	Control Systems Lab	0	0	2	50	50	50	1
8	ESC503P	Microprocessors Lab	0	0	2	50	50	50	1
9	ESC504	Project-3	0	0	2	50	50	50	1
		Total	**15**	**2**	**8**			**900**	**21**

	Course Code	Course Title
Program Elective –II	EPE505	Electric Vehicles Architecture
	EPE506	Electrical Machine Design
	EPE507	Digital Control
Open Elective –I	EOE508	Artificial Intelligence
	EOE509	Computational Electromagnetics
	EOE510	Energy Management

6th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC601	Power System-II	3	0	0	30	70	100	3
2	ESC602	Electrical Measurements and Instrumentation	3	0	0	30	70	100	3
3	ESC603	Electronics Design	3	0	0	30	70	100	3
4		Program Elective-III	3	0	0	30	70	100	3
5		Program Elective-IV	3	0	0	30	70	100	3
6		Open Elective –II	3	0	0	30	70	100	3
7	ESC601P	Power System Lab –II	0	0	2	50	50	100	1
8	ESC602P	Electrical Measurements and Instrumentation Lab	0	0	2	50	50	100	1
9	ESC603P	Electronics Design Lab	0	0	2	50	50	100	1
10	ESC604	Project-4	0	0	2	50	50	100	1
11	ELV605	Social Work*	-	-	-	100		100	1
		Total	**18**	**0**	**8**			**1100**	**23**

	Course Code	Course Title
Open Elective -II	EOC612	Sensors & Actuators
	EOC613	Renewable Energy
	EOC614	Remote Sensing and GIS
Program Elective –III	EPE606	Fuel cell Electrical Vehicles and Hydrogen Technology
	EPE607	Electrical and Hybrid Vehicles
	EPE608	Digital Signal Processing
Program Elective –IV	EPE609	Wind and Solar Energy System
	EPE610	Electrical Vehicles controls and Drives
	EPE611	Digital Control Systems

* At least one day in fortnight

7th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC701	High Voltage Engineering	3	0	0	30	70	100	3
2	ESC702	Energy Storage and Management for Electric Vehicles	3	0	0	30	70	100	3
3		Program Elective -V	3	0	0	30	70	100	3
4		Program Elective -VI	3	0	0	30	70	100	3
5		Open Elective –III	3	0	0	30	70	100	3
6		Open Elective –IV	3	0	0	30	70	100	3
7	ESC703	Major Project	0	0	6	50	50	100	3
8	ESC704P	Introduction to Scilab and its applications	0	0	2	50	50	100	1
9	ESC702P	Energy Storage and Management for Electric Vehicles Lab	0	0	2	50	50	100	1
		Total	**18**	**0**	**10**			**900**	**23**

	Course Code	Course Title
Program Elective –V	EPE705	Materials for Electric and Hybrid Electric Vehicles
	EPE 706	HVDC Transmission Systems
	EPE 707	Power Quality and FACTS
Program Elective –VI	EPE 708	High Voltage Engineering
	EPE 709	Electric Vehicle Testing and Certification
	EPE 710	Control Systems Design
	EPE 711	Power System Dynamics and Control

	Course Code	Course Title
Open Elective-III	EOE 712	Organizational Behavior
	EOE 713	Finance & Accounting
	EOE 714	Basics of Operation Research
Open Elective-IV	EOE 715	Materials Science and Engineering
	EOE 716	Artificial Intelligence
	EOE 717	Computational Fluid Dynamics

8th Semester

Sr. No.	Category	Course Code	Course Title	Hours Per Week			Sessional Marks	Final Marks	Total	Credits
				L	T	P				
1	PROJ/SEC	ESE801	Industrial Training	8 Hrs per Day			400	200	600	15

A) Procedure For Annual Examination And Marks		
Project Evaluation	50 Marks	Total 200 Marks
Project Seminar	50 Marks	
Project Viva	100 Marks	
B) Continuous Assessment Marks		
Assessment By Institute Faculty	200 Marks.	Total 400 Marks
Assessment By Industrial Guide	100 Marks.	
Conduct Marks	100 Marks.	
		Total 600 Marks

Dr Sumit Choudhary Dr Bhoop Singh Dr Vijay Kr Lamba

SEMESTER WISE STRUCTURE AND CURRICULUM

FOR

UG COURSE

IN

ELECTRICAL ENGINEERING (ELECTRICAL VEHICLES)

1st Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	HSM-101	Communication Skills in English	2	0	0	2	30	70	100
2	BSC-102	Mathematics-I	3	1	0	4	30	70	100
3	BSC-103	Physics	3	1	0	4	30	70	100
4	ESC-101	Electronics Engineering – I	3	0	0	3	30	70	100
5	HSM-102	Basics of Environmental Science	2	0	0	2	50	50	100
6	HSM-101P	Communication Skills in English (P).	0	0	2	1	50	50	100
7	BSC-103P	Physics (P)	0	0	2	1	50	50	100
8	ESC-101P	Electronics Engineering – I (P)	0	0	2	1	50	50	100
9	ESC-102P	Workshop Practices (P)	1	0	2	2	50	50	100
10	HSM-101	Sports (Audit Course) Compulsory*	0	0	2	0			
Total Credits						20			800

L: Lecture , T: Tutorial , P: Practical/Laboratory

Sports: Non-credit mandatory course, students have to attain pass marks (40%)

Note: Exams duration will be as under

(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration

Question paper Instructions: Attempt Five Questions in all; Question No.1 is compulsory and attempt four questions from the remaining selecting at least one question from each Unit.

Use of Non-programmable scientific calculator is allowed.

Note: For Labs: Hands-on experiments related to the respective course contents …

<table>
<tr><td>Course code</td><td colspan="4">HSM-101</td></tr>
<tr><td>Category</td><td colspan="4">Humanities and Social Sciences</td></tr>
<tr><td>Course title</td><td colspan="4">Communication Skills in English</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Class work/ Practical</td><td colspan="4">30 Marks</td></tr>
<tr><td>Exam</td><td colspan="4">70 Marks</td></tr>
<tr><td>Total</td><td colspan="4">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="4">03 Hours</td></tr>
<tr><td>Class work/ Practical</td><td colspan="4">30 Marks</td></tr>
</table>

Preamble:

Clear, precise, and effective communication has become a sine qua non in today's information-driven world given its interdependencies and seamless connectivity. Any aspiring professional cannot but master the key elements of such communication. The objective of this course is to equip students with the necessary skills to listen, read, write, and speak so as to comprehend and successfully convey any idea, technical or otherwise, as well as give them the necessary polish to become persuasive communicators.

Prerequisite: None

Objectives of the course:

1. The course will focus on the four integral skills of language, improving the proficiency levels in all ofthem and to learn to use language as a tool for effective communication.
2. This course will widen the understanding of the learners in all genres of literature (short stories, poetry, autobiographies.) with the help of expository pieces.
3. The course will strive to equip the learner with the ability to express oneself and be understood by others with clarity and precision, in both written and spoken forms.
4. This course will encourage creative use of language through translation, paraphrasing and paragraph writing.
5. Along with the above, the course will also build confidence and encourage the students to use a standard spoken form of English in order to prepare them to face job interviews, workplace and in higher studies.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Develop vocabulary and language skills relevant to engineering as a profession
CO 2	Analyze, interpret and effectively summarize a variety of textual content
CO 3	Create effective technical presentations
CO 4	Discuss a given technical/non-technical topic in a group setting and arrive at generalizations/consensus
CO 5	Identify drawbacks in listening patterns and apply listening techniques for specific needs
CO 6	Create professional and technical documents that are clear and adhering to all the necessary conventions

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									1	3		2	1	3
2						1			1	3		2	1	1
3						1			2	3		2	1	1
4									2	3		2	1	2
5		1				1			2	3		2	1	2
6	1					1			1	3		2	1	2

Unit: 1

Remedial English : Parts of speech, Gerunds, Participles and infinitives; Clauses; Sentence constructions (unity; avoidance of choppy and rambling sentences, logic and consistency, conciseness, sequencing of ideas); Sentence errors-agreement between verb and subject, pronoun and antecedents, sequence of tenses, problems involving modifiers (dangling and misplaced modifiers); Shifts in point of view consistency of number and person, tense, mood, voice and subject; Parallelism; Omissions and mixed constructions.

Unit: 2

Vocabulary : Methods of building vocabulary-etmological roots, prefixes and suffixes; Commonly used foreign words and phrases; spelling; words often confused synonyms and homonyms; one word substitutes; verbal idioms.

Unit: 3

Punctuation and Mechanics: End Punctuation; internal Punctuation; Word Punctuation. Comprehension: Abstracting; Summarizing; Observation, Findings and Conclusions; Illustration and Inductive Logic; Deduction and Analogy.

Unit: 4

Presentation: Oral presentation- Extempore, discussion on topics of contemporary relevance, Interviews. Written Comprehension: The ability to write after listening to and reading select speeches, news bulletins, presentations and answering questions based on what has been heard. Reading the given texts to skim, scan,infer and answer comprehension questions. Reading texts like case studies and project reports for critical assessment and book Review.

Suggested Books:

1. Nitin Bhatnagar and Mamta Bhatnagar, Communicative English for Engineers and Professionals. Pearson Education.
2. Bhatnagar, k. Manmohan. Ed. The Spectrum of Life: An Anthology of Modern Prose. Delhi: Macmillan India Ltd., 2006.

3. C. Murlikrishna & Sunita Mishra, Communication Skills for Engineers, Pearson Ed.
4. Sinha, R.P.Current English Grammar and Usage.
5. Rizvi, M. Ashraf. Effective Technical Communication. McGraw Hill Education (India) Pvt. Ltd., 2014.
6. Kumar, Sanjay and Pushp Lata. Communication Skills. OUP, 2011.
7. Raman, Meenakshi and Sangeeta Sharma. Communication Skills. New Delhi: OUP,2011. 9.Hill, L.A.A Guide to Correct English.London:OUP,1965.

Course code	BSC-102			
Category	Basic Science Course			
Course title	Mathematics-I			
Scheme and Credits	L	T	P	Credits
	3	1	0	4
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This course introduces the concepts and applications of differentiation and integration of vector valued functions, differential equations, Laplace and Fourier Transforms. The objective of this course is to familiarize the prospective engineers with some advanced concepts and methods in Mathematics which include the Calculus of vector valued functions, ordinary differential equations and basic transforms such as Laplace and Fourier Transforms which are invaluable for any engineer's mathematical tool box. The topics treated in this course have applications in all branches of engineering.

Prerequisite: Basic Mathematics, Calculus of single and multi variable functions.

Objectives of the course

1. To develop logical understanding of the subject
2. To develop mathematical skill so that students are able to apply mathematical methods & principals insolving problem from Engineering fields.
3. To make aware students about the importance and symbiosis between Mathematics and Engineering.

Course Outcomes:

After the completion of the course the student will be able to

CO 1 Demonstrate proficiency in manipulating matrices using elementary matrices and transformations, and use these techniques to find matrix inverses and ranks

CO 2 Compute eigenvalues and eigenvectors of matrices and apply the Cayley-Hamilton Theorem to verify matrix properties.

CO 3 Analyze sequences and series for convergence using various tests

CO 4 Apply fundamental concepts of differential calculus to analyze functions, including limits, continuity, differentiability, and successive differentiation

CO 5 Solve integration problems involving definite integrals, double integrals, and triple integrals.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	3	2	1			1	1		2	1	1
2	3	3	3	3	2	1			1	1		2	1	1
3	3	3	3	3	2	1			1	1		2	1	1
4	3	3	3	3	2	1			1	1		2	1	1
5	3	3	3	3	2	1			1	1		2	1	1

Unit-I

Matrices & Its Application: Elementary Matrices, Elementary Transformations, Inverse using elementary transformations, Rank of a matrix, Normal form of a matrix, Linear dependence and independence of vectors, Consistency of linear system of equations, Linear and Orthogonal Transformations, Eigenvalues and Eigenvectors, Properties of eigenvalues, Cayley-Hamilton Theorem, Diagonalization of Matrices.

Unit-II

Sequences and Series: Convergence of sequence and series, Tests for convergence, Power series: Taylor's series, series for exponential, trigonometric and logarithm functions, Fourier series: Half range sine and cosine series, Parseval's theorem.

Unit-III

Differential Calculus: Limit, Continuity and Differentiability of function of single variable, Successive Differentiation, Leibnitz Theorem, Taylor's and Maclaurin's Series for Single Variable function, Partial derivatives, Homogeneous functions, Euler's Theorem, Jacobian, Maxima-Minima of function of two variables, Lagrange's Method of undetermined multipliers.

Unit-IV

Integral Calculus: Basic concepts of integration and properties of definite integrals, Applications of single integration to find volume of solids and surface area of solids of revolution, Double integral, Change of order of integration, Double integral in Polar Co-ordinates, Applications of double integral to find area enclosed by plane curves, Triple integral, Beta and Gamma functions.

Suggested Books:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, Pearson Education.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. D. Poole, Linear Algebra: A Modern Introduction, Brooks Cole.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
7. V. Krishnamurthy, V.P. Mainra and J. L. Arora, An introduction to Linear Algebra, Affiliated East–WestPress Private limited

8.

Course code	BSC-103			
Category	Basic Science Course			
Course title	Physics			
Scheme and Credits	L	T	P	Credits
	3	1	0	4
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

The aim of the Engineering Physics Program is to offer students a solid background in the fundamentals of Physics and to impart that knowledge in engineering disciplines. The program is designed to develop scientific attitudes and enable the students to correlate the concepts of Physics with the core programmes

Prerequisite: Higher secondary level Physics, Mathematical course on vector calculus, differential equations and linear algebra

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Solve electrostatic problems, applying boundary conditions, and understanding the physical significance of electrostatic principles in real-world scenarios.

CO 2: Apply concepts of electric displacement and boundary conditions on displacement in dielectric materials.

CO 3: Analyze magnetic fields produced by simple current configurations and understand the implications of magnetostatic principles.

CO 4: Analyze magnetic fields in the presence of magnetic materials, including understanding the effects of magnetization and susceptibility on magnetic fields.

CO 5: Apply concepts of electromagnetic induction and energy storage.

CO6: Apply the free electron theory to metals and understand the Fermi level, density of states, and energy band structures using Bloch's theorem and the Kronig-Penney model

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	3	2	1			1	1		2	1	1
2	3	3	3	3	2	1			1	1		2	1	1
3	3	3	3	3	2	1			1	1		2	1	1
4	3	3	3	3	2	1			1	1		2	1	1
5	3	3	3	3	2	1			1	1		2	1	1
6	3	3	3	3	2	1			1	1		2	1	1

Unit I

Electrostatics in vacuum

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Faraday's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Electrostatics in a linear dielectric medium

Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Unit II

Magnetostatics

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Magnetostatics in a linear magnetic medium

Magnetization and associated bound currents; auxiliary magnetic field H; Boundary conditions on B and H. Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Unit III

Faraday's law

Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations

Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time dependent electric field; calculating magnetic field due to changing electric fields in quasistatic approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Pointing vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Unit IV

Introduction to Solids and Semiconductors

Free electron theory of metals, Fermi level, density of statesin1, 2 and 3 dimensions, Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands. Types of electronic materials: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p -n junction**.**

Suggested Books:

1. AICTE's Prescribed Textbook: Physics (Introduction to Electromagnetic Theory) Khanna Book Publishing Company.
2. David Griffiths, Introduction to Electrodynamics
3. Halliday and Resnick, Physics
4. W. Saslow, Electricity, magnetism and lightD. A. Neamen, "Semiconductor Physics and Devices", Times Mirror High Education Group, Chicago
5. E.S. Yang, "Microelectronic Devices", McGraw Hill, Singapore

Course code	ESC-101			
Category	Engineering Science Course			
Course title	Electronics Engineering – I			
Scheme and Credits	L	T	P	Credits
	3	0	0	3
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This course provides a comprehensive exploration of conducting materials and semiconductor devices, essential for understanding modern electronic systems. The syllabus covers key concepts in electrical engineering and materials science, offering students insights into the behavior and applications of various conducting materials and semiconductor technologies.

Prerequisite: Higher secondary level Physics

Objectives of the course:

The students will:

1. Equip students with a comprehensive understanding of the fundamental principles governing conducting materials and semiconductor devices;
2. Enable students to design, analyze, and implement various electronic circuits utilizing semiconductor components;
3. Cultivate students' analytical skills by encouraging them to evaluate and solve complex problems related to semiconductor technology.

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Describe and explain the fundamental properties of conducting materials and semiconductor devices, including concepts such as drift velocity, mobility, and the P-N junction characteristics.

CO 2: Apply their understanding of semiconductor behavior to design and analyze basic electronic circuits, including rectifiers, clipping, and clamping circuits, demonstrating the practical implications of theoretical concepts.

CO 3: Analyze the operation of bipolar junction transistors and field-effect devices, interpreting their voltage and current characteristics to evaluate their performance in various applications.

CO 4: Evaluate innovative circuit configurations using specialized devices (such as Zener diodes and MOSFETs), assessing their effectiveness for specific applications in electronics and communication systems.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	2	2	1			1	1		2	1	1
2	3	3	3	2	2	1			1	1		2	1	1
3	3	3	3	2	2	1			1	1		2	1	1
4	3	3	3	2	2	1			1	1		2	1	1

Unit-I

Conducting materials: Review of energy bands, description of materials, drift velocity, collision time, Mean, free path, mobility, conductivity, relaxation time, factors affecting conductivity of materials, types of thermal conductivity, Wiedmann-Franz law, super conductivity, effect of magnetic field, conducting materials, applications.

Semiconductor characteristics: Review of Si and Ge as semiconducting materials, Continuity Equation, P-N junction, Drift & Diffusion, Diffusion & Transition capacitances of P-N junction. Introduction to p-n junction diode and its applications

Unit-II

P-N junction diode and its applications: Introduction to p-n junction diode and its applications. Half wave & full wave rectifiers. clipping circuits, clamping circuits, filter circuits, peak to peak detector and voltage, multiplier circuits.

Some Special Devices: Zener diode, Photodiodes, photo detectors, solar cell, light emitting diodes, semiconductor lasers, and light emitting materials.

Unit-III

Bipolar junction transistors: Fundamentals of BJT, BJT biasing :base bias, emitter feedback bias, collector feedback bias, voltage divider bias and its operation , BJT voltages and currents characteristics: CE, CB and CC, and DC & AC load line and bias point. Thermal stability, BJT as a switching circuits, transistor power dissipation. Construction and working of SCR (semiconductor controlled rectifier), DIAC, TRIAC, IGBT,

Unit-IV

Field Effect Devices: JFET: basic Operation and characteristics, drain and transfer characteristics, pinch off voltage, parameters of JFET: Transconductance, ac drain resistance, amplification factor ,Small Signal Model & Frequency Limitations. MOSFET: basic operation, depletion and enhancement type, pinch-off voltage, Shockley equation and Small Signal Model of MOSFET, MOS capacitor. UJT: Introduction and its applications.

Brief introduction to Planar Technology for device fabrication.

Suggested Books:

1. Boylestad and Nashelsky, "Electronic Devices and Circuit Theory" Pearson publishers, 10thEdition
2. Tyagi M.S., "Introduction to Semiconductor Materials and Devices", John Wiley & Sons, 1993.
3. Spencer and Ghausi, Introduction to Electronic Circuit Design, Pearson Education, 2003
4. Dutta, Semiconductor Devices and Circuits, Oxford University Press, ND 2008

Course code	HSM-102			
Category	Humanities and Social Sciences			
Course title	Basics of Environmental Science			
Scheme and Credits	L	T	P	Credits
	2	0	0	2
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble: The syllabus is designed to equip engineering graduates with the knowledge and awareness needed for environmental protection. It aims to ensure that they can make meaningful contributions to environmental sustainability through their engineering practices and decision-making in real-world scenarios.

Prerequisite: NIL

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Explain the scope and importance of environmental studies in relation to natural resources and their impact on ecosystems.

CO 2: Analyze the impact of human activities on different ecosystems and suggest measures to mitigate adverse effects.

CO 3: Assess the effectiveness of current disaster management strategies and propose improvements based on case studies or recent events.

CO 4: Recall key environmental legislation and ethical issues, such as the Environment Protection Act and climate change.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1					2				2	1		2		
2					2				2	1		2		
3					2				2	1		2		
4					2				2	1		2		

Unit I

Environmental studies and Natural Resources: Definition, scope and importance of environmental studies.

Natural Resources: Renewable and non-renewable resources, and associated problems

Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and theireffects on forests and tribal people.

Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water,dam's benefits and problems.
Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources.
Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers-pesticides problems, water logging, salinity.

Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternateenergy sources.

Unit II

Eco Systems: Concept of an eco-system, Structure and function of an eco-system, Producers, consumers, decomposers, Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems:
Forest ecosystem
Grass land ecosystem
Desert ecosystem
Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit III

Environmental Pollution: Definition, Causes, effects and control measures of - Air pollution, Soilpollution, Marine pollution, Noise pollution, Nuclear hazards
Disaster management: Floods, earth quake, cyclone and landslides.

Unit IV

Social issues and the Environment: From unsustainable to sustainable development, Urban problems relatedto energy, Water conservation, rain water harvesting, watershed management.
Environmental ethics: issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection Act, Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection Act, Forest conservation Act, Issues involved in enforcement of environmental legislations.

Recommended Books:

1. Textbook of Environmental studies, Erach Bharucha, UGC.
2. Fundamental concepts in Environmental Studies, D. D. Mishra, S Chand & Co Ltd.

Course code	HSM-101P			
Category	Humanities and Social Sciences			
Course title	Communication Skills in English (P)			
Scheme and Credits	L	T	P	Credits
	0	0	2	1
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			
Class work/ Practical	30 Marks			

Preamble:

Clear, precise, and effective communication has become a sine qua non in today's information-driven world given its interdependencies and seamless connectivity. Any aspiring professional cannot but master the key elements of such communication. The objective of this course is to equip students with the necessary skills to listen, read, write, and speak so as to comprehend and successfully convey any idea, technical or otherwise, as well as give them the necessary polish to become persuasive communicators.

Prerequisite: None

Course Outcomes:

After the completion of the course the student will be able to

CO 1 Develop vocabulary and language skills relevant to engineering as a profession

CO 2 Analyze, interpret and effectively summarize a variety of textual content

CO 3 Create effective technical presentations

CO 4 Discuss a given technical/non-technical topic in a group setting and arrive at generalizations/consensus

CO 5 Identify drawbacks in listening patterns and apply listening techniques for specific needs

CO 6 Create professional and technical documents that are clear and adhering to all the necessary conventions

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									1	3		2	1	3
2						1			1	3		2	1	1
3						1			2	3		2	1	1
4									2	3		2	1	2
5		1				1			2	3		2	1	2
6	1					1			1	3		2	1	2

Lab Activity:

The students will acquire basic proficiency in English with special emphasis on listening,comprehension and speaking skills both at social and professional platforms.

1. Listening comprehension
2. Recognition of phonemes in International Phonetic Alphabet
3. Self introduction and introduction of another person
4. Conversation and dialogues in common everyday situations
5. Communication at work place (Standard phrases and sentences in various situations)
6. Telephonic communication
7. Speeches for special occasions (Welcome speeches, Introduction speeches, Felicitation speechesand Farewell speeches)
8. Tag Questions
9. Formal Presentations on literary texts prescribed in theory paper, Question Formation & Mock Press Conference

.

Suggested Books:

1. Nitin Bhatnagar and Mamta Bhatnagar, Communicative English for Engineers and Professionals. Pearson Education.
2. Bhatnagar, k. Manmohan. Ed. The Spectrum of Life: An Anthology of Modern Prose. Delhi: Macmillan India Ltd., 2006.
3. C. Murlikrishna & Sunita Mishra, Communication Skills for Engineers, Pearson Ed.
4. Sinha, R.P.Current English Grammar and Usage.
5. Rizvi, M. Ashraf. Effective Technical Communication. McGraw Hill Education (India) Pvt. Ltd., 2014.
6. Kumar, Sanjay and Pushp Lata. Communication Skills. OUP, 2011.
7. Raman, Meenakshi and Sangeeta Sharma. Communication Skills. New Delhi: OUP,2011. 9.Hill, L.A.A Guide to Correct English.London:OUP,1965.

Course code	BSC-103 P			
Category	Basic Science Course			
Course title	Physics (P)			
Scheme and Credits	L	T	P	Credits
	0	0	2	1
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

The aim of the Engineering Physics Program is to offer students a solid background in the fundamentals of Physics and to impart that knowledge in engineering disciplines. The program is designed to develop scientific attitudes and enable the students to correlate the concepts of Physics with the core programmes

Prerequisite: Higher secondary level Physics, Mathematical course on vector calculus, differential equations and linear algebra

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Evaluate the resonance phenomena in LCR circuits and interpret how varying component values affect resonance conditions and circuit performance.

CO 2: Describe the Hall effect in semiconductors, including how it relates to the Hall coefficient and the behavior of materials in a magnetic field.

CO 3: Analyze the characteristics of solar cells, including their fill factor, and interpret the results of Planck's constant measurements to validate theoretical predictions.

CO 4: Evaluate experimental data to understand the temperature coefficient of platinum, assess the accuracy of resistance measurements, and interpret the forward and reverse behavior of P-N junction diodes.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	3	2	1			1	1		2	1	1
2	3	3	3	3	2	1			1	1		2	1	1
3	3	3	3	3	2	1			1	1		2	1	1
4	3	3	3	3	2	1			1	1		2	1	1

Note: At least 8 experiments are to be performed by the students.

List of Subject related Experiments:

1. Study of LC circuit and LCR circuit;
2. Study of Resonance phenomena in LCR circuits
3. To study Hall effect in semiconductors and measure the Hall coefficient.
4. Measurement of high resistance by the method of leakage of condenser.
5. To study the magnetic properties of materials using B-H curve.
6. To study the Curies temperature of materials using Dielectric set up.
7. To verify the inverse square law with the help of a photovoltaic cell.
8. To determine Planks constant using photocell.
9. To study the characteristics of Solar cell and find out the fill factor.
10. To find temperature co-efficient of platinum using Callender Griffith bridge.
11. To study the forward and reverse characteristics of P-N junction diode.

Experiments that may be Performed Through Virtual Labs:

S.No.	List of Experiment	Link
1	LC circuit and LCR circuit	https://vlab.amrita.edu/?sub=1&brch=75&sim=326&cnt=1 https://vlab.amrita.edu/?sub=1&brch=75&sim=330&cnt=1 https://vlab.amrita.edu/?sub=1&brch=75&sim=318&cnt=1 https://vlab.amrita.edu/?sub=1&brch=75&sim=325&cnt=1
2	Resonance phenomena in LCR circuits	https://vlab.amrita.edu/?sub=1&brch=75&sim=325&cnt=1
3	To study Hall effect in semiconductors and measure the Hall coefficient	https://mpv-au.vlabs.ac.in/modern-physics/Hall_Effect_Experiment/
4	Measurement of high resistance by the method of leakage of condenser	https://bop-iitk.vlabs.ac.in/exp/condenser-leakage-method/
5	determine Planks constant	https://mpv-au.vlabs.ac.in/modern-physics/Determination_of_Plancks_Constant/
6	VI Characteristics of a Diode	https://be-iitkgp.vlabs.ac.in/exp/characteristics-diode/

Course code	ESC-102 P			
Category	Engineering Science Course			
Course title	Electronics Engineering- I (P)			
Scheme and Credits	L	T	P	Credits
	0	0	2	1
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This course provides a comprehensive exploration of conducting materials and semiconductor devices, essential for understanding modern electronic systems. The syllabus covers key concepts in electrical engineering and materials science, offering students insights into the behavior and applications of various conducting materials and semiconductor technologies..

Prerequisite: Physics

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Identify and describe the functionality and application of essential lab equipment and components, including CRO, multimeter, function generator, and power supply.

CO 2: Perform experiments to determine the V-I characteristics of silicon and germanium diodes, applying theoretical concepts to practical scenarios.

CO 3: Analyze the V-I characteristics of Zener diodes, demonstrating their operation as voltage regulators and evaluating their performance in circuit applications.

CO 4: Compare and contrast the efficiency of half-wave and full-wave rectifiers, including those with filters, assessing their impact on output quality and ripple voltage.

CO 5: Design and implement biasing circuits for bipolar junction transistors (BJTs) and field-effect transistors (FETs), demonstrating an understanding of their characteristics and operational principles..

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	2	1			1	1		2	1	1
2	2	3	2	2	2	1			1	1		2	1	1
3	2	3	2	2	2	1			1	1		2	1	1
4	2	3	2	2	2	1			1	1		2	1	1
5	2	3	2	2	2	1			1	1		2	1	1

Note: At least 8 experiments are to be performed by the students.List of Subject related Experiments:

Note: At least 8 experiments are to be performed by the students.

1. Study of lab equipments and components: CRO, Multimeter, Function Generator, Power supply- Active, Passive Components & Bread Board.
2. Study of V-I Characteristics of Si and Ge Diodes
3. Study of Zener Diode Characteristics and Zener Diode as Voltage Regulator
4. Study of Half Wave and Full Wave Rectifiers
5. Study of Rectifiers with Filters
6. Study of BJT Characteristics
7. Study of FET Characteristics
8. Study of BJT Biasing
9. To plot V-I Characteristics of DIAC.
10. To draw V-I characteristics of TRIAC for different values of Gate Currents.
11. Study of Characteristic of silicon-controlled rectifier.

Experiments that may be Performed Through Virtual Labs:

S.No.	List of Experiment	Link
1	CRO, Multimeter, Function Generator, Power supply-Active, Passive Components & Bread Board	https://ae-iitr.vlabs.ac.in/exp/function-generator/ https://eil-iitg.vlabs.ac.in/Understanding_The_%20Basic_Functions_Of_An%20Oscilloscope.html
2	V-I Characteristics of Si and Ge Diodes	http://vlabs.iitkgp.ac.in/be/exp5/index.html
3	Zener Diode Characteristics and Zener Diode as Voltage Regulator	https://be-iitkgp.vlabs.ac.in/exp/voltage-regulator/index.html
4	Half Wave and Full Wave Rectifiers	https://be-iitkgp.vlabs.ac.in/exp/half-wave-rectification/ https://be-iitkgp.vlabs.ac.in/exp/full-wave-rectification/
5	Rectifiers with Filters	http://vlabs.iitkgp.ac.in/be/exp8/index.html
6	BJT Characteristics	http://vlabs.iitkgp.ac.in/be/exp11/index.html
7	FET Characteristics	http://vlabs.iitkgp.ac.in/tcad/fet/index.html

Course code	MEE-102 P			
Category	Engineering Science Course			
Course title	Workshop Practices (P)			
Scheme and Credits	L	T	P	Credits
	1	0	3	3
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble: The workshop practice module is designed to offer students practical, hands-on experience across fundamental engineering disciplines, including Civil, Mechanical, Electrical, and Electronics Engineering. This module aims to equip students with essential skills and knowledge through direct engagement with basic engineering practices across various domains. Facilitate practical exercises in plumbing and carpentry to enhance understanding of these critical components in engineering projects. Enable students to perform gas welding, foundry operations, and fitting, fostering proficiency in key mechanical engineering techniques. Offer experience in measuring electrical quantities, energy, and resistance to earth, crucial for understanding electrical systems and safety.

Prerequisite: NIL

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Demonstrate the ability to apply basic engineering skills in practical scenarios, including handling common tools and materials

CO 2: Perform basic plumbing and carpentry exercises to gain hands-on experience and practical skills.

CO 3: Execute gas welding, foundry operations, and fitting tasks with proficiency, adhering to safety and operational standards

CO 4: Analyze measurement data to identify any discrepancies or issues, and interpret results in the context of electrical system operation.

CO 5: Perform soldering tasks to assemble and repair electronic components, demonstrating precision and technique.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	2					1		2	1	1
2	2	3	2	2	2					1		2	1	1
3	2	3	2	2	2					1		2	1	1
4	2	3	2	2	2					1		2	1	1
5	2	3	2	2	2					1		2	1	1

Course Content:

Module I: Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.

Module II: CNC machining, Additive manufacturing.

Module III: Fitting operations & power tools.

Module IV: Electrical & Electronics.

Module V: Carpentry.

Module VI: Plastic moulding, glass cutting.

Module VII: Metal casting.

Module VIII: Welding (arc welding & gas welding), brazing.

Practicals:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Suggested Text/Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017

Experiments that may be Performed Through Virtual Labs:

S.No	List of Experiment	Link
1	Welding shop (Arc welding + Gas welding).	http://mmcoep.vlabs.ac.in/LaserSpotWelding/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20Micromachining%20laboratory
2	Casting	http://fabcoep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20FAB%20laboratory

2nd Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	BSC-104	Mathematics-II	3	1	0	4	30	70	100
2	ESC-103	Basic of Electrical Engineering	3	0	0	3	30	70	100
3	BSC-105	Chemistry	3	0	0	3	30	70	100
4	ESE-102	Programming for problem solving using C	3	0	0	3	30	70	100
5	HSM-103	Design Thinking	1	0	2	2	30	70	100
6	ESC-102P	Programming for problem solving using C(P)	0	0	2	1	50	50	100
7	ESC-103P	Basic of Electrical Engineering - I (P)	0	0	2	1	50	50	100
8	ESC-104	IDEA Lab Workshop	0	0	2	1	50	50	100
9	HSM-103	Human Value & Soft Skills	2	0	2	3	50	50	100
Total Credits						21			900

L: Lecture , T: Tutorial , P: Practical/Laboratory

Sports: Non-credit mandatory course, students have to attain pass marks (40%)

Note: Exams duration will be as under

(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration

Question paper Instructions: Attempt Five Questions in all; Question No.1 is compulsory and attempt four questions from the remaining selecting at least one question from each Unit.

Use of Non-programmable scientific calculator is allowed.

Note: For Labs: Hands-on experiments related to the respective course contents …

Course code	BSC-104			
Category	Basic Science Course			
Course title	Mathematics-II			
Scheme and Credits	L	T	P	Credits
	3	1	0	4
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This curriculum outlines a comprehensive study of mathematical concepts essential for students pursuing a degree in Electronics Engineering, particularly in the specialized field of VLSI Design and Technology. The course is designed to enhance analytical and problem-solving skills through a structured approach to mathematical theories and applications.

Prerequisite: Basic Mathematics, Calculus of single and multi variable functions.

Objectives of the course:

The students will learn:

1. The essential tool of matrices and linear algebra in a comprehensive manner;
2. The effective mathematical tools for the solutions of differential equations that model physical Processes;
3. The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems;
4. Mathematics fundamental necessary to formulate, solve and analyze engineering problems.

Course Outcomes:

After the completion of the course the student will be able to

CO 1 Identify and explain key concepts in linear algebra, including linear systems of equations, the properties of matrices, and determinants;

CO 2 Analyze various types of ordinary differential equations, including first-order and higher-order equations, and evaluate the suitability of different solution methods, such as the variation of parameters and power series methods.

CO 3 Apply complex variable theory to differentiate analytic and harmonic functions, utilizing the Cauchy-Riemann equations to find harmonic conjugates and exploring the properties of elementary analytic functions

CO 4 Construct and evaluate contour integrals using the Cauchy-Goursat theorem and apply the Cauchy Residue theorem to determine the values of definite integrals involving complex functions, thereby showcasing their ability to synthesize complex variable techniques.

CO 5 Demonstrate an understanding of the relationships between eigenvalues, eigenvectors, and matrix diagonalization.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	3	2	1			1	1		2	1	1
2	3	3	3	3	2	1			1	1		2	1	1
3	3	3	3	3	2	1			1	1		2	1	1
4	3	3	3	3	2	1			1	1		2	1	1
5	3	3	3	3	2	1			1	1		2	1	1

Unit-I

Matrices: Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices;

Determinants: Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

Unit-II

First order ordinary differential equations: Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.

Unit-III

Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Unit-IV

Complex Variable – Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Suggested Books:

1. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
5. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
6. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
7. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.

8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course code	ESC-103			
Category	Engineering Science Course			
Course title	Programming for Problem Solving Using C			
Scheme and Credits	L	T	P	Credits
	3	0	0	3
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble: The syllabus is prepared with the view of preparing the Engineering Graduates capable of writing readable C programs to solve computational problems that they may have to solve in their professional life. The course content is decided to cover the essential programming fundamentals which can be taught within the given slots in the curriculum. This course has got 2 Hours per week for practicing programming in C. A list showing 24 mandatory programming problems are given at the end. The instructor is supposed to give homework/assignments to write the listed programs in the rough record as and when the required theory part is covered in the class. The students are expected to come prepared with the required program written in the rough record for the lab classes.

Prerequisite: NIL
Course Outcomes:

After the completion of the course the student will be able to

CO 1: Design a simple computer system configuration based on specific requirements and justifies your choices.

CO 2: Examine a given program development process and identify any gaps or inefficiencies in the approach.

CO 3: Write simple C programs that utilize fundamental syntax and constructs, demonstrating correct usage.

CO 4: Implement structured programming techniques to solve basic programming problems, demonstrating the use of functions and control structures..

CO 5: Design and develop efficient algorithms for complex problems, documenting and validating their performance and correctness.

CO6: Develop test cases and scripts to systematically analyze and validate program output for a range of input scenarios.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	2					1		2	1	1
2	2	3	2	2	2					1		2	1	1
3	2	3	2	2	2					1		2	1	1
4	2	3	2	2	2					1		2	1	1
5	2	3	2	2	2					1		2	1	1
6	2	3	2	2	2					1		2	1	1

Unit I

Introduction to Programming; Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples, From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Arithmetic expressions and precedence.

Unit II

Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

Arrays, Arrays (1-D, 2-D), Character arrays and Strings

Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit III

Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Structures, Defining structures and Array of Structures

Unit IV

Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

File handling.

Suggested Books:

1. Programming for Problem Solving, Khanna Book Publishing Co.

2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.

4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor Host Institute
1	Introduction to Programming in C	Dr. Satyadev Nanda Kumar, IIT Kanpur
2	Problem Solving through Programming in C	Dr. Anupam Basu, IIT Kgp

Course code	ESC-103				
Category	Basic Science Course				
Course title	Basics of Electrical Engineering				
Scheme and Credits	L	T	P	Credits	
	3	0	0	3	
Class work/ Practical	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Preamble:

The aim of the Basics of Electrical Engineering Program is to equip the students with an understanding of the fundamental principles of electrical engineering, and provide an overview of evolution of electronics, and introduce the working principle and examples of fundamental electronic devices and circuits.

Prerequisite: Physics and Mathematics (Pre-university level)

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Apply Ohm's Law and Kirchhoff's Laws to analyze and solve series, parallel, and series-parallel DC circuits.

CO 2: Evaluate and analyze single-phase AC circuits by calculating average, RMS, form factor, and peak factor values.

CO 3: Explain the necessity and advantages of three-phase power systems, including generation, phase sequence, balanced supply, and balanced load.

CO 4: Proficiency in understanding transformer operations and characteristics, as well as synchronous generator principles.

CO 5: Analyze and interpret the operation, types, and characteristics of DC machines, including practical considerations for motor starters.

CO6: Understanding three-phase induction motors, and knowledge of different electrical power sources and generation concepts

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	2	1			1	1		2	1	1
2	2	3	2	2	2	1			1	1		2	1	1
3	2	3	2	2	2	1			1	1		2	1	1
4	2	3	2	2	2	1			1	1		2	1	1
5	2	3	2	2	2	1			1	1		2	1	1
6	2	3	2	2	2	1			1	1		2	1	1

Unit I

D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

Single Phase A.C. Circuits covering, Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

Unit II

Transformers covering, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation;

DC Machines covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

Unit III

Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Unit IV

Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geothermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation;

Suggested Books:

1. Ritu Sahdev (2022), Basic Electrical Engineering, Khanna Book Publishing.
2. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.
3. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
4. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
5. E. Huges, "Electrical Technology", ELBS.
6. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.

Course code	BSC-105			
Category	Basic Science Course			
Course title	Chemistry			
Scheme and Credits	L	T	P	Credits
	3	0	0	3
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This curriculum outlines a comprehensive study to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.

Prerequisite: Basic Chemistry.

Objectives of the course:

The students will:

1. Understand Quantum Mechanics and Molecular Theory;
2. Apply Spectroscopic Techniques;
3. Analyze Intermolecular Forces and Thermodynamic Concepts;
4. Explore Stereochemistry;

Course Outcomes:

After the completion of the course the student will be able to

CO 1 Describes and apply the Schrödinger equation and its solutions, including particle in a box models, to analyze the electronic structure of conjugated molecules and nanoparticles;

CO 2 Analyze spectroscopic data and evaluate the principles behind various spectroscopic techniques, including electronic spectroscopy, fluorescence, and NMR;

CO 3 Evaluate the impact of intermolecular forces on the physical properties of substances and assess the implications of potential energy surfaces for chemical reactions;

CO 4 Synthesizes knowledge from thermodynamic functions to predict and manipulate chemical equilibrium using free energy concepts.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	2	2	1			1	1		2	1	1
2	3	3	3	2	2	1			1	1		2	1	1
3	3	3	3	2	2	1			1	1		2	1	1
4	3	3	3	2	2	1			1	1		2	1	1

Unit-I

Atomic and Molecular Structure: Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Unit-II

Spectroscopic techniques and applications: Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering**.**

Unit-III

Intermolecular forces and potential energy surfaces: Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams**.**

Unit-IV

Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

Stereochemistry: Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

Suggested Books:

1. Chemistry – I with Lab Manual, Khanna Book Publishing.
2. Engineering Chemistry, by Manisha Agrawal.
3. University chemistry, by B. H. Mahan
4. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
5. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

Course code	ESC-104			
Category	Basic Science Course			
Course title	Design Thinking			
Scheme and Credits	L	T	P	Credits
	3	1	0	4
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This course aims to empower students with creative thinking skills and a thorough understanding of the innovation cycle through the Design Thinking process. By exploring new approaches to problem-solving, students will learn how to develop innovative products that meet real-world needs. Through practical exercises and projects, participants will engage with the principles of Design Thinking, enabling them to translate their creativity into actionable solutions in their future professional endeavors..

Prerequisite: Basic understanding of engineering principles and concepts.

Objectives of the course:

The students will:

1. Develop and apply creative thinking techniques that enable them to identify and address complex engineering challenges;
2. Understanding of the Design Thinking innovation cycle, including stages such as empathize, define, ideate, prototype, and test;
3. Translate their ideas into tangible solutions by engaging in hands-on projects that require the application of the Design Thinking process to create innovative products.

Course Outcomes:

After the completion of the course the student will be able to

CO 1 Compare and classify the various learning styles and memory techniques and Apply them in their engineering education;

CO 2 Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products;.

CO 3 Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products

CO 4 Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, techniques during prototype development.

CO 5 Perceive individual differences and its impact on everyday decisions and further create a better

customer experience.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1				3	2	1		3	1	1		2		1
2				3	2	1		3	1	1		2		1
3				3	2	1		3	1	1		2		1
4				3	2	1		3	1	1		2		1
5				3	2	1		3	1	1		2		1

Unit-I

An Insight to Learning: Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting

Remembering Memory: Understanding the Memory process, Problems in retention, Memory enhancement techniques

Emotions: Experience & Expression: Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers

Unit-II

Basics of Design Thinking: Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test

Being Ingenious & Fixing Problem: Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving

Process of Product Design: Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design

Unit-III

Prototyping & Testing: What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

Celebrating the Difference: Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences

Unit-IV

Design Thinking & Customer Centricity: Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product

Feedback, Re-Design & Re-Create: Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".

Suggested Books:

1. Developing Thinking Skills (The way to Success), By, E Balaguruswamy (2022), Khanna Book Publishing Company.
2. Design Thinking: Understanding How Designers Think and Work" by Nigel Cross
3. Change by Design: How Design Thinking Creates New Alternatives for Business and Society by Tim Brown
4. The Design of Everyday Things by Don Norman
5. Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days by Jake Knapp
6. Design Thinking for Strategic Innovation: How to Create New Growth Through Design, Lead Change, and Ignite New Ideas by Idris Mootee
7. Design Thinking: Integrating Innovation, Customer Experience, and Brand Value by Thomas Lockwood

Course code	ESC-103 P			
Category	Engineering Science Course			
Course title	Basics of Electrical Engineering			
Scheme and Credits	L	T	P	Credits
	0	0	2	1
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

The aim of the Basics of Electrical Engineering Program is to equip the students with an understanding of the fundamental principles of electrical engineering, and provide an overview of evolution of electronics, and introduce the working principle and examples of fundamental electronic devices and circuits.

Prerequisite: Physics and Mathematics (Pre-university level)

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Apply Ohm's Law and Kirchhoff's Laws to analyze and solve series, parallel, and series-parallel DC circuits.

CO 2: Evaluate and analyze single-phase AC circuits by calculating average, RMS, form factor, and peak factor values.

CO 3: Explain the necessity and advantages of three-phase power systems, including generation, phase sequence, balanced supply, and balanced load.

CO 4: Proficiency in understanding transformer operations and characteristics, as well as synchronous generator principles.

CO 5: Analyze and interpret the operation, types, and characteristics of DC machines, including practical considerations for motor starters.

CO6: Understanding three-phase induction motors, and knowledge of different electrical power sources and generation concepts

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	2	1			1	1		2	1	1
2	2	3	2	2	2	1			1	1		2	1	1
3	2	3	2	2	2	1			1	1		2	1	1
4	2	3	2	2	2	1			1	1		2	1	1
5	2	3	2	2	2	1			1	1		2	1	1
6	2	3	2	2	2	1			1	1		2	1	1

Note: At least 8 experiments are to be performed by the students.List of Subject related Experiments:

1. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. (Resistors, Capacitors and Inductors)
2. Verification of Ohm's Law, Kirchhoff current and voltage laws
3. To verify Thevenin's and Norton theorems.
4. To verify Maximum power transfer and Superposition theorems.
5. To perform direct load test of a transformer and plot efficiency Vs load characteristic.
6. To perform O.C. and S.C. tests of a transformer.
7. Measurement of power in a 3-phase system by two wattmeter method.
8. To verify the resonance in R-L-C circuits.
9. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
10. Torque Speed Characteristic of shunt dc motor.

Experiments that may be Performed Through Virtual Labs:

S.No.	List of Experiment	Link
1	To verify Thevenin's and Norton theorems	https://asnm-iitkgp.vlabs.ac.in/exp/verification-norton-theorem/ https://asnm-iitkgp.vlabs.ac.in/exp/verification-thevenin-theorem/
2	Resonance phenomena in LCR circuits	https://vlab.amrita.edu/?sub=1&brch=75&sim=325&cnt=1 https://asnm-iitkgp.vlabs.ac.in/exp/rlc-circuit-analysis/ https://asnm-iitkgp.vlabs.ac.in/exp/rlc-series-circuit/
3	Torque Speed Characteristic of shunt dc motor	https://ems-iitr.vlabs.ac.in/exp/dcshunt-motor-armature-control/
4	Verification of Ohm's Law, Kirchhoff current and voltage laws	http://vlabs.iitkgp.ernet.in/be/exp4/index.html http://210.212.227.217/eeevlab/index.php?page=t&exp=3
5	Measurement of power in a 3-phase system by two wattmeter method.	https://elms-iitr.vlabs.ac.in/exp/three-phase-power/
6	To verify Maximum power transfer and Superposition theorems	https://asnm-iitkgp.vlabs.ac.in/exp/verification-superposition-theorem/ https://asnm-iitkgp.vlabs.ac.in/exp/maximum-power-transfer-theorem/

Course code	EEE-102 P			
Category	Engineering Science Course			
Course title	Programming for Problem Solving Using C P			
Scheme and Credits	L	T	P	Credits
	0	0	2	1
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble: The syllabus is prepared with the view of preparing the Engineering Graduates capable of writing readable C programs to solve computational problems that they may have to solve in their professional life. The course content is decided to cover the essential programming fundamentals which can be taught within the given slots in the curriculum. This course has got 2 Hours per week for practicing programming in C. A list showing 24 mandatory programming problems are given at the end. The instructor is supposed to give homework/assignments to write the listed programs in the rough record as and when the required theory part is covered in the class. The students are expected to come prepared with the required program written in the rough record for the lab classes.

Prerequisite: NIL
Course Outcomes:

After the completion of the course the student will be able to

CO 1: To formulate simple algorithms for arithmetic and logical problems & translate the algorithms to programs (in C language).

CO 2: Test and execute the programs and correct syntax and logical errors & implement conditional branching, iteration and recursion.

CO 3: Ddecompose a problem into functions and synthesize a complete program using divide and conquer approach

CO 4: Use arrays, pointers and structures to formulate algorithms and programs

CO 5: Apply programming to solve matrix addition and multiplication problems and searching and sorting problems.

CO6: Develop test cases and scripts to systematically analyze and validate program output for a range of input scenarios.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	2					1		2	1	1
2	2	3	2	2	2					1		2	1	1
3	2	3	2	2	2					1		2	1	1
4	2	3	2	2	2					1		2	1	1
5	2	3	2	2	2					1		2	1	1
6	2	3	2	2	2					1		2	1	1

Note: At least 10 experiments are to be performed by the students.

PRACTICALS:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures

Experiments that may be Performed Through Virtual Labs:

S.No	List of Experiment	Link
1	Simple computational problems using arithmetic expressions.	http://psiiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2	Iterative problems e.g., sum of series.	http://psiiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3	1D Array manipulation.	http://cse02-iiith.vlabs.ac.in/exp4/index.html
4	Matrix problems, String operations.	http://psiiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html
6	Programming for solving Numerical methods problems.	http://psiiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7	Recursive functions.	http://psiiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

Course code	GE-104			
Category	Engineering Science Course			
Course title	IDEA Lab Workshop			
Scheme and Credits	L	T	P	Credits
	0	0	2	1
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

The Idea & Innovation Lab, is a dynamic space dedicated to fostering creativity, collaboration, and hands-on learning. Our lab is designed to empower individuals with the essential skills and knowledge required to transform innovative ideas into tangible projects. Through engaging workshops and hands-on experiences, we aim to demystify mechanical and electronic fabrication processes, enabling participants to confidently design and build standalone systems and projects, complete with professional enclosures. Participants will develop the necessary skills to create both print and electronic documentation for their projects, ensuring that their ideas are not only realized but also clearly articulated for future reference and sharing.

Prerequisite: Basic Understanding of Technology & Safety Awareness.

Course Outcomes:

After the completion of the course the student will be able to

CO 1: Apply mechanical and electronic fabrication techniques to design and construct functional prototypes, demonstrating their understanding of the processes involved..

CO 2: Analyze project requirements and constraints, evaluating various design options and selecting appropriate materials and tools for successful project execution.

CO 3: Create comprehensive print and electronic documentation for their projects, including schematics, user manuals, and project reports that clearly communicate their design processes and outcomes.

CO 4: Evaluate the effectiveness and functionality of their final projects through testing and peer feedback, identifying areas for improvement and potential enhancements..

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2		1			1	1		2	1	1
2	2	3	2	2		1			1	1		2	1	1
3	2	3	2	2		1			1	1		2	1	1
4	2	3	2	2		1			1	1		2	1	1

Course Contents:

1. Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD.
2. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub.
3. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.
4. Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output)
5. Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab.
6. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly
7. Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use.
8. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming.
9. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging
10. 3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering.
11. Discussion and implementation of a mini project.
12. Documentation of the mini project (Report and video)

Laboratory Activities:

1. Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2. Machining of 3D geometry on soft material such as soft wood or modelling wax.
3. 3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4. Embedded programming using Arduino and/or Raspberry Pi.
5. Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Course code	HSV-103			
Category	Basic Science Course			
Course title	Human Value & Soft Skills			
Scheme and Credits	L	T	P	Credits
	2	0	2	2
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

Human Values course, a foundational component of your educational journey designed to deepen your understanding of essential ethical principles and humanistic perspectives. Building on the initial exposure you received during the Induction Program through Universal Human Values, this course aims to further explore the importance of human values in personal, professional, and societal contexts. Throughout this semester, you will engage in reflective discussions, case studies, and collaborative activities that highlight the significance of empathy, integrity, respect, and social responsibility. Our goal is to equip you with the insights and tools necessary to navigate complex moral dilemmas and foster a sense of purpose in your life and career.

Prerequisite: Nil.

Objectives of the course:

The students will:

1. Understand the essential complementarity between 'values' and 'skills,' recognizing how they contribute to sustained happiness and prosperity, which are fundamental aspirations of all human beings;
2. Apply a holistic perspective towards life and profession, integrating their understanding of human reality and existence into practical scenarios that enhance both personal and professional growth;
3. Commit to value-based living, reflecting on their behaviors and choices to align them with universal human values, promoting a sense of social responsibility and ethical conduct.

Course Outcomes:

After the completion of the course the student will be able to

CO 1 Articulate the relationship between values and skills, demonstrating how this understanding contributes to their overall happiness and prosperity;

CO 2 Develop a holistic perspective that integrates their understanding of human reality with practical applications in their personal and professional lives;

CO 3 Assess the ethical implications of their actions and decisions, fostering trustful and mutually beneficial interactions in their relationships with others and with nature.

CO 4 Evaluate their own beliefs and behaviors in light of universal human values, fostering a commitment to value-based living that supports ethical decision-making and social responsibility.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1					2	1			1	1		2	1	
2					2	1			1	1		2	1	
3					2	1			1	1		2	1	
4					2	1			1	1		2	1	

Unit-I

Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Sharing about Oneself, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Exploring Human Consciousness, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations, Exploring Natural Acceptance.

Unit-II

Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, Exploring the difference of Needs of Self and Body, Body as an Instrument of the Self, Understanding Harmony in the Self, Exploring Sources of Imagination in the Self, Harmony of the Self with the Body, Exploring Harmony of Self with the Body

Unit-III

Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, Exploring the Feeling of Trust, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order

Unit-IV

Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

Suggested Books:

1. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019.
2. The Teacher’s Manual- Teachers’ Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019.
3. Professional Ethics and Human Values, Premvir Kapoor, Khanna Book Publishing Company, New Delhi, 2022.
4. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
5. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
6. Small is Beautiful - E. F Schumacher.
7. Bharat Mein Angreji Raj – Pandit Sunderlal
8. Rediscovering India - by Dharampal.

3rd Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC301	Electrical Circuit Analysis	3	1	0	30	70	100	4
2	ESC302	Analog Electronics Circuits	3	0	0	30	70	100	3
3	ESC303	Electrical Machines-1	3	0	0	30	70	100	3
4	ESC304	Electromagnetic Fields	3	1	0	30	70	100	4
5	BSC305	Mathematics-III	3	1	0	30	70	100	4
6	ESC-306	Python	2	0	2	50	50	100	3
7		Mandatory Course*	2	0	0	100	0	100	0
8	ESC302P	Analog Electronics Circuit Lab	0	0	2	50	50	100	1
9	ESC303P	Electrical Machines Lab -1	0	0	2	50	50	100	1
10	ESC307	Project-1	0	0	2	50	50	100	1
		Total	**20**	**4**	**12**			**1000**	**24**

***Non Credit Course**

	Course Code	Course Title
Mandatory Course	MC-01 (Common to all)	Indian Constitution
	MC-02 (Common to all)	Essence of Indian Traditional Knowledge

ELPC301	Electrical Circuit Analysis	3L:1T:0P	4 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the transient and steady-state response of electrical circuits.
3. Analyse circuits in the sinusoidal steady-state (single-phase and three-phase). Analyze two port circuit behaviour

Unit 1: Network Theorems (10 Hours)

Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem, Analysis with dependent current and voltage sources, Node and Mesh Analysis, Concept of duality and dual networks

Unit 2: Solution of First and Second order networks (8 Hours)

Solution of first and second order differential equations for Series and parallel R-L, R-C, R- L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Unit 3: Sinusoidal steady state analysis (8 Hours)

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits, Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

Unit 4: Electrical Circuit Analysis Using Laplace Transforms (8 Hours)

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances

Two Port Network and Network Functions (6 Hours)

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Text / References:

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”, Mc GrawHill Education,2013.
4. C. K. Alexander and M. N. O. Sadiku, “Electric Circuits”, McGraw HillEducation, 2004.
5. K. V. V. Murthy and M. S. Kamath, “Basic Circuit Analysis”, Jaico Publishers,1999.

ELPC302	Analog Electronic Circuits	3L:0T:0P	3 Credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the characteristics of transistors.
2. Design and analyse various rectifier and amplifier circuits. Design sinusoidal and non-sinusoidal oscillators.
3. Understand the functioning of OP-AMP and design OP-AMP based circuits.

Unit 1: Diode circuits

PN junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits

BJT circuits

Structure and I-V characteristics of a BJT; BJT as a switch, BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common- collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

Unit 2: MOSFET circuits

MOSFET structure and I-V characteristics, MOSFET as a switch, MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans- conductance, high frequency equivalent circuit.

Unit 3: Differential, multi-stage and operational amplifiers

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Unit4: Linear applications of op-amp

Idealized analysis of op-amp circuits, Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift).Analog to Digital Conversion.

Text/References:

1. A. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York,Oxford UniversityPress, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S.,1992.
3. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education,1988.
4. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press,1989.
5. P.R.Gray,R.G.MeyerandS.Lewis,“AnalysisandDesignofAnalogIntegrated Circuits”

ELPC303	Electrical Machines-I	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of magnetic circuits.
2. Understand the operation of dc machines.
3. Analyse the differences in operation of different dc machine configurations. Analyse single phase and three phase transformers circuits.

Unit 1:Magnetic fields and magnetic circuits

Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

Unit 2: Electromagnetic force and torque

B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency

Unit 3: DC machines

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Unit 4: DC machine - motoring and generation

Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors, Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Transformers

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three- phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Text / References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, Mc GrawHill Education,2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines",CBS Publishers,2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers,2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers,2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education,2010.

ELPC304	Electromagnetic Fields	3L:1T:0P	4 credits

Course Outcomes:

At the end of the course, students will demonstrate the ability

1. To understand the basic laws of electromagnetism.
2. To obtain the electric and magnetic fields for simple configurations under static conditions.
3. To analyse time varying electric and magnetic fields.
4. To understand Maxwell's equation in different forms and different media. To understand the propagation of EM waves.

This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

Unit 1: Review of Vector Calculus

Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, partial differentiation, integration, vector operator del, gradient, divergence and Curl ; integral theorems of vectors. Conversion of a vector from one coordinate system to another

Unit 2: Static Electric Field

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Conductors, Dielectrics and Capacitance

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Unit 3: Static Magnetic Fields

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Magnetic Forces, Materials and Inductance (6 Hours)

Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

Unit 4: Time Varying Fields and Maxwell's Equations (6 Hours)

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.

Electromagnetic Waves (6 Hours)

Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

Text / References:

1. M. N. O. Sadiku, “Elements of Electromagnetics”, Oxford University Publication,2014.
2. A. Pramanik, “Electromagnetism - Theory and applications”, PHI Learning Pvt.Ltd, New Delhi,2009.
3. A. Pramanik, “Electromagnetism-Problems with solution”, Prentice Hall India,2012.
4. G. W. Carter, “The electromagnetic field in its engineering aspects”, Longmans,1954.
5. W. J. Duffin, “Electricity and Magnetism”, McGraw Hill Publication,1980.
6. W. J. Duffin, “Advanced Electricity and Magnetism”, McGraw Hill,1968.
7. G. Cullwick, “The Fundamentals of Electromagnetism”, Cambridge UniversityPress, 1966.
8. B. D. Popovic, “Introductory Engineering Electromagnetics”, Addison-Wesley Educational Publishers, International Edition,1971.
9. W. Hayt, “Engineering Electromagnetics”, McGraw Hill Education,2012.

	Python	3L:1T:0P	3 credits

Unit-I

PROBLEM-SOLVING STRATEGIES: - Problem-solving strategies defined, Importance of understanding multiple problem-solving strategies, Trial and Error, Heuristics, Means- Ends Analysis, and Backtracking (Working backward).

THE PROBLEM-SOLVING PROCESS: - Computer as a model of computation, Understanding the problem, formulating a model, developing an algorithm, Writing the program, Testing the program, and evaluating the solution.

ESSENTIALS OF PYTHON PROGRAMMING: - Creating and using variables in Python, Numeric and String data types in Python, Using the math module, Using the Python Standard Library for handling basic I/O - print, input, Python operators and their precedence.

Unit-II

ALGORITHM AND PSEUDOCODE REPRESENTATION: - Meaning and Definition of Pseudocode, Reasons for using pseudocode, The main constructs of pseudocode - Sequencing, selection (if-else structure, case structure) and repetition (for, while, repeat- until loops),

Sample problems* FLOWCHARTS: -** Symbols used in creating a Flowchart - start and end, arithmetic calculations, input/output operation, decision (selection), module name (call), for loop (Hexagon), flow-lines, on-page connector, off-page connector.

Unit-III

SELECTION AND ITERATION USING PYTHON: - if-else, elif, for loop, range, while loop. Sequence data types in Python - list, tuple, set, strings, dictionary, Creating and using Arrays in Python (using Numpy library).

DECOMPOSITION AND MODULARISATION* :- Problem decomposition as a strategy for solving complex problems, Modularisation, Motivation for modularisation, Defining and using functions in Python, Functions with multiple return values

RECURSION: - Recursion Defined, Reasons for using Recursion, The Call Stack, Recursion and the Stack, Avoiding Circularity in Recursion, Sample problems - Finding the nth Fibonacci number, greatest common divisor of two positive integers, the factorial of a positive integer, adding two positive integers, the sum of digits of a positive number **.

Unit-IV

COMPUTATIONAL APPROACHES TO PROBLEM SOLVING (Introductory diagrammatic/algorithmic explanations only. Analysis not required) :- Brute-force Approach - - Example: Padlock, Password guessing Divide-and-conquer Approach –

- Example: The Merge Sort Algorithm

- Advantages of Divide and Conquer Approach - Disadvantages of Divide and Conquer Approach Dynamic Programming Approach

- Example: Fibonacci series - Recursion vs Dynamic Programming Greedy Algorithm Approach - Example: Given an array of positive integers each indicating the completion time for a task, find the maximum number of tasks that can be completed in the limited amount of time that you have. - Motivations for the Greedy Approach Characteristics of the Greedy Algorithm - Greedy Algorithms vs

Dynamic Programming Randomized Approach –

Example 1: A company selling jeans gives a coupon for each pair of jeans. There are n different coupons. Collecting n different coupons would give you free jeans. How many jeans do you expect to buy before getting a free one?

Example 2: n people go to a party and drop off their hats to a hat-check person. When the party is over, a different hat-check person is on duty and returns the n hats randomly back to each person. What is the expected number of people who get back their hats?

NPTEL Course (if any): https://nptel.ac.in/courses/108106075

Text/Reference Books:

1. G.A Vijayalakshmi Pai. A textbook of Data Structures and Algorithms
2. Mastering Linear Data Structures. Wiley Online Library, 2023.
3. Steven S. Skiena. The Algorithm Design Manual. Springer, 2020.
4. Narasimha Karumanchi. Data Structures and Algorithms Monk Publications, 2016.
5. Sachi Nandan Mohanty, Pabitra Kumar Tripathy. Data Structures and Algorithms Using C++: A Practical Implementation. Scrivener Publishing LLC, 2021.

ELBS321	**Mathematics-III (Probability and Statistics)**	**3L:1T:0P**	**4 credits**

Unit 1: Basic Probability

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.

Unit 2: Continuous Probability Distributions

Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.

Bivariate Distributions

Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Unit 3: Basic Statistics

Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

Unit 4: Applied Statistics

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Small samples

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes

Text / References:

1. E. Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons,2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, “Introduction to Probability Theory”,Universal Book Stall,2003.
3. S. Ross, “A First Course in Probability”, Pearson Education India,2002.
4. W. Feller, “An Introduction to Probability Theory and its Applications”, Vol. 1,Wiley, 1968.
5. N.P. Bali and M. Goyal, “A text book of Engineering Mathematics”,Laxmi Publications, 2010.
6. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers,2000.
7. T. Veerarajan, “Engineering Mathematics”, Tata McGraw-Hill, New Delhi,2010.

MC-01	Indian Constitution	2L:0T:0P	0 Credits

CONSTITUTION OF INDIA– BASIC FEATURES AND FUNDAMENTAL PRINCIPLES

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950.

The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

COURSE CONTENT

1. Meaning of the constitution law and constitutionalism.
2. Historical perspective of the Constitution of India.
3. Salient features and characteristics of the Constitution of India.
4. Scheme of the fundamental rights.
5. The scheme of the Fundamental Duties and its legal status.
6. The Directive Principles of State Policy – Its importance and implementation.
7. Federal structure and distribution of legislative and financial powers between the Union and the States.
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India

13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

REFERENCES:

1. The Constitutional Law Of India 9th Edition, by Pandey. J. N.
2. The Constitution of India by P.M.Bakshi
3. Constitution Law of India by Narender Kumar
4. Bare Act by P. M. Bakshi

MC-02	**Essence of Indian Knowledge Tradition**	**2L:0T:0P**	**0 credits**

भारतीयविद्यासार

Course objective

The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. Part-I focuses on introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view, and basic principles of Yoga and holistic health caresystem.

Course Contents

- Basic structure of Indian Knowledge System: अष्टादशविद्या -४वेद,४उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थापत्य आदि) ६वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद) ४ उपाड्ग (धर्मशास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References

- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, BharatiyaVidyaBhavan, Mumbai. 5thEdition,2014
- Swami Jitatmanand, *Modern Physics and Vedant*, BharatiyaVidyaBhavan
- Swami Jitatmanand, *Holistic Science and Vedant*, BharatiyaVidyaBhavan
- Fritzof Capra, *Tao ofPhysics*
- Fritzof Capra, *The Wave oflife*
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad,Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission,Kolkata
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanamwith VyasaBhashya*, VidyanidhiPrakashan, Delhi2016
- RN Jha, *Science of Consciousness Psychotherapyand Yoga Practices*, VidyanidhiPrakashan, Delhi2016
- P B Sharma (English translation), *ShodashangHridayan*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.
Outcome: Ability to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.

ELPC352	**Analog Electronic Circuit Lab**	**0L:0T:2P**	**1 Credits**

List of Experiments

1. Study the following devices: (a) Analog & digital multimeters (b) Function/ Signal generators (c)Regulated d. c. power supplies (constant voltage and constant current operations) (d) Study ofanalog CRO, measurement of time period, amplitude, frequency & phase angle using Lissajousfigures.
2. Plot V-I characteristic of P-N junction diode & calculate cut-in voltage, reverse Saturation current andstatic & dynamicresistances.
3. PlotV-Icharacteristicofzenerdiodeandstudyofzenerdiodeasvoltageregulator.Observetheeffectofload changes and determine load limits of the voltageregulator.
4. Plot frequency response curve for single stage amplifier and to determine gain bandwidthproduct.
5. Plot drain current - drain voltage and drain current – gate bias characteristics of field effect transistorand measure of Idss&Vp
6. Application of Diode as clipper &clamper
7. Plot gain- frequency characteristic of two stage RC coupled amplifier & calculate its bandwidthand compare it with theoreticalvalue.
8. Plot gain- frequency characteristic of emitter follower & find out its input and outputresistances.
9. Plot input and output characteristics of BJT in CB, CC and CE configurations. Find theirh-parameters.
10. Study half wave rectifier and effect of filters on wave. Also calculate theoretical & practical ripplefactor.
11. Study bridge rectifier and measure the effect of filter network on D.C. voltage output & rippleFactor.
12. To plot the characteristics ofMOSFET.
13. TodeterminethefollowingparametersofOP-AMP.a)InputBiasCurrent.b)InputOffsetCurrent.c)Input Offset Voltage. d) CMRR
14. To plot the frequency response curve of an amplifier with and withoutfeedback
15. To determine the frequency of oscillations of a given RC phase shiftOscillator.
16. Design & realize Wein -bridge oscillator using op amp741.
17. To design & realize zero crossing detector using op amp741

NOTE: At least ten experiments are to be performed; at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

ELPC353	Electrical Machine-1 Lab	0L:0T:2P	1 Credits

List of Experiments

1. To obtain magnetization characteristics of separately excited DC Machine.
2. To obtain magnetization characteristics of self-excited DC Machine.
3. To obtain Load characteristics D.C series generator.
4. To obtain Load characteristics of D.C Shunt Generator.
5. To obtain speed torque, speed current and torque current characteristics of DC shunt motor.
6. Speed control of DC shunt motor.
7. To obtain efficiency of dc machine using Swinburne's Test.
8. To perform polarity test on transformer and also find turn ratio.
9. To perform OC & SC tests on single - phase transformer and draw equivalent circuit.
10. To perform direct load test on single - phase transformer and draw efficiency vs load curve.
11. Sumpner's test on Transformers
12. Scott Connection of Transformers
13. Parallel Operation of Two Single – Phase Transformers.

NOTE: At least ten experiments are to be performed; at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

4th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC401	Digital Electronics	3	1	0	30	70	100	4
2	ESC402	Electrical Machines – II	3	0	0	30	70	100	3
3	ESC403	Power Electronics	3	1	0	30	70	100	4
4	ESC404	Signal and Systems	3	1	0	30	70	100	4
5		Program Elective –I	3	0	0	30	70	100	3
6	MC-03	Environmental Sciences	2	0	0	100	0	100	0
7	ESC401P	Digital Electronics Lab	0	0	2	50	50	100	1
8	ESC402P	Electrical Machines Lab–II	0	0	2	50	50	100	1
9	ESC403P	Power Electronics Lab	0	0	2	50	50	100	1
10	ESC405	Project-2	0	0	2	50	50	100	1
		Total	**17**	**3**	**8**	**240**	**660**	**1000**	**22**

*** Non Credit Course**

	Course Code	Course Title
Program Elective -1	EPE406	Electrical Energy Conservation and Auditing
	EPE407	Transducer and IOT
	EPE408	Introduction to Electrical Vehicles

ELPC401	Digital Electronics	3L:1T:0P	4 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand working of logic families and logic gates.
2. Design and implement Combinational and Sequential logic circuits.
3. Understand the process of Analog to Digital conversion and Digital to Analog conversion.
4. Be able to use PLDs to implement the given logical problem.

Unit 1: Fundamentals of Digital Systems and logic families

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

Unit 2: Combinational Digital Circuits

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

Unit 3: Sequential circuits and systems

A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K,T and D typesflipflops, applications of flipflops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flipflops, special counter IC's, asynchronous sequential counters, applications of counters.

Unit 4: A/D and D/A Converters (7Hours)

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/Dconverterusing Voltage to frequency and voltage to timeco n version, specifications of A/D converters, example of A/D converterICs

Semiconductor memories and Programmable logic devices. Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array(FPGA).

Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education,2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India,2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India,2016.

ELPC402	Electrical Machines – II	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of rotating magnetic fields.
2. Understand the operation of ac machines.
3. Analyse performance characteristics of ac machines.

Unit: Fundamentals of AC machine windings

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single- turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Unit 2: Pulsating and revolving magnetic fields

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Unit 3: Induction Machines

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effectofparameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors.Generator operation. Self-excitation.Doubly-Fed Induction Machines.

Unit 4: Single-phase induction motors

Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Synchronous machines

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves.Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics.Parallel operation of alternators - synchronization and load division.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education,2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers,2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers,2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education,2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education,1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley &Sons, 2007.

ELPC403	Power Electronics	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the differences between signal level and power level Devices.
2. Analyse controlled rectifier circuits.
3. Analyse the operation of DC-DC choppers.
4. Analyse the operation of voltage source inverters.

Unit 1: Power switching devices

Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Thyristor rectifiers

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Unit 2: DC-DC buck converter

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of outputvoltage.

DC-DC boost converter

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Unit 3: Single-phase voltage source inverter

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

Unit 4: Three-phase voltage source inverter

Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Text/References:

1. M. H. Rashid, "*Power electronics: circuits, devices, and applications*", Pearson Education India,2009.
2. N.MohanandT.M.Undeland,"PowerElectronics:Converters,ApplicationsandDesign", John Wiley & Sons,2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics",Springer Science & Business Media,2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India,2009.

ELPC404	Signals and Systems	2L:1T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of continuous time and discrete time systems.
2. Analyse systems in complex frequency domain.
3. Understand sampling theorem and its implications.

Unit 1: Introduction to Signals and Systems:

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. 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. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Unit 2: Behavior of continuous and discrete-time LTI systems

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations.State- space Representation of systems.State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Unit 3: Fourier, Laplace and z- Transforms

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) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Unit 4: Sampling and Reconstruction

The 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 controlsystems.

Text/References:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, PrenticeHall 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.
5. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall, 2009.
6. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education,2007.
7. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press,2009.

	Introduction to Electrical Vehicles	**3L:0T:0P**	**3 credits**

Course Outcomes:

CO1 Understand basics of Electric Vehicles Development.

CO2 Understand basic scheme of electric vehicle storage system.

CO3 Analyse need of different controlling system for electric vehicle.

CO4 Apply new topologies to electric vehicle.

CO5 Evaluate performance parameters of electric hybrid vehicle.

CO6 Understand recent industrial power electronic applications for electric vehicle.

Unit I: Electric Vehicles Development Electric vehicles (EV) development, past, present and future, comparison with IC engine driven vehicles.

Unit II: Storage Units Batteries, fuel cells, ultracapacitors. Power converters in EV. Different types of motors used in EV and their torquespeed characteristics, motor control techniques,

Vehicle Control High performance and efficiency-optimized control, sensor less control. Electric vehicles modeling and their Characteristics.

Unit III : Electric drive-trains Basic concept of electric traction - introduction to various electric drive-train topologies - power flow control in electric drive-train topologies - fuel efficiency analysis

Unit IV: Hybrid Electric Vehicle Fuel cell Vehicles, Hybrid Electric Vehicles (HEV), series, parallel and series-parallel (split) systems,

Recent Technologies Recent industrial power electronic applications. Advanced topic on the subject

Text Books:

1. Sandeep Dharmeja, Electric Vehicle Battery Systems, 1st Edition, Newnes, 2001
2. K.T.Chau, Zheng Wang, Chaos in Electrical Drive Systems: Analysis, Control & Applications, 1st Edition, John Wiley and Sons, 2011
3. Chung Chow Chan, K.T.Chau, Modern Electric Vehicle Technology, 1st Edition, Oxford University Press, 2001
4. Springer Books, Electrical Vehicle Integration into Modern Power Networks
5. A.T.P.So George C.Barney waterstones.com, International Journal of Elevator Engineering, United Kingdom
6. John Lowry, John Wiley and Sons, Electrical Vehicle Technology Explained-James Larminie, 1st Edition, 2003

	Design and Engineering	3L:0T:0P	3 credits

Unit 1: Introduction and Electric Motor Design

Fundamentals of electric motors and working principles, Hands-on motor construction: coil winding, motor design,

Introduction to FEMM (Finite Element Method Magnetics) for motor simulation, Basic motor controller design using MOSFETs and Arduino

Unit 2: Battery Technology and Management

Basics of lithium-ion batteries: chemistry, structure, selection; Battery safety and pack design considerations; Introduction to Battery Management Systems (BMS); Monitoring battery parameters: voltage, current, temperature, SoC; Charging technology: types, architecture, process, and protocols

Unit 3: Energy Modeling and Communication in EVs

Vehicle energy consumption modelling; WLTP and other driving cycles for range estimation; Automotive communication protocols: I2C, CAN; Implementation of I2C communication between motor controller and BMS

Unit 4: Case Studies, Regulations & Sustainability

Real-world EV case studies (e.g., Formula Electric); Reverse engineering and simulation of BLDC motors using FEMM; Introduction to CMVR 1989 standards and regulatory landscape; Retrofitment design and compliance; Carbon credits, sustainability metrics, and environmental impact

Books:

1. "Fundamentals of Electric Vehicles: Technology and Economics" by Johannes Liebl – Offers technical, regulatory, and economic perspectives, including case studies.
2. CMVR (Central Motor Vehicles Rules, 1989) – Official regulation document – Available via Indian government portals
3. "Sustainable Automotive Technologies 2014" by Aleksandar Subic et al. – Includes sections on carbon credits, sustainability strategies, and lifecycle analysis.

	Transducer and IOT	3L:0T:0P	3 credits

Unit 1: Sensors / Transducers:

Introduction to instrumentation system, static and dynamic characteristics of an instrumentation system, Principles and classification of transducers, Electrical transducers, basic requirements of transducers. Types of strain gauges, theory of operation of resistive strain gauge, gauge factor, types of electrical strain gauges, gauging techniques and other factors, strain gauge circuits and temperature compensation, applications of strain gauges.

Displacement, Forces and Torque Measurement:

Resistive potentiometer (Linear, circular and helical), L.V.D.T., R.V.D.T. and their characteristics, variable inductance and capacitance transducers, Piezoelectric transducers-output equations and equivalent circuit, Hall effect devices and Proximity sensors, Large displace-ment measurement using synchros and resolvers, Shaft encoders. Load cells and their applications, various methods for torque measurement.

Pressure, Flow and Level Measurement:

Unit 2: Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement, Variable inductance and capacitance transducers, Piezoelectric transducers, L.V.D.T. for measurement of pressure, Low pressure and vacuum pressure measurement using Pirani gauge, McLeod gauge, Ionization gauge. Differential pressure meter like Orifice plate, Venturi tube, flow nozzle, Pitot tube, Rotameter, Turbine flow meter, Electromagnetic flow meter, hot wire anemometer, Ultrasonic flow meter. Resistive, inductive and capacitive techniques for level measurement, Ultrasonic and radiation methods, Air purge system (Bubbler method).

Unit 3 Temperature Measurement:

Resistance type temperature sensors – RTD & Thermistor, Thermocouples & Thermopiles, Laws of thermocouple – Fabrication of industrial thermocouples – Signal conditioning of thermocouples output - Radiation methods of temperature measurement – Radiation fundamentals – Total radiation & selective radiation pyrometers – Optical pyrometer – Two color radiation pyrometers

Unit 4: Introduction to Internet of Things and Embedded IoT devices:

IoT Definition, IoT characteristics, M2M and IoT, End to End IoT Architecture, Physical design of IoT, Logical Design of IoT, Overview of IoT protocols, IoT levels and deployment templates, Challenges for IoT, Interdependencies of IoT and cloud computing, Web of things.Sensors and actuators for IoT applications, IoT components and implementation, Programming of NodeMCU and Raspberry PI, Implementation of IoT with Edge devices, Reading sensor data and transmit to cloud, Controlling devices through cloud using mobile application and web application, Broad categories of IoT applications: Consumer IoT, Commercial IoT, Industrial IoT, Infrastructure IoT, Military Things (IoMT)

Books:

1. "Transducers and Instrumentation" by D.V.S. Murty
2. "Measurement Systems: Application and Design" by Ernest O. Doebelin & Dhanesh Natarajan "Principles of Industrial Instrumentation" by D. Patranabis
3. "Internet of Things: A Hands-On Approach" by Arshdeep Bahga & Vijay Madisetti "Instrumentation, Measurement and Analysis" by B.C. Nakra & K.K. Chaudhry
4. "Sensors and Transducers" by Ian R. Sinclair
5. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes et al.

	Environmental Sciences	2L:0T:0P	0 credits

Course Objectives:

The prime objective of the course is to provide the students a detailed knowledge on the threats and challenges to the environment due to developmental activities. The students will be able to identify the natural resources and suitable methods for their conservation and sustainable development. The focus will be on awareness of the students about the importance of ecosystem and biodiversity for maintaining ecological balance. The students will learn about various attributes of pollution management and waste management practices. The course will also describe the social issues both rural and urban environment and environmental legislation

Unit1: The Multidisciplinary Nature of Environmental Studies

Definition, scope and importance. Need for public awareness.

Unit 2: **Natural Resources: Renewable and Non-Renewable Resources**

Natural resources and associated problems:

Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

Energy resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources. Case studies.

Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources.Equitable use of resources for sustainable lifestyles.

Unit-3: Ecosystems

Concept of an ecosystem.Structure and function of an ecosystem.Producers, consumers and decomposers. Energy flow in the ecosystem.Ecological succession.Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Introduction – Definition: genetic, species and ecosystem diversity.

Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels.

India as a mega-diversity nation.Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: insitu and ex-situ conservation of biodiversity

Unit 4: Environmental Pollution

Definition Causes, effects and control measures of: Air pollution b) Water pollution c) Soil pollution d) Marine pollution e) Noise pollution f) Thermal pollution g) Nuclear hazards

Solid waste Management: Causes, effects and control measures of urban andindustrial wastes. Role of an individual in prevention of pollution.Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

Social Issues and the Environment

From Unsustainable to Sustainable development Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns.Case studies.

Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.Wasteland reclamation.Consumerism and waste products.

Environment Protection Act.Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act

Wildlife Protection Act.Forest Conservation Act. Issues involved in enforcement of environmental legislation Public awareness.

RERERENCES

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela 2008 PHI Learning Pvt Ltd.
3. Environmental Science by Daniel B. Botkin& Edwards A. Keller, Wiley INDIA edition.
4. Fundamentals of Ecology by Odum, E.P., Barrick, M. and Barret, G.W. Thomson Brooks/Cole Publisher, California, 2005.

ELPC451	Digital Electronics Lab	0L:0T:2P	1 credits

Hands-on experiments related to the course contents of **ELPC401**

List of Experiments

1. Study of TTL gates – AND, OR, NOT, NAND, NOR, EX-OR,EX-NOR.
2. Design & realize a given function using K-maps and verify its performance.
3. To verify the operation of multiplexer & Demultiplexer.
4. To verify the operation of comparator.
5. To verify the truth tables of S-R, J-K, T & D type flipflops.
6. To verify the operation of bi-directional shift register.
7. To design & verify the operation of 3-bit synchronous counter.
8. To design and verify the operation of synchronous UP/DOWN decade counter using J K flip-flops & drive a seven-segment display using the same.
9. To design and verify the operation of asynchronous UP/DOWN decade counter using J K flip-flops & drive a seven-segment display using the same.
10. To design & realize a sequence generator for a given sequence using J-Kflip-flops.
11. Study of CMOS NAND & NOR gates and interfacing between TTL and CMOSgates.
12. Design a 4-bit shift-register and verify its operation . Verify the operation of a ring counter and a Johnson counter.

NOTE : At least ten experiments are to be performed, at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

ELPC452	Electrical Machine-II Lab	0L:0T:2P	1 credits

Hands-on experiments related to the course contents of **ELPC402**

List of Experiments

1. To study starting methods of induction motors.
2. Determination of the effect of rotor resistance on the torque speed curve.
3. Load test on 3 - phase squirrel cage induction motor.
4. Load test on 3 - phase slip ring induction motor.
5. No load and Blocked rotor test on 3 - phase induction motor.
6. Effect of capacitor on the starting and running of single phase induction motor and method of reversing the direction of rotation.
7. Brake test on single - phase induction motor
8. Determination of Equivalent Circuit of Single - Phase Induction Motor
9. To determine voltage regulation of alternator by direct loading.
10. Determination of regulation of an alternator by emf method.
11. Determination of regulation of an alternator by ZPF method.
12. To determine Xd and Xqofa salient pole synchronous machine by slip test.
13. To determine sub transient reactance (Xd'' and Xq'') of synchronous machine.
14. Determination of negative sequence and zero sequence reactance os a synchronous generator.
15. To perform parallel operation of alternators using dark lamp method.
16. To plot V-curve and invert V-curve of synchronous motor.

NOTE: Atleast ten experiments are to be performed; atleast seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

ELPC453	Power Electronics Lab	0L:0T:2P	1 credits

Hands-on experiments related to the course contents of **ELPC403.**

List of Experiments

1. To plot characteristics of Diode , Thyristor and Triac.
2. To plot characteristics of Transistor and MOSFET.
3. To Use R and R-C firing circuits , UJT firing circuit.
4. Study of complementary voltage commutation using a lamp flasher , Ring Counter.
5. Study of Thyristorised DC circuit breaker.
6. Study of AC voltage Regulator.
7. Study of full wave Converter.
8. Study of DC chopper.
9. Study of Series Inverter.
10. Study of Bridge Inverter.
11. Study of Single phase Cycloconverter

NOTE : At least ten experiments are to be performed, at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

5th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	End Sem	Total	Cr.
			L	T	P				
1	ESC501	Power Systems – I	3	0	0	30	70	100	3
2	ESC502	Control Systems	3	1	0	30	70	100	4
3	ESC503	Microprocessors	3	1	0	30	70	100	4
4		Program Elective –II	3	0	0	30	70	100	3
5		Open Elective –I	3	0	0	30	70	100	3
6	ESC501P	Power Systems Lab-1	0	0	2	50	50	50	1
7	ESC502P	Control Systems Lab	0	0	2	50	50	50	1
8	ESC503P	Microprocessors Lab	0	0	2	50	50	50	1
9	ESC504	Project-3	0	0	2	50	50	50	1
		Total	**15**	**2**	**8**			**900**	**21**

	Course Code	Course Title
Program Elective –II	EPE505	Electric Vehicles Architecture
	EPE506	Electrical Machine Design
	EPE507	Energy Storage Systems
Open Elective –I	EOE508	Artificial Intelligence
	EOE509	Computational Electromagnetics
	EOE510	Energy Management

	Power Systems-1	**3L:0T:0P**	**3 credits**

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the concepts of powersystems.
2. Understand the various power systemcomponents.
3. Evaluate fault currents for different types offaults.
4. Understand the protection against over-voltages and insulation coordination. Understand basic protection schemes.
5. Understand concepts of dc power transmission and renewable energy systems

Unit 1: Basic Concepts
Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids.
Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources.Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Synchronous Grids and Asynchronous (DC) interconnections. Power Transfer in AC circuits and Reactive Power.
Unit 2: Power System Components
Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Corona. Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations. Sinusoidal Steady state representation of Lines: Short, medium and long lines. Power Transfer, Voltage profile and Reactive Power. Characteristics of transmission lines. Surge Impedance Loading. Series and Shunt Compensation of transmission lines.
Loads: Types, Voltage and Frequency Dependence of loads,Per Unit System and Per Unit Calculations
Unit 3: Over-voltages and Insulation Requirements
Protection against Over-voltages, Insulation Coordination.
Introduction to DC Transmission and Renewable energy systems
HVDC transmission: types of links; Introduction to solar PV systems
Unit 4: Fault Analysis and Protection Systems (10 hours)
Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding
Switchgear: Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection.
Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

Text/References:
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.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric PowerSystems”, Wiley, 2012.

	Power Systems-I Lab	**0L:0T:2P**	**1 credits**

Hands-on experiments related to the course contents of ELPC-501. Visits to power system installations (generation stations, EHV substations etc.) are suggested.

	Control Systems	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will be able to

1. Understand the modeling of linear-time-invariant systems using transfer function and state- space representations.
2. Design specifications for second order systems based on time response.
3. Interpret the Concept of stability and its assessment for linear-time invariant systems using various methods.
4. Design controllers in time and frequency domain.
5. Explain the basic concept of optimal and non linear control systems.

Unit 1: Introduction to control problem

Industrial Control examples, Mathematical models of physical systems, Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback, Transfer Function of control system, impulse response and its relation with transfer function of linear systems. Transfer function from Block diagram reduction technique and signal flow graph, Mason's gain formula.

Unit 2: Time Response Analysis

Standard test signals, Time response of first and second order systems for standard test inputs, Application of initial and final value theorem, Design specifications for second-order systems based on the time-response. Concept of Stability, Routh-Hurwitz Criteria, Relative Stability analysis, Root-Locus technique, Construction of Root-loci

Unit 3: Frequency-response analysis

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 Optimal Control and Nonlinear Control

Performance Indices, Regulator problem, Tracking Problem., Nonlinear system–Basic concepts and analysis

Unit 4: Introduction to Controller Design

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems, Root-loci method of feedback controller design, Design specifications in frequency-domain, Frequency-domain methods of design, Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs, Analog and Digital implementation of controllers.

State Variable Analysis of Linear Dynamic Systems

State variables, State variable representation of system, dynamic equations, merits for higher order differential equations and solution, Concept of controllability and observability and techniques to test them

Text/References:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
3. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

I. J. Nagrath and M.Gopal, "Control Systems Engineering", New Age International, 2009

ELPC552	Control Systems Lab	0L:0T:2P	3 credits

Hands-on/Computer experiments related to the course contents of ELPC502.

ELPC503	Microprocessors	3– 0–0	3 Credits

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic architecture of 8086 microprocessor.
CO2	Write assembly language programs to perform a given task.
CO3	Write interrupt service routines for all interrupt types
CO4	Interface memory and I/O devices to 8086 using peripheral devices
CO5	Write microcontroller programs and interface devices

Detailed syllabus

UNIT-I Introduction: Evolution of Microprocessors, Internal Architecture of 8085/8086, BIU and EU, Registers in of 8085/8086, Memory segmentation

Instruction sets and Addressing modes: Addressing modes-register related, Addressing modes-memory related, Instruction formats, Instruction set of 8086-functional groups, Assembler Directives, assembly language programming.

UNIT-II Pin and timing diagrams of 8086: Pin diagram of 8086 in minimum mode & Maximum mode configuration, Timing diagram of typical read write instructions.

Interrupts- Steps in interrupt process, Interrupt structure in 8086, Internal and external interrupts-interrupt service routines.

UNIT-III Interfacing the microprocessor- Interfacing of I/O devices, Interfacing I/O-programmable peripheral interface-8255, Interfacing of multi digit seven segment display, Interfacing timer-Programmable interval timer-8254.

UNIT-IV Serial interface and data converters-USART 8251, Serial interface standards-RS 232 C and RS -485, Interfacing of ADCs and DACs,

Microcontrollers- Introduction to Microcontroller, 8051 Microcontroller, memory and I/ O organization, Applications of Microcontroller.

Reading:

1. Douglas V. Hall : Microprocessors and Interfacing, TMH-Revised Second Edition, 2005
2. A.K. Ray & Burchandi: Advanced Microprocessors and Peripherals, TMH,

2003. Ajay V. Deshmukh: Microcontrollers –Theory and Applications, TMH, 2009.

ELPC553	**Microprocessors Laboratory**	**0L:0T:2P**	**1 credits**

Hands-on experiments related to the course contents of ELPC503

	Electrical Machine Design	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will be able to

1. Understand the construction and performance characteristics of electrical machines.
2. Analyze the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
3. Estimate the overall dimensions and operating characteristics of AC/DC machines
4. Explain the concept of computer aided design CAD and optimal design of electrical machines

Unit 1: Introduction

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

Transformers

Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Unit 2: Induction Motors

Sizing of an induction motor, main dimensions, output equation, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

Synchronous Machines

Sizing of a synchronous machine, main dimensions, output equation, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design, cooling of turbo alternators.

Unit-3: DC Machines

Sizing of a direct current machine, main dimensions, output equation, selection of number of poles, core length, armature diameter, Length of air gap, Choice of armature winding, number of armature coils, number of armature slots, slot dimensions, Armature voltage drop, depth of armature core, design of field system, Design of commutator

Unit 4: Computer aided Design (CAD):

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Text / References:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons,1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing,2006.
4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan,1969.

	Computational Electromagnetics	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the basic concepts of electro-magnetic.
2. Understand computational techniques for computing fields.
3. Apply the techniques to simple real-life problems.

Unit 1: Introduction

Conventional design methodology, Computer aided design aspects – Advantages. Review of basic fundamentals of Electrostatics and Electromagnetics. Development of Helmhotz equation, energy transformer vectors- Poynting and Slepian, magnetic Diffusion-transients and time-harmonic.

Unit 2: Analytical Methods

Analytical methods of solving field equations, method of separation of variables, Roth's method, integral methods- Green's function, method of images.

Finite Difference Method (FDM)

Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method- Uniqueness and convergence.

Unit 3: Finite Element Method (FEM)

Overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.

Unit 4: Special Topics

{Background of experimental methods-electrolytic tank, R-C network solution, Field plotting (graphical method)}, hybrid methods, coupled circuit - field computations, electromagnetic - thermal and electromagnetic - structural coupled computations, solution of equations, method of moments, Poisson's fields.

Applications

Low frequency electrical devices, static / time-harmonic / transient problems in transformers, rotating machines, actuators.CAD packages.

Text/Reference Books

2. P. P. Silvester and R. L. Ferrari "Finite Element for Electrical Engineers", Cambridge University press,1996.
3. M. N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC press,2001.

	Electric Vehicles Architecture	3L:0T:0P	3 credits

CO1 Understand the Architecture of HEV.
CO2 Analyse the power flow in series and parallel HEV.
CO3 Analyse the power flow in series-parallel HEV.
CO4 Analysis of Parallel Drive Train and Torque Coupling
CO5 Understand the concept of Basic Architecture of Electric Drive Trains
CO6 Understand the concept of EV configuration.

Unit I: Basic Architecture of Hybrid Drive Trains and Analysis of Series Drive Train

Hybrid Electric Vehicles (HEV): The gasoline ICE and battery, Diesel ICE and battery, Battery and FC, Battery and capacitor, Battery and flywheel, Battery and battery hybrids. Energy use in conventional vehicles, Energy saving potential of hybrid drive trains: Regenerative braking, More efficient operation of the ICE, including reduction of idle, Smaller ICE, Potential for higher weight, Electrical losses. Various HEV configurations and their operation modes: Series configuration, Parallel configuration, Series-parallel configuration, Complex configuration.

Unit II: Power Flow in HEVs -I

Power Flow Control: Optimal ICE operating point, Optimal ICE operating line, Safe battery voltage. Power Flow Control in Series Hybrid: Mode 1, normal driving or acceleration, Mode 2, light load, Mode 3, braking or deceleration, Mode 4, vehicle at stop. Power Flow Control in Parallel Hybrid: Mode 1, start up, Mode 2, normal driving, Mode 3, braking or deceleration, Mode 4, light load

Power Flow in HEVs -II

Power Flow Control in Series-Parallel Hybrid: Mode 1: At startup, Mode 2: During full throttle acceleration, Mode 3: During normal driving, Mode 4: During normal braking or deceleration, Mode 5: To charge the battery during driving, Mode 6: When the vehicle is at standstill,

The operating modes of EM dominated system, Power Flow Control Complex Hybrid Control: Mode 1: During startup, Mode 2: During full throttle acceleration, Mode 3: During normal driving, Mode 4: During driving at light load, Mode 5: During braking or deceleration, Mode 6: Axial balancing.

Unit III : Torque Coupling and Analysis of Parallel Drive Train

Introduction to Parallel Hybrid Electric Drive Train, Torque Coupling, Speed Coupling, Post-Transmission Parallel Hybrid Drive Train with Torque Coupling, Pre-Transmission Parallel Hybrid Drive Train with Torque Coupling, Parallel Hybrid Drive Train with Speed Coupling: Hybrid traction, Engine alone traction, Motor alone traction, Regenerative braking, Battery charging from the ICE. Complex Hybrid Drivetrain.

Unit IV: Basic Architecture of Electric Drive Trains-I

Electric Vehicle (EV) Configuration: Electric propulsion-The electronic controller, Power converter, Electric Motor (EM), Mechanical transmission, Driving wheels. Energy source-The energy source (battery, fuel cell, ultracapacitor), Energy management unit, Energy refueling unit. Auxiliary system- Power steering unit, Temperature control unit, Auxiliary power supply. EV alternatives based on drivetrains: EV configuration with clutch, gearbox and differential-I, EV configuration without clutch and gearbox, EV configuration with clutch, gearbox and differential-II

Basic Architecture of Electric Drive Trains-II

EV configuration with two EM, EV configuration with in wheel motor and mechanical gear, EV configuration with in wheel motor and no mechanical gear. EV alternatives based on power source configuration: EV configuration with battery source, EV configuration with two battery sources, EV configuration with battery and fuel cell source, EV configuration with multiple energy sources, EV configuration with battery and capacitors sources, EV configuration with battery and flywheel sources, Single and Multi-motor drives, In wheel drives

Text Books:

1. M. Ehsani,:Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,2005
2. K.T.Chau, Zheng Wang, Chaos in Electrical Drive Systems: Analysis, Control & Applications, 1st Edition, John Wiley and Sons, 2011
3. L. Guzzella and A. Sciarretta: Vehicle Propulsion Systems: Introduction to Modeling and Optimization, Springer, 2007, fifth edition.
4. Springer Books, Electrical Vehicle Integration into Modern Power Networks
5. A.T.P.So George C.Barney waterstones.com, International Journal of Elevator Engineering, United Kingdom
6. John Lowry, John Wiley and Sons, Electrical Vehicle Technology Explained-James Larminie, 1st Edition, 2003

	Energy Storage Systems	3L:0T:0P	3 credits

Course Outcomes
CO1 Understand the concept of Electrochemical Battery.
CO2 Identify the suitable Electrochemical energy storage system for Electric Vehicle..
CO3Analyse and Compare the different energy storage system.
CO4 Understand the knowledge of the Ultra-capacitors.
CO5 Explain use of energy management system for energy storage systems.
CO6 Analyse the Electric Vehicles Charging Station.

Unit I: Electrochemical Battery 1
Introduction to Electrochemical Battery, Electro Chemical Reactions, Battery capacity, Discharge Rate, SOC, SOD, SOH, DOD, Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency, Battery Technologies (used in Tesla Car), Lead-acid battery.
Electrochemical Battery 2
Nickel based battery (Nickel Metal Hydride), Lithium battery (Li-ion and LiPolymer), Introduction to graphene battery, Compare all Electrochemical batteries.
Unit II: Fuel Cell
Overview of key fuel cell technologies- Various types of fuel cells, Materials for electrodes, electrolytes and other components, Working mechanisms, Hydrogen generation and storage: limitations, Recent progress in fuel cells, Safety issues and cost expectation and life cycle analysis of fuel cells.
Ultra-capacitors
Features of Ultra capacitors, Basic principle operation of Ultra capacitors, Fundamentals of Electrochemical Supercapacitors, Electrode and electrolyte interfaces and their capacitances, ChargeDischarge characteristics, Energy/power density, Design, Fabrication, Ultra capacitor Technologies, Graphene based Ultra capacitor, Introduction to Flywheel, Hybridization of different energy storage devices.
Unit III: Energy Management System
In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies with optimization techniques used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies and implementation issues of energy management strategies.
Unit IV: Electric Vehicles Charging Station
Types of charging station, Selection and Sizing of charging station, Components of charging station, Single line diagram of charging station, Charging Station Placement for Electric Vehicles.

Text Books:

1. 1.M. Ehsani,:Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,2005
2. K.T.Chau, Zheng Wang, Chaos in Electrical Drive Systems: Analysis, Control & Applications, 1st Edition, John Wiley and Sons, 2011
3. L. Guzzella and A. Sciarretta: Vehicle Propulsion Systems: Introduction to Modeling and Optimization, Springer, 2007, fifth edition.
4. John Lowry,: Electrical Vehicle Technology Explained-James Larminie, John Wiley and Sons, 1st Edition, 2003
5. V. Hacker, S. Mitsushima (sdE.):Fuel Cells and Hydrogen: From Fundamentals to Applied Research, Elsevier 2018

	Artificial Intelligence	**3L:0T:0P**	**3 credits**

Unit 1: Introduction to Artificial Intelligence and Problem Solving
Definition and history of AI; Applications and scope of AI in various fields; Intelligent agents: Structure, types, and environments; State-space search: Problem formulation; Uninformed search techniques: BFS, DFS, UCS, Iterative deepening; Informed search: Greedy search, A*, heuristic functions, Constraint Satisfaction Problems (CSPs)

Unit 2: Knowledge Representation and Reasoning
Introduction to Knowledge Representation (KR); Propositional logic and inference techniques; First-order predicate logic: Syntax, semantics, unification; Rule-based systems, forward and backward chaining; Ontologies and semantic networks; Basics of reasoning under uncertainty: Bayesian networks, fuzzy logic

Unit 3: Machine Learning and Expert Systems
Introduction to machine learning: Types (Supervised, Unsupervised, Reinforcement); Decision trees, k-NN, Naïve Bayes classifiers; Clustering techniques: k-means, hierarchical clustering; Basics of neural networks and backpropagation; Overview of deep learning; Expert systems: Architecture and applications

Unit 4: Natural Language Processing and Emerging AI Trends
Natural Language Processing (NLP): Tokenization, parsing, stemming, N-grams; Speech and text processing basics; Introduction to computer vision (optional); Robotics and perception in AI; Ethical considerations and limitations of AI; Overview of AI frameworks and tools (TensorFlow, Scikit-learn, OpenAI API); Case studies in AI: Autonomous vehicles, healthcare AI, generative models

Recommended Books:

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell & Peter Norvig
2. "Artificial Intelligence" by Elaine Rich, Kevin Knight, and Shivashankar B. Nair
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
4. "Artificial Intelligence: Structures and Strategies for Complex Problem Solving" by George F. Luger

	Energy Management	**3L:0T:0P**	**3 credits**

Unit 1: Introduction to Energy Management and Energy Audit
Overview of global and national energy scenarios; Basics of energy conservation and demand-side management; Definitions and objectives of energy management; Types of energy audits: preliminary and detailed Energy audit methodology: data collection, analysis, benchmarking ; Roles and responsibilities of energy managers and auditors; Case studies of industrial energy audits

Unit 2: Energy Efficiency in Electrical Systems
Electrical load management and maximum demand control; Power factor improvement techniques;
Transformers and distribution losses; Electric motors: efficiency, selection, and variable frequency drives (VFDs); Lighting systems: types, design considerations, and retrofits; Energy-efficient appliances and automation systems

Unit 3: Thermal Energy Systems and Energy Conservation
Combustion systems and boiler efficiency; Waste heat recovery techniques; Steam systems: distribution, insulation, and condensate recovery; Furnaces and kilns: heat loss and efficiency improvement; Energy conservation in HVAC systems; Co-generation and tri-generation systems

Unit 4: Energy Economics, Policy, and Sustainable Practices
Life Cycle Costing (LCC) and Payback Period analysis; Net Present Value (NPV), Internal Rate of Return (IRR); Financial appraisal of energy projects; Government policies on energy efficiency and conservation (e.g., PAT, ECBC); Renewable energy integration in energy management; Sustainable building concepts and energy certification systems (LEED, GRIHA)

Recommended Books:

1. “Energy Management Handbook” by Wayne C. Turner & Steve Doty
2. “Guidebook for National Certification Examination for Energy Managers and Energy Auditors” – Bureau of Energy Efficiency (BEE), Govt. of India
3. “Energy Management” by Paul W. O’Callaghan
4. “Handbook on Energy Audits and Management” by Abbi & Jain

6th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC601	Power System-II	3	0	0	30	70	100	3
2	ESC602	Electrical Measurements and Instrumentation	3	0	0	30	70	100	3
3	ESC603	Electronics Design	3	0	0	30	70	100	3
4		Program Elective-III	3	0	0	30	70	100	3
5		Program Elective-IV	3	0	0	30	70	100	3
6		Open Elective –II	3	0	0	30	70	100	3
7	ESC601P	Power System Lab –II	0	0	2	50	50	100	1
8	ESC602P	Electrical Measurements and Instrumentation Lab	0	0	2	50	50	100	1
9	ESC603P	Electronics Design Lab	0	0	2	50	50	100	1
10	ESC604	Project-4	0	0	2	50	50	100	1
11	ELV605	Social Work*	-	-	-	100		100	1
		Total	**18**	**0**	**8**			**1100**	**23**

	Course Code	Course Title
Open Elective -II	EOC612	Sensors & Actuators
	EOC613	Renewable Energy
	EOC614	Remote Sensing and GIS
Program Elective –III	EPE606	Fuel cell Electrical Vehicles and Hydrogen Technology
	EPE607	Electrical and Hybrid Vehicles
	EPE608	Digital Signal Processing
Program Elective –IV	EPE609	Wind and Solar Energy System
	EPE610	Electrical Vehicles controls and Drives
	EPE611	Digital Control Systems

* At least one day in fortnight

ELPC601	Power Systems – II	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Use numerical methods to analyse a power system in steady state.
2. Understand stability constraints in a synchronous grid.
3. Understand methods to control the voltage, frequency and powerflow.
4. Understand the monitoring and control of a power system.
5. Understand the basics of power system economics.

Unit 1: Power Flow Analysis

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non- linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

Unit 2: Stability Constraints in synchronous grids

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. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta der methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

Unit 3: Control of Frequency and Voltage

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Power flow control using embedded dc links and phase shifters

Unit 4: Monitoring and Control

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State- estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.

Power System Economics and Management

Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

Text/References:

1. J.GraingerandW.D.Stevenson,“PowerSystemAnalysis”,McGrawHillEducation, 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.

5. B.M. Weedy, B.J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley,2012.

ELPC651	Power Systems– II Lab	0L:0T:2P	1 credits

Hands-on and computational experiments related to the course contents of ELPC601. This should include programming of numerical methods for solution of the power flow problem and stability analysis. Visit to load dispatch centre is suggested.

ELPC602	Electrical Measurements and Instrumentation	3L:0T:0P	3 credits

Course outcomes: At the end of this course, the students will be able to:

1. Learn about various measurement instruments for measurement of Voltage, Current, Power, Power Factor & Frequency, their construction, operating principle, limitations, etc.;
2. Understand statistical data analysis & errors in instruments;
3. Analyse the static characteristics of instruments
4. Understand the measurement of parameters & variables with the help of D.C. & A.C. bridges.
5. Analyze the concept and applications of sensors and transducers

UNIT- I- Fundamental Concepts Relating to Measurements: Standards, True Value, Static Characteristic of Instruments (Accuracy, Precision, Resolution, Threshold, Sensitivity, Drift, Hysteresis & Dead-band, Dead Time); Classification of Instruments (Absolute & Secondary Instruments; Indicating, Recording & Integrating instruments); Generalized Instrument (Block diagram, description of blocks); Three forces in Electromechanical indicating instruments; Comparison of damping methods & their suitability; Scale information.

Errors in Measurements (Gross, Systematic, Random); Basic statistical analysis applied to measurements: Mean, standard deviation, Six-sigma estimation, C_p, C_{pk}.

UNIT- II- Measuring Instruments For Voltage & Current: Construction, Operating Principle, torque equation, Shape of scale, use as Ammeter or as Voltmeter (Extension of Range), Use on AC/DC or both, Advantages & disadvantages, Errors (Both on AC/DC) of PMMC types, Electrodynamic Type, Moving iron type (attraction, repulsion & combined types), & Induction type instruments

Wattmeters Power Factor & Frequency Meters: Construction, operating principle, Torque equation, Shape of scale, Errors, Advantages & Disadvantages of Electro-dynamic& Induction type Wattmeters; Construction, operation, principle, Torque equation, Advantages & disadvantages of Single phase power factor meters (Electro- dynamic& Moving Iron types) & Frequency meters (Electrical Resonance Type: Ferro dynamic & Electro-dynamic types).

UNIT- III - Measurement of Resistances (Medium, Low & High): Voltmeter-ammeter method & Substitution Method for medium range resistance measurement; Limitations of Wheatstone bridge; Four-terminal resistance; Kelvin's double bridge method for low resistance measurement, Difficulties in high resistance measurements; Measurement of high resistance by direct deflection & loss of charge methods, Meggar.

UNIT- IV - Measurement of Inductance (L), Capacitance (C) & Frequency by A.C. Bridges: General balance equation, Circuit diagram, Phasor diagram, Advantages, disadvantages, applications of Maxwell's inductance- capacitance, Hays, Owens, Schering &Wein's bridges. Clamp on meter, Digital Storage Oscilloscope.

Sensors and Transducers: Sensors and Transducers for Physical parameters, temperature, pressure, torque, flow, speed and position sensors

TEXT BOOK/REFERENCE BOOKS:

1. A Course in Elect. & Electronic Measurements & Instrumentation by A. K. Sawhney; Khanna Pub.
2. Dr. J.S. Saini, "A Textbook on Measurements & Instrumentation (With Experiments)"; Pub.: New Age International, New Delhi.
3. Electrical Measurements by E.W. Golding & F.C. Widdis; Pub.: Reem Publications
4. Electronic Instrumentation & Measurement Technique, W.D. Cooper & A.D. Helfrick; Pub.: Prentice Hall
5. Measuring Systems by Ernest O. Doebelin & Dhanesh N. Manik; Pub.: McGraw Hill

ELPC652	Electrical Measurements and Instrumentation Lab	0L:0T:2P	1 credits

Hands-on experiments related to the course contents of ELPC602

ELPC603	Electronics Design	1L:0T:0P	1 credits

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Understand the practical issues related to practical implementation of applications using electronic circuits.
2. Choose appropriate components, software and hardwareplatforms.
3. Design a Printed Circuit Board, get it made and populate/solder it with components. Work as a team with other students to implement an application.

Unit 1:Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits;
Unit 2: Introduction to electronic instrumentation and PC based data acquisition;
Unit 3: Electronic system design, Analog system design, Interfacing of analog and digital systems,
Unit 4 :Embedded systems, Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations. Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application.

Text/Reference Books

1. A. S. Sedra and K. C. Smith, “Microelectronic circuits”, Oxford University Press,2007.
2. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press,1997.
3. H.W.Ott, “Noise Reduction Techniques in Electronic Systems”, Wiley,1989.
4. W.C. Bosshart, “Printed Circuit Boards: Design and Technology”, Tata McGrawHill, 1983.
5. G.L. Ginsberg, “Printed Circuit Design”, McGraw Hill, 1991.

ELPC653	Electronics Design Lab	0L:0T:4P	2 credits

Hands-on experiments related to the course contents of ELPC603

	Electrical and Hybrid Vehicles	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energystorage.
3. Understand the different strategies related to energy storagesystems.

Unit 1: Introduction

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit 2: Electric Trains

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive- train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit 3: Energy Storage

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit 4: Energy Management Strategies

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

References:

1. C.Mi,M.A.MasrurandD.W.Gao,“HybridElectricVehicles:PrinciplesandApplicationswith Practical Perspectives”, John Wiley & Sons,2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: EnergyManagement Strategies”, Springer,2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press,2004.
4. T. Denton, “Electric and Hybrid Vehicles”, Routledge,2016.

	Digital Signal Processing	3L:0T:0P	3 credits

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. Analyse discrete-time systems using z-transform.
3. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms. Design digital filters for various applications.
4. Apply digital signal processing for the analysis of real-life signals.

Unit 1: Discrete-time signals and systems

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Unit 2: Z-transform

Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z- transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Unit 3: Discrete Fourier Transform

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Connvolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Unit 4:Design of Digital filters

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

Applications of Digital Signal Processing

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill,2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall,1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall,1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing",PrenticeHall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall,1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

	Wind and Solar Energy Systems	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

Unit 1: Physics of Wind Power:

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power- cumulative distribution functions.

Wind generator topologies:

Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Unit 2: The Solar Resource:

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Solar photovoltaic:

Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

Unit 3: Network Integration Issues:

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Unit 4: Solar thermal power generation:

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text / References:

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd.,2005.
2. G. M. Masters, “Renewable and Efficient Electric Power Systems**”,** John Wiley and Sons,2004.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill,1984.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd.,2006.
5. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications,2004.
6. J.A.DuffieandW.A.Beckman,“SolarEngineeringofThermalProcesses”,JohnWiley&Sons, 1991.

	Digital Control Systems	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Obtain discrete representation of LTI systems.
2. Analyse stability of open loop and closed loop discrete-time systems.
3. Design and analyse digital controllers.
4. Design state feedback and output feedbackcontrollers.

Unit 1: Discrete System Representation and Analysis (12 hours)

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit, Effects of Sampling and Quantization. Choice of sampling frequency.ZOH equivalent.

Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.

Unit 2: Stability of Discrete Time System (6 hours)

Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

Unit 3: State Space Approach for discrete time systems (10 hours)

State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Unit 4: Design of Digital Control System and Discrete output feedback control (8 hours)

Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator. Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text Books :

1. K. Ogata, “Digital Control Engineering”, Prentice Hall, Englewood Cliffs,1995.
2. M. Gopal, “Digital Control Engineering”, Wiley Eastern,1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, “Digital Control of Dynamic Systems”, Addison-Wesley,1998.
4. B.C. Kuo, “Digital Control System”, Holt, Rinehart and Winston,1980.

	Electrical Vehicles controls and Drives	3L:0T:0P	3 credits

Course Outcomes
CO1 Appraise the need and possibility of extracting electrical motor for electrical vehicle.
CO2 Analyse need of different controlling system for electric vehicle
CO3Understand scheme of electric vehicle drives.
CO4 Apply the concept of Hybrid Electric Drive Trains.
CO5 Evaluate the performance parameters of Electric Propulsion Systems.

Unit I: Electric motors
Electric motors Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor Motor Controllers Component sizing, Physical locations, Mechanical connection of motor Electrical connection of motor

Control Unit and Control Strategies
Controller Overview, Switch Controller, Solid-State Controller, Electronic Controllers, AC Controller, DC Motor Controller- The Lesson of the Jones Switch, An Off-the-Shelf Curtis PWM DC Motor Controller, AC Controllers, Today‘s Best Controller Solution, Zilla Controller (One of the Best DC Controller for Conversions) ZAPI., Control Strategies, Max. SOC-of-PPS Control Strategy, Thermostat Control Strategy (Engine-On–Off)

Unit II: Electric Vehicle Drives
Electric Vehicle Drives Configurations of Electric Vehicles, Performance of Electric Vehicles, Traction Motor Characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance, Tractive Effort in Normal Driving, Energy Consumption

Permanent Magnetic Brush-Less DC Motor Drives
Basic Principles of BLDC Motor Drives, BLDC Machine Construction and Classification Properties of PM Material, Alnico, Ferrites, Rare-Earth PMs, case studies

Unit III : Concept of Hybrid Electric Drive Trains
Concept of Hybrid Electric Drive Trains Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, TorqueCoupling, Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid Electric Drive Trains, Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Train.

Unit IV: Electric Propulsion Systems
DC Motor Drive, Principle of Operation and Performance, Combined Armature Voltage and Field Control, Chopper Control of DC Motors, Multi quadrant Control of Chopper-Fed, DC Motor Drives, Two-Quadrant Control of Forward Motoring and Regenerative Braking, Single Chopper with a Reverse Switch, Class C Two Quadrant Chopper, Four-Quadrant Operation, Induction Motor Drives, Basic Operation Principles of Induction Motor, Steady-State Performance, Constant Volt/Hertz Control, Power Electronic Control, Field Orientation Control, Field Orientation Principle, Control, Direction Rotor Flux Orientation Scheme, Indirect Rotor Flux Orientation Scheme, Voltage Source Inverter for FO, Voltage Control in Voltage Source Invert, Current Control in Voltage Source Inverter.

Text Books:
1. M. Ehsani,:Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,2005
2. K.T.Chau, Zheng Wang, Chaos in Electrical Drive Systems: Analysis, Control & Applications, 1st Edition, John Wiley and Sons, 2011
3. Chung Chow Chan, K.T.Chau, Modern Electric Vehicle Technology, 1st Edition, Oxford University Press, 2001
4. A.T.P.So George C.Barney waterstones.com, International Journal of Elevator Engineering, United Kingdom

	Fuel cell Electrical Vehicles and Hydrogen Technology	**3L:0T:0P**	**3 credits**

Unit I: Introduction to Hydrogen and Fuel Cell Technology
Hydrogen as an energy carrier: properties, advantages, challenges; Overview of hydrogen economy and energy systems; Introduction to fuel cells: working principle, types, and classification; Comparison of fuel cells with batteries and IC engines; Applications of hydrogen in stationary and mobile energy systems

Unit 2: Fuel Cell Systems for Electric Vehicles
Proton Exchange Membrane Fuel Cells (PEMFC): construction, operation, and characteristics; Fuel cell stack and balance of plant (BoP); Fuel cell system integration in Electric Vehicles (FCEVs); Fuel cell hybrid systems and powertrain configuration; Efficiency, performance, and emissions comparison with BEVs and ICEs

Unit 3: Hydrogen Production, Storage, and Distribution
Hydrogen production methods: steam methane reforming, electrolysis, biomass gasification, photo-electro-chemical processes; Green hydrogen vs. grey/blue hydrogen; Hydrogen storage: compressed gas, liquid hydrogen, metal hydrides, chemical carriers; Safety issues and regulations in hydrogen handling; Hydrogen distribution infrastructure: pipelines, transport, refuelling stations

Unit 4: Policy, Standards, and Future Trends
National and international hydrogen roadmaps (India, EU, Japan, USA); Government policies and incentives for hydrogen and FCEVs; Codes, standards, and certifications (ISO, SAE, BIS); Techno-economic analysis and life cycle assessment of hydrogen systems; Emerging research areas: solid oxide fuel cells, hydrogen blending in gas grids, hydrogen in aviation and shipping

Books & References:
1. "Fuel Cell Technology Handbook" by Gregor Hoogers
2. "Hydrogen and Fuel Cells: Emerging Technologies and Applications" by Bent Sørensen
3. "Hydrogen Fuel: Production, Transport, and Storage" by Ram B. Gupta

7th Semester

Sr. No.	Course Code	Course Title	Hours Per Week			Internal Marks	Final Marks	Total	Credits
			L	T	P				
1	ESC701	High Voltage Engineering	**3**	**0**	**0**	30	70	100	3
2	ESC702	Energy Storage and Management for Electric Vehicles	3	0	0	30	70	100	3
3		Program Elective -V	3	0	0	30	70	100	3
4		Program Elective -VI	3	0	0	30	70	100	3
5		Open Elective –III	3	0	0	30	70	100	3
6		Open Elective –IV	3	0	0	30	70	100	3
7	ESC703	Major Project	0	0	6	50	50	100	3
8	ESC704P	Introduction to Scilab and its applications	0	0	2	50	50	100	1
9	ESC702P	Energy Storage and Management for Electric Vehicles Lab	0	0	2	50	50	100	1
		Total	**18**	**0**	**10**			**900**	**23**

	Course Code	Course Title
Program Elective –V	EPE705	Materials for Electric and Hybrid Electric Vehicles
	EPE 706	HVDC Transmission Systems
	EPE 707	Power Quality and FACTS
Program Elective –VI	EPE 708	Power System Protection
	EPE 709	Electric Vehicle Testing and Certification
	EPE 710	Control Systems Design
	EPE 711	Power System Dynamics and Control

	Course Code	Course Title
Open Elective-III	EOE 712	Organizational Behavior
	EOE 713	Finance & Accounting
	EOE 714	Basics of Operation Research
Open Elective-IV	EOE 715	Materials Science and Engineering
	EOE 716	Augmented / Virtual Reality
	EOE 717	Computational Fluid Dynamics

	Power System Protection	3L:0T:0P	3 credits

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components. Understand the basic principles of digital protection.
4. Understand system protection schemes, and the use of wide-area measurements.

Unit 1: Introduction and Components of a Protection System

Principles of Power System Protection, Fuse (Introduction, types and Applications), Relays – operating principle, types, zone of protection and applications, Instrument transformers and modelling, Circuit Breakers- arcing phenomenon, types, characteristics, ratings and applications, surge diverters, absorbers and grounding

Unit 2: Faults and Over-Current Protection

Review of Fault Analysis, Sequence Networks, Introduction to Over current Protection and over current relay co-ordination.

Equipment Protection Schemes

Directional, Distance, Differential protection, Transformer and Generator protection, Bus bar Protection, Bus Bar arrangement schemes

Unit3: Digital Protection

Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues.

Modeling and Simulation of Protection Schemes

Simulation of transients using Electro-Magnetic Transients (EMT) programs. Relay Testing.

Unit 4: System Protection

Effect of Power Swings on Distance Relaying, Under-frequency, under- voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide- Area Measurement Systems (WAMS).Application of WAMS for improving protection systems.

Text/References

1. J. L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 1987.
2. Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.
3. A.G. Phadke and J.S. Thorp, "Computer Relaying for Power Systems", John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer,2008.
5. D. Reimert, "Protective Relaying for Power Generation Systems", Taylor and Francis,2006.

	HVDC Transmission Systems	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the advantages of dc transmission over actransmission.
2. Understand the operation of Line Commutated Converters and Voltage SourceConverters.
3. Understand the control strategies used in HVdc transmissionsystem.
4. Understand the improvement of power system stability using an HVdcsystem.

Unit 1: DC Transmission Technology

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

Analysis of Line Commutated and Voltage Source Converters

Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links.

Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using aVSC.

Unit 2:Control of HVdc Converters:

Principles of Link Control in aLCCHVdc system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.

Unit3: Components of HVdc systems:

Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects. Insulators, Transient Over-voltages.dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Mono polar Operation. Ground Electrodes.

Stability Enhancement using HVDC Control

Basic Concepts : Power System Angular, Voltage and Frequency Stability.

Power Modulation: basic principles – synchronous and asynchronous links, Voltage Stability Problem in AC/dc systems.

Unit 4: MTDC Links

Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVDC Technology. Introduction to Modular Multi-level Converters.

Text/References:

1. K. R. Padiyar, “HVDC Power Transmission Systems”, New Age International Publishers,2011.
2. J. Arrillaga, “High Voltage Direct Current Transmission”, Peter Peregrinus Ltd.,1983.
3. E. W. Kimbark, “Direct Current Transmission”, Vol.1, Wiley-Interscience,1971.

ELPE713	Power Quality and FACTS	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. Understand the working principles of FACTS devices and their operating characteristics.
3. Understand the basic concepts of powerquality.
4. Understand the working principles of devices to improve power quality.

Unit 1: Transmission Lines and Series/Shunt Reactive Power Compensation

Basics of AC Transmission Analysis of uncompensated AC transmission lines Passive Reactive Power Compensation Shunt and series compensation at the mid-point of an AC line Comparison of Series and Shunt Compensation.

Thyristor-based Flexible AC Transmission Controllers (FACTS)

Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC, Fault Current Limiter.

Unit 2: Voltage Source Converter based (FACTS) controllers

Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse- Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.

Unit 3: Application of FACTS

Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC, Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.

Power Quality Problems in Distribution Systems

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations, Flicker and its measurement. Tolerance of Equipment: CBEMA curve.

Unit 4: DSTATCOM

Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters, Synchronous Reference Frame Extraction of Reference Currents ,Current Control Techniques in for DSTATCOM.

Dynamic Voltage Restorer and Unified Power Quality Conditioner (6 hours)

Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.

Text/References

1. N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press,1999.
2. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New AgeInternational (P) Ltd. 2007.
3. T.J.E.Miller,“ReactivePower Control inElectricSystems”,JohnWileyandSons,NewYork,1983.
4. R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education,2012.
5. G. T. Heydt, “Electric Power Quality”, Stars in a Circle Publications,1991

ELPE714	High Voltage Engineering	3L:0T:0P	3 credits

Course outcomes:

At the end of the course, the student will demonstrate

1. Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
2. KnowledgeofgenerationandmeasurementofD.C.,A.C.,&Impulsevoltages.Knowledgeoftestson H. V. equipment and on insulating materials, as per thestandards.
3. Knowledge of how over-voltages arise in a power system, and protection against these over-voltages.

Unit 1: Breakdown

Gases : Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge

Breakdown in liquid and solid Insulating materials

Pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Unit 2: Generation of High Voltages

Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Measurements of High Voltages and Currents

Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Unit 3: Lightning and Switching Over-voltages

Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

Unit 4: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories

Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.

Text/Reference Books

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education,2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers,2007.
3. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.
4. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
5. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.
6. Various IS standards for HV Laboratory Techniques and Testing

	Control Systems Design	3L:0T:0P	3 credits

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand various design specifications.
2. Designcontrollerstosatisfythedesireddesignspecificationsusingsimplecontroller structures(P,PI,PID, compensators).
3. Design controllers using the state-space approach.

Unit 1: Design Specifications

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response.Effect of addition of pole on system performance. Effect of addition of zero on system response.

Design of Classical Control System in the time domain

Introduction to compensator.Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation.Realization of compensators.

Unit 2: Design of Classical Control System in frequency domain

Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

Design of PID controllers

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

Unit3: Control System Design in state space

Review of state space representation. Concept of controllability &observability, effect of pole zero cancellation on the controllability &observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. SeparationPrinciple.

Unit 4: Nonlinearities and its effect on system performance

Various types of non-linearities.Effect of various non-linearities on system performance. Singular points. Phase plot analysis.

Text and Reference Books :

1. N. Nise, "Control system Engineering", John Wiley,2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley,2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern,1988.
4. K. Ogata, "Modern Control Engineering", Prentice Hall,2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall,1995.
6. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill,1995.
7. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems",Saunders College Pub, 1994.

	Power System Dynamics and Control	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the problem of power system stability and its impact on the system.
- Analyse linear dynamical systems and use of numerical integration methods.
- Model different power system components for the study of stability.
- Understand the methods to improve stability.

Unit 1: Introduction to Power System Operations

Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and control.

Analysis of Linear Dynamical System and Numerical Methods

Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System, Analysis using Numerical Integration Techniques, Issues in Modeling: Slow and Fast Transients, Stiff System

Unit 2: Modeling of Synchronous Machines and Associated Controllers

Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.

Unit 3 : Modeling of other Power System Components

Modeling of Loads. Load Models - induction machine model. HVDC and FACTS controllers, Wind Energy Systems.

Unit 4 : Stability Analysis

Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi- machine systems – Intra- plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs.

Enhancing System Stability

Planning Measures. Stabilizing Controllers (Power System Stabilizers).Operational Measures-Preventive Control. Emergency Control.

Text/Reference Books

1. K.R. Padiyar, “ Power System Dynamics, Stability and Control”, B. S. Publications,2002.
2. P. Kundur, “ Power System Stability and Control”, McGraw Hill,1995.
3. P. Sauer and M. A. Pai, “ Power System Dynamics and Stability” , Prentice Hall,1997.

HSMC-03	Organizational Behaviour	3L:0T:0P	3 credits

Course Objectives:
The objective of this course is to expose the students to basic concepts of management and provide insights necessary to understand behavioural processes at individual, team and organizational level.

MODULE-1

Introduction to management: concept, nature; evolution of management thoughts –traditional, behavioural, system, contingency and quality viewpoints; Managerial levels, skills and roles in an organization; Functions of Management: Planning, Organizing, Directing, Controlling, Problem solving and Decision making; Management control; managerial ethics and social responsibility; Management Information System (MIS).

MODULE-2

Fundamentals of Organizational Behavior: Concept, evolution, importance and relationship with other Fields; Contemporary challenges of OB; Individual Processes and Behavior – differences, Personality concept, determinant, theories and applications; Values, Attitudes and Emotions, Perception- concept, process and applications, Learning and Reinforcement; Motivation: concept, theories and applications; Stress management.

MODULE-3

Interpersonal Processes- Work teams and groups- Definition of Group, Stages of group development, Group cohesiveness, Types of groups, Group processes and Decision Making; Team Building; Conflict- concept, sources, types, management of conflict; Power and Political Behavior; Leadership: concept, function and styles.

MODULE-4

Organizational Processes and structure: organizational design: various organizational structures and their effect on human behavior; Organizational climate; Organizational culture; Organizational change: Concept, Nature, Resistance to Change, Change Management, Implementing Change and Organizational Development

Course Outcomes:

1. The students learn how to influence the human behaviour.
2. Students will be able to understand behavioural dynamics in organizations.
3. Students will be able to apply managerial concepts in practical life.
4. Students will be able to understand organizational culture and change.

REFERENCES:

1. Robbins, S.P. and Decenzo, D.A. Fundamentals of Management, Pearson Education Asia, New Delhi.

2. Stoner, J et. al, Management, New Delhi, PHI, New Delhi
3. SatyaRaju, Management – Text & Cases, PHI, New Delhi
4. Kavita Singh, OrganisationalBehaviour: Text and cases. New Delhi: Pearson Education.
5. Pareek, Udai, Understanding OrganisationalBehaviour, Oxford University Press, New Delhi
6. Robbins, S.P. & Judge, T.A., OrganisationalBehaviour, Prentice Hall of India, New Delhi

HSMC-04	Finance and Accounting	3L:0T:0P	3 credits

Course Objectives:

The purpose of the course is to understand nature of accounting and its interaction with other accounting and their comparison. It also focuses what kind of information the manager need, from where these can be obtained and how this information can be used to carry out important managerial decision.

MODULE-1:

Meaning nature and scope of different types of accounting and their comparison.Accounting principles and Indian accounting standards, IFRS, Preparation of final accounts of company with basic adjustments. Reading and understanding of Annual report.

MODULE-2:

Analysis and interpretation of financial statements – meaning, importance and techniques, ratio analysis; fund flow analysis; cash flow analysis (AS-3)

MODULE-3:

Classification of costs, preparation of cost sheet, inventory valuation, overview of standard costing and variance analysis; material variance and labour variance.

MODULE-4:

Budgetary control- meaning, need, objectives, essentials of budgeting, different types of budgets cash budget, flexible budget zero base budget; marginal costing, BEP analysis, decision making for optimum sales mix, exploring new markets, make/Buy decisions, expand/ contract, accepting and rejecting decisions

Course Outcomes:

1. This course will impart knowledge to the students regarding preparation of financial statements their analysis.
2. The students will be able to understand applications of cost accounting and cost control techniques like standard costing etc.
3. The course will help them to take better managerial decisions.
4. Students will be able to know about budget control techniques.

REFERENCES:

1. Singhal, A.K. and Ghosh Roy, H.J., Accounting for Managers, JBC Publishers and Distributors, New Delhi
2. Pandey, I.M., Management Accounting, Vikas Publishing House, New Delhi
3. Horngren, Sundem and Stratton, Introduction to Management Accounting, Pearson Education, New Delhi.
4. Jain, S.P and Narang, K.L., Advanced Cost Accounting, Kalyani Publishers, Ludhiana.
5. Khan, M.Y. and Jain, P.K., Management Accounting, TMH, New Delhi

HSMC-05	Basics of Operation Research	3L:0T:0P	3 credits

Course Objectives:

1. To introduce the student with Different types of OR Models and Linear Programming Model
2. To introduce the students about Dual Sensitive Method and Sensitive Analysis.
3. To introduce the concept of Assignment Problem.
4. To introduce the students with Network Model
5. To introduce the concept of Dynamic Programming and Queuing Model.

MODULE-1:

The origin of OR, Phases of an O.R. study, Impact of OR, Formulation of Linear-programming model, Graphical solution. Converting the linear programming problem to standard form, Simplex method.

MODULE-2:

Big-M method, Two-phase method, Degeneracy, Alternate optima, unbounded and infeasible solution.

MODULE-3:

Definition of the dual problem, prima-dual relationship, Dual Simplex method, Post optimal and sensitivity analysis.

MODULE-4:

Assignment problem and its mathematical formulation, solution of assignment problem (Hyngarian method), Transportation problem and its mathematical formulation.Initial basic feasible solution of transportation problem by North-West corner rule. Lowest-Cost Entry method and Vogel's Approximation method, Optimal solution of transportation problem.

MODULE-5:

Network models, Minimal spanning tree algorithm, Shortest-route problem (Floyd's Algorithm and Dijkstras algorithm), Maximal flow problem, Introduction to CPM & PERT.

MODULE-6:

Introduction to Dynamic Programming, General inventory Model, Static Economic Order Quantity (EOQ) Models.

MODULE-7:

Elements of a Queuing model, Pure Birth & Death model, Generalized Poisson Queuing, Specialized Poisson Queues.

Course Outcomes:

After completion of the course student will be able to:

1. Understand different types of OR Model and solve Linear programming problems.
2. Understand dual simplex problem and sensitive analysis.
3. Solve Assignment problem.
4. Understand Dynamic Programming and Queuing Model.

REFERENCES:

1. Operations Research by Hamdy A Taha
2. Introduction to Operations Research by Hiller and Dieherman, TMH
3. Optimization Theory and Application: SS Rao, John Wiley.