Gurugram University Gurugram

DEPARTMENTOF ENGINEERING & TECHNOLOGY
(FACULTY OF SCIENCES & TECHNOLOGY)

SCHEME & CURRICULUM

for

BACHELOR OF TECHNOLOGYUG DEGREE PROGRAMME

in

Electronics & Communication Engineering (VLSI Design & Technology)

(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 Electronic Engineering (VLSI Design & Technology) 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 Electronics Engineering (VLSI Design & Technology)
- 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 Electronics Engineering and allied areas by collaborating with industryand other R&D organizations.

ABOUT THE PROGRAM

The Bachelor of Technology (B.Tech.) program in in VLSI (Very Large Scale Integration) Design & Technology offers students a comprehensive education in integrated circuit design, combining theoretical knowledge with practical skills. Students learn fundamental concepts in digital logic design, analog and digital electronics, and semiconductor physics, while gaining expertise in VLSI design methodologies, hardware description languages (HDLs), and IC fabrication processes. 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 5G. With a focus on both technical proficiency and innovation, this program addresses the growing demand for skilled VLSI 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.

Electronics & Communication Engineering (VLSI Design & Technology)

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.
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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 VLSI Design & Technology.
PSO2	Deploy traditional and innovative techniques / tools in diverse domains of Electronic 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	28	1000	23
4.	IV	27	1000	22
5.	V	30	1100	23
6.	VI	28	1000	24
7.	VII	25	900	20
8.	VIII	30	600	16
	Total	220	7300	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.

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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

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-102	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-102P	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-101	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	Basic of ElectricalEngineering (P)	0	0	2	1	50	50	100
7	ESC-101P	Programming for problem solving using (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

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CREDIT DISTRIBUTION IN THE SECOND YEAR OF UNDERGRADUATE ENGINEERING PROGRAM

3rd Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-301	Electronic Devices	3	0	0	3	30	70	100
2	ESC-302	Digital Electronics	3	0	0	3	30	70	100
3	ESC-303	Signals and Systems	3	0	0	3	30	70	100
4	ESC-304	Network Theory	3	0	0	3	30	70	100
5	ESC-305	Python	2	0	2	3	50	50	100
6	ESC -306	VHDL - Hardware Description Language	3	0	0	3	30	70	100
7	ESC -301P	Electronic Devices Lab	0	0	2	1	50	50	100
8	ESC-302P	Digital Electronics Lab	0	0	2	1	50	50	100
9	ESC-306P	VHDL - Hardware Description Language	0	0	2	1	50	50	100
10	ESC-101P	Project Based Learning-1	0	0	4	2	50	50	100
Total Credits						23			1000

4th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-401	Analog Circuits	3	0	0	3	30	70	100
2	ESC-402	Microcontrollers and Computer Architecture	3	0	0	3	30	70	100
3	ESC-403	Analog and Digital Communication	3	0	0	3	30	70	100
4	ESC-404	Microfabrication-I	3	0	0	3	30	70	100
5	BSC-405	Numerical Techniques	3	0	0	3	30	70	100
6	HSM-406	Management - Organizational Behavior	2	0	0	2	30	70	100
7	ESC-401P	Analog Circuits Lab	0	0	2	1	50	50	100
8	ESC-402P	Microcontrollers and Computer Architecture Lab	0	0	2	1	50	50	100
9	ESC-406P	Microfabrication I Lab	0	0	2	1	50	50	100
10	ESC-201P	Project Based Learning-2	0	0	4	2	50	50	100
Total Credits						22			1000

5th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-501	CMOS Integrated Circuits	3	0	0	3	30	70	100
2	ESC-502	Hardware Description Language - Verilog	3	0	0	3	30	70	100
3	ESC-503	Microfabrication-II	3	0	0	3	30	70	100
4	ESC-504	SOC Design 1: Design & Verification	3	0	0	3	30	70	100
5	ESC-505	Control Systems	3	0	0	3	30	70	100
6	ESC-506	Embedded Systems	3	0	0	3	30	70	100
7	ESC-502P	Hardware Description Language – Verilog Lab	0	0	2	1	50	50	100
8	ESC-503P	Microfabrication-II Lab	0	0	2	1	50	50	100
9	ESC-504P	SOC Design 1: Design & Verification Lab	0	0	2	1	50	50	100
10	ESC-506P	Embedded Systems Lab (P)	0	0	2	1	50	50	100
11	ESC-507	Project Based Learning-3	0	0	4	2	50	50	100
		Total Credits				24			1100

6th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-601	MOSFET Physics and Sub-Micron Devices	3	0	0	3	30	70	100
2	ESC-602	SOC Design 2: Chip Implementation with Physical Design Leading to Tape-Out	3	0	0	3	30	70	100
3	ESC-603	Semiconductor Equipment Design and Technology	3	0	0	3	30	70	100
4	ESC-604	Semiconductor Materials Synthesis and Characterization	3	0	0	3	30	70	100
5	PE-1	Program Elective-1	3	0	0	3	30	70	100
6	OE-1	Open Elective-1	3	0	0	3	30	70	100
7	ESC-605	Device Modeling using TCAD Lab	0	0	2	1	50	50	100
8	ESC-602P	SOC Design 2: Chip Implementation with Physical Design Leading to Tape-Out Lab	0	0	2	1	50	50	100
9	PE-1P	Program Elective-1 Lab	0	0	2	1	50	50	100
10	ESC-607P	Minor Project	0	0	4	2	50	50	100
		Total Credits				23			1000

7th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	PE-2	Program Elective-2	3	0	0	3	30	70	100
2	PE-3	Program Elective-3	3	0	0	3	30	70	100
3	OE-2	Open Elective-2	3	0	0	3	30	70	100
4	OE-3	Open Elective-3	3	0	0	3	30	70	100
5	HSM-5	Slot for HSM Course	3	0	0	3	30	70	100
6	XC-29	Major Project Phase 1	0	0	4	2	50	50	100
7	PE-1	Program Elective-2 Lab	0	0	2	1	50	50	100
8	PE-1	Program Elective-3 Lab	0	0	2	1	50	50	100
9	XC-28	Industry/Foundry visit/Survey Compulsory	0	0	2	1	50	50	100
Total Credits						20			900

8th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	PE-2	3 Months Certificate course 1	01		04	3	100		100
2	PE-3	3 Months Certificate course 2	01		04	3	100		100
3	XC-P3	Internship / Final Year Project Phase -2			20	10	200	200	400
Total Credits						16			600

Program Elective Courses:

					PE1 Basket
Sr. No.	Course code	Course Title	Semester	Hrs /Week	Credits
1	PE1A	Analog IC Design	VI	3:0:0	3
2	PE1B	FPGA Programming	VI	3:0:0	3
3	PE1C	Quantum Computing	VI	3:0:0	3
4	PE1D	Digital Signal Processing in VLSI	VI	3:0:0	3
					PE2 Basket
1	PE2A	Device Modeling using TCAD	VII	3:0:0	3
2	PE2B	Mixed Signal Design	VII	3:0:0	3
3	PE2C	Low Power VLSI Design	VII	3:0:0	3
					PE3 Basket
1	PE3A	Design for Testability	VII	3:0:0	3
2	PE3B	IC Packaging	VII	3:0:0	3
3	PE3C	Verification Tools and Techniques	VII	3:0:0	3
					PE4 Basket
1	PE4A	Emerging Memory Devices	VII	3:0:0	3
2	PE4B	Biomedical Electronics	VII	3:0:0	3
3	PE4C	Memory Design	VII	3:0:0	3

Open Elective Courses:

					OE1 Basket
Sr. No.	Course code	Course Title	Semester	Hrs /Week	Credits
1	OE1A	AI & ML for VLSI CAD	VI	3:0:0	3
2	OE1B	MEMS and NEMS	VI	3:0:0	3
3	OE1C	Vacuum Technology	VI	3:0:0	3
					OE2 Basket
1	OE2A	Introduction to MEMS	VII	3:0:0	3
2	OE2B	AI Circuits	VII	3:0:0	3
3	OE2C	Nano Science & Technology	VII	3:0:0	3
					OE3 Basket
1	OE3A	Solar Photovoltaic Technology	VII	3:0:0	3
2	OE3B	Flexible & Organic Electronics	VII	3:0:0	3
3	OE3C	Computational Techniques	VII	3:0:0	3

15/4/25
Dr Sumit Choudhary   Dr Bhoop Singh   Dr Vijay Kr Lamba 15/4.

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SCHEME & CURRICULUM

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BACHELOR OF TECHNOLOGYUG DEGREE PROGRAMME

in

ELECTRICAL ENGINEERING (Electrical Vehicles)

(Session 2025-2026)

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SCHEME & CURRICULUM

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BACHELOR OF TECHNOLOGY

in

Electronics Engineering (VLSI Design & Technology)

(Session 2025-2026)

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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	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

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-301	Electronic Devices	3	0	0	3	30	70	100
2	ESC-302	Digital Electronics	3	0	0	3	30	70	100
3	ESC-303	Signals and Systems	3	0	0	3	30	70	100
4	ESC-304	Network Theory	3	0	0	3	30	70	100
5	ESC-305	Python	2	0	2	3	50	50	100
6	ESC -306	VHDL - Hardware Description Language	3	0	0	3	30	70	100
7	ESC -301P	Electronic Devices Lab	0	0	2	1	50	50	100
8	ESC-302P	Digital Electronics Lab	0	0	2	1	50	50	100
9	ESC-306P	VHDL - Hardware Description Language	0	0	2	1	50	50	100
10	ESC-101P	Project Based Learning-1	0	0	4	2	50	50	100
Total Credits						23			1000

4th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-401	Analog Circuits	3	0	0	3	30	70	100
2	ESC-402	Microcontrollers and Computer Architecture	3	0	0	3	30	70	100
3	ESC-403	Analog and Digital Communication	3	0	0	3	30	70	100
4	ESC-404	Microfabrication-I	3	0	0	3	30	70	100
5	BSC-405	Numerical Techniques	3	0	0	3	30	70	100
6	HSM-406	Management - Organizational Behavior	2	0	0	2	30	70	100
7	ESC-401P	Analog Circuits Lab	0	0	2	1	50	50	100
8	ESC-402P	Microcontrollers and Computer Architecture Lab	0	0	2	1	50	50	100
9	ESC-406P	Microfabrication I Lab	0	0	2	1	50	50	100
10	ESC-201P	Project Based Learning-2	0	0	4	2	50	50	100
Total Credits						22			1000

5th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-501	CMOS Integrated Circuits	3	0	0	3	30	70	100
2	ESC-502	Hardware Description Language - Verilog	3	0	0	3	30	70	100
3	ESC-503	Microfabrication-II	3	0	0	3	30	70	100
4	ESC-504	SOC Design 1: Design & Verification	3	0	0	3	30	70	100
5	ESC-505	Control Systems	3	0	0	3	30	70	100
6	ESC-506	Embedded Systems	3	0	0	3	30	70	100
7	ESC-502P	Hardware Description Language – Verilog Lab	0	0	2	1	50	50	100
8	ESC-503P	Microfabrication-II Lab	0	0	2	1	50	50	100
9	ESC-504P	SOC Design 1: Design & Verification Lab	0	0	2	1	50	50	100
10	ESC-506P	Embedded Systems Lab (P)	0	0	2	1	50	50	100
11	ESC-507	Project Based Learning-3	0	0	4	2	50	50	100
Total Credits						24			1100

6th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-601	MOSFET Physics and Sub-Micron Devices	3	0	0	3	30	70	100
2	ESC-602	SOC Design 2: Chip Implementation with Physical Design Leading to Tape-Out	3	0	0	3	30	70	100
3	ESC-603	Semiconductor Equipment Design and Technology	3	0	0	3	30	70	100
4	ESC-604	Semiconductor Materials Synthesis and Characterization	3	0	0	3	30	70	100
5	PE-1	Program Elective-1	3	0	0	3	30	70	100
6	OE-1	Open Elective-1	3	0	0	3	30	70	100
7	ESC-605	Device Modeling using TCAD Lab	0	0	2	1	50	50	100
8	ESC-602P	SOC Design 2: Chip Implementation with Physical Design Leading to Tape-Out Lab	0	0	2	1	50	50	100
9	PE-1P	Program Elective-1 Lab	0	0	2	1	50	50	100
10	ESC-607P	Minor Project	0	0	4	2	50	50	100
Total Credits						23			1000

7th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	PE-2	Program Elective-2	3	0	0	3	30	70	100
2	PE-3	Program Elective-3	3	0	0	3	30	70	100
3	OE-2	Open Elective-2	3	0	0	3	30	70	100
4	OE-3	Open Elective-3	3	0	0	3	30	70	100
5	HSM-5	Slot for HSM Course	3	0	0	3	30	70	100
6	XC-29	Major Project Phase 1	0	0	4	2	50	50	100
7	PE-1	Program Elective-2 Lab	0	0	2	1	50	50	100
8	PE-1	Program Elective-3 Lab	0	0	2	1	50	50	100
9	XC-28	Industry/Foundry visit/Survey Compulsory	0	0	2	1	50	50	100
Total Credits						20			900

8th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	PE-2	3 Months Certificate course 1	01		04	3	100		100
2	PE-3	3 Months Certificate course 2	01		04	3	100		100
3	XC-P3	Internship / Final Year Project Phase -2			20	10	200	200	400
Total Credits						16			600

Program Elective Courses:

					PE1 Basket
Sr. No.	**Course code**	**Course Title**	**Semester**	**Hrs /Week**	**Credits**
1	PE1A	Analog IC Design	VI	3:0:0	3
2	PE1B	FPGA Programming	VI	3:0:0	3
3	PE1C	Quantum Computing	VI	3:0:0	3
4	PE1D	Digital Signal Processing in VLSI	VI	3:0:0	3
					PE2 Basket
1	PE2A	Device Modeling using TCAD	VII	3:0:0	3
2	PE2B	Mixed Signal Design	VII	3:0:0	3
3	PE2C	Low Power VLSI Design	VII	3:0:0	3
					PE3 Basket
1	PE3A	Design for Testability	VII	3:0:0	3
2	PE3B	IC Packaging	VII	3:0:0	3
3	PE3C	Verification Tools and Techniques	VII	3:0:0	3
					PE4 Basket
1	PE4A	Emerging Memory Devices	VII	3:0:0	3
2	PE4B	Biomedical Electronics	VII	3:0:0	3
3	PE4C	Memory Design	VII	3:0:0	3

Open Elective Courses:

					OE1 Basket
Sr. No.	**Course code**	**Course Title**	**Semester**	**Hrs /Week**	**Credits**
1	OE1A	AI & ML for VLSI CAD	VI	3:0:0	3
2	OE1B	MEMS and NEMS	VI	3:0:0	3
3	OE1C	Vacuum Technology	VI	3:0:0	3
					OE2 Basket
1	OE2A	Introduction to MEMS	VII	3:0:0	3
2	OE2B	AI Circuits	VII	3:0:0	3
3	OE2C	Nano Science & Technology	VII	3:0:0	3
					OE3 Basket
1	OE3A	Solar Photovoltaic Technology	VII	3:0:0	3
2	OE3B	Flexible & Organic Electronics	VII	3:0:0	3
3	OE3C	Computational Techniques	VII	3:0:0	3

SEMESTER WISE STRUCTURE AND CURRICULUM

FOR

UG COURSE

IN

ELECTRONICS ENGINEERING

(VLSI Design & Technology)

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 …

Course code	HSM-101			
Category	Humanities and Social Sciences			
Course title	Communication Skills in English			
Scheme and Credits	L	T	P	Credits
	2	0	0	2
Class work/ Practical	30 Marks			
Exam	70 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

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/

<table>
<tr><td>Course code</td><td colspan="4">ESC-102 P</td></tr>
<tr><td>Category</td><td colspan="4">Engineering Science Course</td></tr>
<tr><td>Course title</td><td colspan="4">Electronics Engineering- I (P)</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>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Class work/ Practical</td><td colspan="4">50 Marks</td></tr>
<tr><td>Exam</td><td colspan="4">50 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>
</table>

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

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-301	Electronic Devices	3	0	0	3	30	70	100
2	ESC-302	Digital Electronics	3	0	0	3	30	70	100
3	ESC-303	Signals and Systems	3	0	0	3	30	70	100
4	ESC-304	Network Theory	3	0	0	3	30	70	100
5	ESC-305	Python	2	0	2	3	50	50	100
6	ESC -306	VHDL - Hardware Description Language	3	0	0	3	30	70	100
7	ESC -301P	Electronic Devices Lab	0	0	2	1	50	50	100
8	ESC-302P	Digital Electronics Lab	0	0	2	1	50	50	100
9	ESC-306P	VHDL - Hardware Description Language	0	0	2	1	50	50	100
10	ESC-101P	Project Based Learning-1	0	0	4	2	50	50	100
Total Credits						23			1000

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

(c) Theory exams will be of 03 hours duration.

(d) 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	ECE-301			
Category	Engineering Science Courses			
Course title	Electronic Devices			
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 is designed to provide foundational concepts that underpin modern electronic devices. From quantum mechanics to the behavior of charge carriers in materials, you will gain insights into how semiconductors operate and their crucial role in technology. We will delve into the intricacies of semiconductor physics, including the formation and characteristics of PN junctions, which are vital for diodes and transistors. Additionally, you will learn about metal-semiconductor contacts and the principles governing MOS devices, essential components in digital circuits. Through a combination of theoretical understanding and practical applications, this course aims to equip you with the knowledge needed to navigate the complexities of semiconductor technology. By the end, you will have a solid foundation to further your studies in electronics, electrical engineering, and related fields.

Prerequisite: Nil**.**

Objectives of the course:

The students will learn:

1. Grasp the basic principles of quantum mechanics, energy bands, and carrier transport mechanisms in intrinsic and extrinsic semiconductors, including diffusion and drift currents;
2. Examine the formation and characteristics of PN junctions, including depletion regions, biasing conditions, and the practical applications of diodes in circuits such as rectifiers, clippers, and clampers;
3. Investigate the fundamentals of metal-semiconductor contacts and MOS devices, focusing on their construction, operation, IV characteristics, and the implications of device scaling in modern technology.

Course Outcomes:

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

CO 1 Identify and explain the fundamental concepts of semiconductor physics, including quantum mechanics, electron behavior in periodic lattices, and energy band structures in intrinsic and extrinsic silicon;

CO 2 Analyze and apply the principles of PN junction formation, including depletion regions and bias conditions, to evaluate the characteristics and applications of PN junction diodes in various circuits;

CO 3 Design and assess metal-semiconductor contacts and MOS devices, understanding their IV characteristics and interface issues, while distinguishing between ohmic and Schottky contacts;

CO 4 Demonstrate the application of n-channel and p-channel MOSFETs in digital systems, including their operational characteristics and roles as switches, while discussing current trends in MOSFET technology and scaling.

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	1			1	1		2	1	1
2		3	3	3	2	1			1	1		2	1	1
3		3	3	3	2	1			1	1		2	1	1
4		3	3	3	2	1			1	1		2	1	1
5		3	3	3	2	1			1	1		2	1	1

Unit-I

Introduction to Semiconductors: Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance.

Unit-II

Introduction to Semiconductor Physics and PN Junctions: Semiconductor fundamentals: intrinsic and extrinsic semiconductors. PN junction formation, depletion region, and forward/backward bias. PN Junction Diode Applications, Diode characteristics and ideal diode equation. Diode circuits: rectifiers, clippers, and clampers.

Unit-III

Metal Semiconductor (MS) Contacts and MOS Devices: MS Contacts fundamentals: construction and operation, Energy bands, IV Characteristics, MS interface issues. Considerations for ohmic and Schottky contacts. MOS Device characteristics and operation, p-MOS and n-MOS Low frequency and High frequency operation and characteristics, MOS device interface, and Energy bands diagrams.

Unit-IV

Introduction MOSFETs: MOSFET fundamentals: n-channel and p-channel MOSFETs, MOSFET characteristics and regions of operation, MOSFET Applications, MOSFET as a switch and its role in digital systems. Advanced MOSFET Concepts and Final Review, MOSFET scaling and technology trends.

Suggested Books:

1. G. Streetman, and S. K. Banerjee, ― Solid State Electronic Devices, 7th edition, Pearson,2014.
2. D. Neamen, D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, ― Physics of Semiconductor Devices,‖ 3rd edition, John Wiley &Sons, 2006.

4. C.T. Sah, ― Fundamentals of solid-state electronics, World Scientific Publishing Co. Inc, 1991.
5. Y. Tsividis and M. Colin, ― Operation and Modeling of the MOS Transistor,‖ Oxford Univ.Press, 2011.
6. A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.
7. A.K. Maini, Analog Electronics, Khanna Book Publishing, New Delhi, 2022.

Course code	ECE-303			
Category	Engineering Science Courses			
Course title	Signal & Systems			
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 is designed to provide you with a comprehensive understanding of the fundamental concepts that form the backbone of modern engineering and applied sciences. Signals and systems are critical for a wide range of applications, from communications and control systems to image processing and data analysis. Throughout this course, you will explore various types of signals—continuous and discrete—as well as the systems that process them. We will cover essential topics such as signal representation, time-domain analysis, frequency-domain techniques, and the role of linear time-invariant systems. By engaging with both theoretical frameworks and practical applications, you will develop the skills needed to analyze and design systems that effectively process information

Pre-requisites: Basic Electrical Engineering, Basic of Mathematics.

Objectives of the course: The students will learn:

1. Identify and describe various types of signals and systems commonly encountered in communication engineering;
2. Apply transformation techniques to analyze and interpret real-life periodic and aperiodic signals within linear time-invariant (LTI) systems;
3. Analyze complex systems and signals by employing various techniques learned to gain insights into their properties and behaviour;
4. Synthesize a comprehensive understanding of different types of signals, systems, and transformation techniques to facilitate advanced study in signal processing, image processing, and related fields

Course Outcomes:

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

CO1: Analyze and categorize different types of signals by evaluating their characteristics and behaviors.

CO2: Apply transformation techniques to represent continuous and discrete systems in both the time and frequency domains.

CO3: Demonstrate a comprehensive understanding of Laplace and Fourier transforms, including their definitions, properties, and practical applications.

CO4: Demonstrate the ability to analyze signals using the Discrete Fourier Transform (DFT) and its properties, understand the relationships between DFT, Z-transform, and Laplace transform, and effectively apply convolution techniques to process discrete-time signals.

Unit-I

Signal and its representation: Introduction of signals and systems; classification of signal, continuous time and discrete time signals, operations performed on them, even and odd signals, periodic and non-periodic signals, deterministic and random signals, energy signals, power signals, elementary signals; impulse, unit step, ramp and exponentials, classification of systems.

Properties of Systems: linearity, causality, stability, linear time invariant (LTI) systems, convolution integral for continuous-time systems, convolution sum for discrete time systems, properties of linear time-invariant systems, system described by differential and difference equations.

Unit-II

Fourier series: representation of periodic signals: Representation of periodic signals by trigonometric and exponential series, properties of continuous time Fourier series, discrete time Fourier series and its properties, continuous and discrete time filtering.

Continuous time Fourier transforms: Definition of Fourier transform and its inverse, properties of the transform, common transform pairs, and convolution and multiplication theorems. Discrete time Fourier transform: Definition and properties, Convolution theorem, frequency response corresponding to difference Equations

Unit-III

Laplace Transform: Definition, region of convergence, properties, analysis of LTI systems, solution of differential equations, system functions, poles and zeros, stability.

Z-Transform: Definition, region of convergence, inversion, basic properties, solution of difference equations, system functions, poles and zeros and stability.

Unit-IV

Discrete Fourier transform: Properties of discrete Fourier transform relation between discrete Fourier transform, Z and Laplace transform. Convolution of sequences, circular convolution theorem, overlap add and overlap save methods of convolution. Sampling: Uniform sampling, sampling theorem, aliasing, decimation, interpolation.

Web link(s):

1. https://nptel.ac.in/courses/108/106/108106075/ (NPTEL Video by Prof. V.G.K.Murti from IIT Madras)
2. https://nptel.ac.in/courses/108/104/108104100/ (NPTEL Video by Prof. Aditya from IIT Kanpur)
3. https://nptel.ac.in/courses/10810410

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	1	-	1	-	-	-	1	-	-	1	1	3
2	3	3	1	-	1	-	-	-	1	-	-	1	1	1
3	3	2	2	-	1	-	-	-	2	-	-	1	1	1
4	3	2	2	-	1	-	-	-	2	-	-	1	1	2

Suggested Books:

1 Signals & Systems by Simon Haykin , PHI
2 Signals & Systems by Oppenheim, PHI, Second Edition
3 Principles of Linear Systems and Signals, B.P Lathi, Second Edition.
4 Fundamentals of Signal & Systems using the Web and Matlab, Kamen Pearson

Course code	ECE-301			
Category	Engineering Science Courses			
Course title	Digital Electronics			
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 is designed to provide you with a solid foundation in the principles and applications of digital circuits. Throughout this course, you will explore key concepts such as binary systems, logic gates, combinational and sequential circuits, and the fundamentals of microcontrollers. We will engage in hands-on projects and simulations, allowing you to apply theoretical knowledge in practical scenarios.

Prerequisite: Nil**.**

Objectives of the course:

The students will learn:

1. Develop a strong foundation in Boolean algebra, De Morgan's Theorem, and various forms of logic representation, including Sum of Products (SOP) and Product of Sums (POS);
2. Learn to design and implement various combinational logic circuits using MSI devices, including multiplexers, decoders, encoders, and arithmetic components like adders and subtractors, understanding their practical applications in digital systems;
3. Cultivate the ability to integrate knowledge from all units to solve complex design problems, preparing for advanced topics in digital systems and circuit design.

Course Outcomes:

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

CO 1 To apply Boolean algebra and De Morgan's Theorem to simplify complex logical expressions and convert them between Sum of Products (SOP) and Product of Sums (POS) forms;

CO 2 Analyze and construct Karnaugh maps for up to six variables to minimize Boolean functions effectively, enabling the design of efficient digital circuits;

CO 3 Design and implement combinational logic circuits using various MSI devices, such as multiplexers, decoders, and adders, showcasing the ability to solve practical engineering problems in digital logic design;

CO 4 Evaluate and compare different sequential logic elements, such as flip-flops and counters, to design reliable synchronous systems, including finite state machines and pulse train generators;

CO 5 Create and implement complex digital systems using various logic families and programmable logic devices (FPGAs), demonstrating proficiency in interfacing, memory elements, and real-world applications of digital design principles.

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

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan‘sTheorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, CodeConversion.

Unit II:

Combination Logic Design: MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU.

Unit III:

Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Rippleand Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM,Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, PseudoRandom Binary Sequence generator, Clock generation.

Unit IV

Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices.

NPTEL Course (if any): https://nptel.ac.in/courses/117106086

Text/Reference Books:

1. M.Morris Mano and Michel.D.Ciletti, Digital Design with an introduction to HDL, VHDL and Verilog, Sixth edition Pearson education
2. R. Anand, Digital System Design Using VHDL, Khanna Book Publishing Company.
3. R. Anand, Digital Electronics, Khanna Book Publishing Company.

4. R.P. Jain, ―Modern digital Electronics‖, Tata McGraw Hill, 4th edition, 2009.
5. Douglas Perry, ―VHDL‖, Tata McGraw Hill, 4th edition, 2002.
6. W.H. Gothmann, ―Digital Electronics- An introduction to theory and practice‖, PHI, 2nd edition ,2006.
7. D.V. Hall, ―Digital Circuits and Systems‖, Tata McGraw Hill, 1989

Course code	ECE-304			
Category	Engineering Science Courses			
Course title	Network Theory			
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 an in-depth exploration of the principles and techniques used to analyze linear and nonlinear networks, emphasizing the interconnectedness of components and their behavior under various conditions. Students will engage with core concepts such as Kirchhoff's laws, Thevenin's and Norton’s theorems, and the principles of superposition and resonance. By mastering these foundational tools, learners will develop the ability to model and predict the behavior of complex networks.

Prerequisite: BEEE, Electronics Engineering 1.

Objectives of the course:

The students will learn:

1. Develop a comprehensive understanding of fundamental concepts in network theory, including Kirchhoff's laws, Ohm's law, and the principles of voltage and current division, enabling students to analyze simple and complex electrical circuits);
2. Gain proficiency in various circuit analysis techniques, such as Thevenin’s and Norton’s theorems, superposition, and mesh and nodal analysis, to systematically solve and simplify electrical networks;
3. Apply theoretical knowledge to real-world scenarios by designing and analyzing electrical circuits using simulation software, preparing students for practical challenges in electrical engineering and related fields.

Course Outcomes:

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

CO 1 Describe fundamental concepts in graph theory and network analysis, including graphs, trees, and network matrices, and demonstrate their relationships and significance in electrical engineering contexts.;

CO 2 Apply key network theorems such as Thevenin’s, Norton’s, and superposition to solve complex circuit problems in both DC and AC systems, showcasing the ability to analyze and simplify electrical networks effectively;

CO 3 Analyze and characterize two-port networks using various parameters (ABCD, hybrid, and inverse hybrid), demonstrating an understanding of their interconnections and applications in circuit design and analysis;

CO 4 Evaluate and interpret network functions in terms of complex frequency, poles, and zeros, enabling the assessment of driving point and transfer functions for one-port and two-port networks;

CO 5 Design and synthesize passive networks, including RC, RL, and LC circuits, utilizing positive real functions and employing Foster and Cauer forms, to create effective filters and attenuators for various applications in signal processing.

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

Graph Theory: Graph, Tree and link branches, Network matrices and their relations, Choice of linearly independent network variables, Topological equations for loop current and topological equation for nodal voltage, Duality.

Unit II

Network Theorems: Source transformation, Superposition Theorem, Thevenin's theorem, Norton's theorem, Millman's theorem, Reciprocity theorem and Maximum power transfer theorem as applied to A.C. circuits, Compensation theorem, Tellegen's theorem and their applications.

Unit III

Two Port Networks: Two port network description in terms of open circuits impedance, Short circuit admittance, Hybrid and inverse hybrid, ABCD and inverse ABCD parameters, Interconnection of two port network, Indefinite admittance matrix and its applications.

Network Functions: Concepts of complex frequency, Transform impedance, Networks function of one port and two port network, concepts of poles and zeros, property of driving point and transfer function.

Unit IV

Passive Network Synthesis: Introduction, Positive Real Functions: Definition, Necessary and sufficient conditions for a function to be positive real, Synthesis vs. analysis, Elements of circuit synthesis, Foster and cauer forms of LC Networks, Synthesis of RC and RL networks**.**

Filters and Attenuators: Classification of filters, Analysis of a prototype low pass filter, High pass filter, Band pass filter, Band stop filter, M-derived filter, Attenuation, Types of attenuators: symmetrical and asymmetrical.

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

Text/Reference Books:

1. Hayt, W., Engineering Circuit Analysis, Tata McGraw-Hill (2006).
2. Hussain, A., Networks and Systems, CBS Publications (2004).
3. Valkenberg, Van, Network Analysis, Prentice-Hall of India Private Limited (2007).

4. Gayakwad, A. Op-Amps and Linear Integrated Circuits, Prentice-Hall of India (2006).

5. Chakarbarti,A., Circuit Theory, DhanpatRai and Co. (P) Ltd. (2006).

6. Roy Chowdhuary, D., Networks and Systems, New Age International (P) Limited, Publishers (2007).

7. Sudhakar, A., Circuits and Networks, Tata McGraw-Hill (2006).

8. Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education, (2009).

Course code	ECE-304			
Category	Engineering Science Courses			
Course title	Python			
Scheme and Credits	L	T	P	Credits
	2	0	2	3
Class work/ Practical	50 Marks			
Exam	50 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This course introduces fundamental concepts of data structures and algorithms, essential for effective problem-solving in computer science and programming. Students will learn to design, analyze, and implement various data structures such as arrays, linked lists, stacks, queues, trees, and graphs. The course also covers algorithmic techniques, including sorting, searching, recursion, and dynamic programming. Emphasis is placed on understanding the efficiency and trade-offs associated with different data structures and algorithms. Practical application of these concepts will be reinforced through programming assignments and problem-solving exercises.

Prerequisite: Nil.

Objectives of the course:

The students will learn:

1. Provide a comprehensive overview of data structures and algorithms, emphasizing their importance, applications, and the fundamental concepts necessary for effective programming and problem-solving;
2. Equip students with the skills to design, implement, and manipulate various data structures, including arrays, linked lists, stacks, queues, trees, and graphs, fostering a hands-on approach to understanding their operations and applications;
3. Develop the ability to analyze and compare different algorithms, including sorting and searching techniques, as well as understand recursion and dynamic programming principles, enabling students to select appropriate methods for solving complex computational problems.

Course Outcomes:

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

CO 1 Design and implement arrays, linked lists, stacks, and queues;

CO 2 Analyze and implement various tree structures, including binary trees and balanced trees;

CO 3 Evaluate the efficiency and trade-offs of different data structures and algorithms;

CO 4 Apply data structures and algorithms to solve real-world programming challenges;

CO 5 Write efficient and well-organized code for complex problem-solving.

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

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.

Course code	ECE-306			
Category	Engineering Science Courses			
Course title	VHDL - Hardware Description Language			
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 offers a comprehensive exploration of VHDL, covering its syntax, semantics, and practical applications in digital circuit design. Students will learn how to describe complex hardware systems at various levels of abstraction, from high-level behavioral modeling to low-level structural representation. Through hands-on exercises, learners will gain proficiency in writing, simulating, and synthesizing VHDL code, enabling them to create efficient and reliable digital systems. As technology continues to evolve, the ability to effectively utilize VHDL is essential for engineers involved in fields such as FPGA design, ASIC development, and embedded systems. By the end of this course, students will be equipped with the skills to tackle real-world design challenges, understand the intricacies of digital hardware, and contribute to innovative technological advancements.

Prerequisite: Nil.

Objectives of the course:

The students will learn:

1. The principles of digital design and the role of Hardware Description Languages (HDLs) in modeling and implementing digital systems, highlighting the differences between traditional programming languages and HDL;
2. Equip students with knowledge of the basic concepts of VHDL, including levels of abstraction, data types, syntax, and instantiation. Students will learn to implement various modeling techniques, such as switch-level, gate-level, and dataflow-level modeling, through practical examples;
3. Enable students to create and synthesize digital designs using User Defined Primitives (UDPs) and implement Finite State Machines (FSMs) in HDL.

Course Outcomes:

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

CO 1 Explain the fundamental concepts of digital design and the key differences between traditional programming languages and Hardware Description Languages (HDLs);

CO 2 Describe the various levels of abstraction supported by HDLs and demonstrate an understanding of data types, syntax, and the process of component declaration and instantiation in VHDL;

CO 3 Implement digital designs using different modeling techniques, such as gate-level and dataflow-level modeling, and create switch-level models to solve practical design problems;

CO 4 Analyze and design Finite State Machines (FSMs) using HDL, evaluating their performance and functionality in different applications;

CO 5 Develop and synthesize complete digital systems using FPGA and CPLD platforms, incorporating User Defined Primitives (UDPs) and effectively utilizing HDL to simulate and validate designs.

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	1			1	1		2	2	1
2		3	3	3	2	1			1	1		2	2	1
3		3	3	3	2	1			1	1		2	2	1
4		3	3	3	2	1			1	1		2	2	1
5		3	3	3	2	1			1	1		2	2	1

Unit-I

Introduction to digital design. Introduction to hardware descriptive language (HDL). Difference between computer programming languages and HDLs Examples and HDL based digital design flow based on FPGA and CPLD. Basic concepts of HDL (VHDL), Level of abstractions supported by HDLs, Data types and syntaxes of HDLs. Instantiation concepts. Switch level modeling and its example

Unit-II

Component declaration, component instantiation, Generics and Configuration. Packages and libraries, Gate level modeling and its example, Dataflow level modeling and its example.

Entity declaration, Architecture body, process statement, variable and signal assignment statements, Wait statements, If statements, case statements, Loop statements etc

Unit-III

User Defined Primitives (UDPs) and its examples, Finite State Machine (FSM) implementation by HDL, FSM implementation example in HDL.

Synthesis and simulation of combinational and sequential logic, FPGA and CPLD based Implementation using HDL.

Unit-IV

Hardware modeling examples: ALU, Binary multiplier, Pulse counter, Barrel shifter, UART, Traffic light controller, DRAM Model etc.

Text/Reference Books:

1. VHDL: Programming by Example by Douglas L. Perry
2. VHDL: A Comprehensive Introduction" by Bhaskar, A.
3. VHDL for Engineers by Kenneth L. Short
4. Digital Design and Computer Architecture" by David Harris and Sarah Harris

5. HDL Primer, By J. Bhaskar, Publication: PHI

Course code	ECE-301			
Category	Engineering Science Courses			
Course title	Electronic Devices (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 is designed to provide foundational concepts that underpin modern electronic devices. From quantum mechanics to the behavior of charge carriers in materials, you will gain insights into how semiconductors operate and their crucial role in technology. We will delve into the intricacies of semiconductor physics, including the formation and characteristics of PN junctions, which are vital for diodes and transistors. Additionally, you will learn about metal-semiconductor contacts and the principles governing MOS devices, essential components in digital circuits. Through a combination of theoretical understanding and practical applications, this course aims to equip you with the knowledge needed to navigate the complexities of semiconductor technology. By the end, you will have a solid foundation to further your studies in electronics, electrical engineering, and related fields.

Prerequisite: Nil.

Objectives of the course:

The students will learn:

1. Grasp the basic principles of quantum mechanics, energy bands, and carrier transport mechanisms in intrinsic and extrinsic semiconductors, including diffusion and drift currents;
2. Examine the formation and characteristics of PN junctions, including depletion regions, biasing conditions, and the practical applications of diodes in circuits such as rectifiers, clippers, and clampers;
3. Investigate the fundamentals of metal-semiconductor contacts and MOS devices, focusing on their construction, operation, IV characteristics, and the implications of device scaling in modern technology.

Course Outcomes:

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

CO 1 Explain how intrinsic carrier concentration (n_i) changes with temperature and the relationship between thermal energy and carrier excitation in intrinsic silicon;

CO 2 Explain the relationship between carrier mobility, resistivity, and conductivity in semiconductors;

CO 3 Design and assess metal-semiconductor contacts and MOS devices, understanding their IV characteristics and interface issues, while distinguishing between ohmic and Schottky contacts;

CO 4 Explain how the various parameters of a MOSFET—such as gate voltage, gate dimensions, substrate material, and oxide material—affect its electrical characteristics and performance..

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	1			1	1		2	1	1
2		3	3	3	2	1			1	1		2	1	1
3		3	3	3	2	1			1	1		2	1	1
4		3	3	3	2	1			1	1		2	1	1

List of Experiments (Out of 12 Experiments students have to perform any Eight Experiments)

Experiment 1: Determining Carrier Concentration in Intrinsic Silicon

- **Objective**: To calculate the intrinsic carrier concentration n_i of silicon using temperature-dependent measurements.
- **Apparatus**: Silicon wafer, Hall effect measurement setup.
- **Expected Outcome**: Measurement of intrinsic carrier concentration as a function of temperature, demonstrating how Niincreases with temperature.

Experiment 2: Measuring Carrier Mobility in Semiconductors

- **Objective**: To determine the carrier mobility of electrons and holes in an intrinsic semiconductor.
- **Apparatus**: Semiconductor sample, Hall effect apparatus, power supply.
- **Expected Outcome**: Values of carrier mobility, demonstrating how mobility affects conductivity.

Experiment 3: Sheet Resistance Measurement in Semiconductors

- **Objective**: To measure the sheet resistance of thin semiconductor films using the four-point probe method.
- **Apparatus**: Four-point probe, resistivity measurement setup.
- **Expected Outcome**: Measurement of sheet resistance as a function of material properties and film thickness.

Experiment 4: Diffusion and Drift Current in a Semiconductor

- **Objective**: To measure the diffusion and drift current in an intrinsic semiconductor.
- **Apparatus**: Semiconductor sample, power supply, ammeter, voltmeter.
- **Expected Outcome**: A clearer understanding of how diffusion and drift currents contribute to total current in semiconductors.

Experiment 5: PN Junction Formation and Depletion Region

- **Objective**: To observe the formation of depletion region in a PN junction under different biasing conditions.
- **Apparatus**: PN junction diode, power supply, ammeter, voltmeter.
- **Expected Outcome**: The depletion region narrows under forward bias and widens under reverse bias.

Experiment 6: Forward and Reverse Bias Characteristics of a PN Junction Diode

- **Objective**: To study the current-voltage (I-V) characteristics of a PN junction diode under forward and reverse bias.
- **Apparatus**: PN junction diode, variable power supply, ammeter, voltmeter.
- **Expected Outcome**: The diode will show exponential current increase in forward bias and a small leakage current in reverse bias.

Experiment 7: Diode Applications: Rectifiers, Clippers, and Clampers

- **Objective**: To understand the practical applications of diodes in circuits such as rectifiers, clippers, and clampers.
- **Apparatus**: Diode, resistors, capacitors, signal generator, oscilloscope.
- **Expected Outcome**: A clear understanding of how diodes are used for rectification, signal clipping, and voltage clamping in practical circuits.

Experiment 8: Schottky Barrier Formation and IV Characteristics

- **Objective**: To investigate the formation of a Schottky barrier in a Metal-Semiconductor (MS) junction and measure its I-V characteristics.
- **Apparatus**: Metal-Semiconductor junction (e.g., Au-Si), power supply, ammeter, voltmeter.
- **Expected Outcome**: The current will show rectification, with the Schottky barrier height determined from the forward voltage characteristics.

Experiment 9: I-V Characteristics of n- and p-MOSFETs

- **Objective**: To measure and compare the I-V characteristics of n-channel and p-channel MOSFETs.
- **Apparatus**: n-channel and p-channel MOSFETs, power supply, ammeter, voltmeter.
- **Expected Outcome**: The n-channel MOSFET will conduct with a positive gate voltage, while the p-channel MOSFET will conduct with a negative gate voltage.

Experiment 10: MOSFET Characteristics and Regions of Operation

- **Objective**: To observe the behavior of a MOSFET in different regions of operation: cutoff, linear, and saturation.
- **Apparatus**: n-channel MOSFET, power supply, ammeter, voltmeter, function generator.
- **Expected Outcome**: The MOSFET will show different current characteristics in the cutoff, linear, and saturation regions, corresponding to the gate voltage.

Experiment 11: MOSFET as a Switch in Digital Circuits

- **Objective**: To investigate the switching behavior of MOSFETs when used in logic circuits.
- **Apparatus**: n-channel and p-channel MOSFETs, logic gate circuit (e.g., CMOS inverter), function generator, oscilloscope.
- **Expected Outcome**: The MOSFETs will exhibit fast switching characteristics with minimal delay, and the output will mirror the input signal (inverted).

Experiment 11: MOSFET Transfer Characteristics and Threshold Voltage Measurement

Objective: To measure the transfer characteristics of a MOSFET and determine the threshold voltage.

Expected Outcome: The transfer characteristic curve will show a threshold voltage below which the MOSFET does not conduct, and above which the current increases significantly.

Experiment 12: Displays drain current as a function of source-drain voltage for different values of gate voltage, gate dimensions, substrate material, and oxide material in an n-type MOSFET.

- **Objective**: To investigate how the drain current (I_D) of an n-type MOSFET varies with source-drain voltage (V_{DS}) for different values of gate voltage (V_{GS}), gate dimensions (length and width), substrate material, and oxide material..
- **Tool**: Using MOSFET Simulator on NanoHub.
- **Expected Outcome**: As the MOSFET gate length is reduced, the current increases, and other scaling effects such as short-channel effects and threshold voltage shift can be observed.

For Simulation students will use Nanohub Tools

Suggested Books:

1. G. Streetman, and S. K. Banerjee, ― Solid State Electronic Devices, 7th edition, Pearson,2014.
2. D. Neamen, D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, ― Physics of Semiconductor Devices,‖ 3rd edition, John Wiley &Sons, 2006.
4. C.T. Sah, ― Fundamentals of solid-state electronics, World Scientific Publishing Co. Inc, 1991.
5. Y. Tsividis and M. Colin, ― Operation and Modeling of the MOS Transistor,‖ Oxford Univ.Press, 2011.
6. A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.
7. A.K. Maini, Analog Electronics, Khanna Book Publishing, New Delhi, 2022.

Course code	ECE-301			
Category	Engineering Science Courses			
Course title	Digital Electronics (L)			
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 is designed to provide you with a solid foundation in the principles and applications of digital circuits. Throughout this course, you will explore key concepts such as binary systems, logic gates, combinational and sequential circuits, and the fundamentals of microcontrollers. We will engage in hands-on projects and simulations, allowing you to apply theoretical knowledge in practical scenarios.

Prerequisite: Nil.

Objectives of the course:

The students will learn:

1. Develop a strong foundation in Boolean algebra, De Morgan's Theorem, and various forms of logic representation, including Sum of Products (SOP) and Product of Sums (POS);
2. Learn to design and implement various combinational logic circuits using MSI devices, including multiplexers, decoders, encoders, and arithmetic components like adders and subtractors, understanding their practical applications in digital systems;
3. Cultivate the ability to integrate knowledge from all units to solve complex design problems, preparing for advanced topics in digital systems and circuit design.

Course Outcomes:

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

CO 1 To apply Boolean algebra and De Morgan's Theorem to simplify complex logical expressions and convert them between Sum of Products (SOP) and Product of Sums (POS) forms;

CO 2 Analyze and construct Karnaugh maps for up to six variables to minimize Boolean functions effectively, enabling the design of efficient digital circuits;

CO 3 Design and implement combinational logic circuits using various MSI devices, such as multiplexers, decoders, and adders, showcasing the ability to solve practical engineering problems in digital logic design;

CO 4 Evaluate and compare different sequential logic elements, such as flip-flops and counters, to design reliable synchronous systems, including finite state machines and pulse train generators;

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

1. **Introduction to Digital Electronics Lab: Nomenclature of Digital ICs, Specifications, Study of the Datasheet, Concept of Vcc and Ground**
   Objective: To familiarize students with the nomenclature and specifications of digital ICs, as well as to understand the importance of Vcc (supply voltage) and ground (GND) in digital circuits.
   Expected Outcome: Students will understand the basic components of a datasheet for digital ICs, identify key parameters such as power supply, pin configuration, and understand the significance of Vcc and GND in powering digital ICs.
2. **Implementation of the Given Boolean Function Using Logic Gates in Both SOP and POS Forms**
   Objective: To implement a given Boolean function using logic gates in both Sum of Products (SOP) and Product of Sums (POS) forms.
   Expected Outcome: Students will be able to simplify a Boolean function and implement it in both SOP and POS forms using basic logic gates.
3. **Verification of State Tables of RS, JK, T, and D Flip-Flops Using NAND & NOR Gates**
   Objective: To verify the state tables of RS, JK, T, and D flip-flops by constructing them using NAND and NOR gates.
   Expected Outcome: Students will demonstrate the functioning of flip-flops (RS, JK, T, D) and verify their state tables by constructing them from basic gates and simulating their operations.
4. **Implementation and Verification of Decoder/De-multiplexer and Encoder Using Logic Gates**
   Objective: To design and verify the operation of a decoder/de-multiplexer and encoder using logic gates.
   Expected Outcome: Students will implement a decoder/de-multiplexer (e.g., 2-to-4 decoder) and an encoder (e.g., 8-to-3 encoder) and verify their functionality.
5. **Implementation of 4x1 Multiplexer Using Logic Gates**
   Objective: To implement a 4x1 multiplexer using basic logic gates.
   Expected Outcome: Students will successfully design and implement a 4-input, 1-output multiplexer using logic gates (AND, OR, NOT).
6. **Implementation of 4-bit Parallel Adder Using 7483 IC**
   Objective: To implement a 4-bit parallel adder using the 7483 IC and verify the addition of binary numbers.
   Expected Outcome: Students will implement a 4-bit parallel adder and verify that it correctly adds two 4-bit binary numbers.
7. **Design and Verify the 4-bit Synchronous Counter**
   Objective: To design and verify the operation of a 4-bit synchronous counter.
   Expected Outcome: Students will design a 4-bit counter using flip-flops and verify its counting operation.
8. **Design and Verify the 4-bit Asynchronous Counter**
   Objective: To design and verify the operation of a 4-bit asynchronous counter.
   Expected Outcome: Students will design an asynchronous counter, observe its operation, and compare it with a synchronous counter.

9. **Static and Dynamic Characteristics of NAND and Schmitt-NAND Gate (Both TTL and MOS)**
   Objective: To study the static and dynamic characteristics of TTL and MOS-based NAND gates, including noise margin and propagation delay.
   Expected Outcome: Students will measure the static and dynamic characteristics (such as noise margin and propagation delay) of NAND gates made from TTL and MOS technologies.
10. **Design and Implementation of S-R and JK Flip-Flops**
    Objective: To design and implement S-R and JK flip-flops.
    Expected Outcome: Students will understand the basic working of S-R and JK flip-flops and implement them using logic gates and ICs.

Additional Notes: Students have to complete a total of eight experiments, ensuring a thorough understanding of digital logic design.

Text/Reference Books:

1. M.Morris Mano and Michel.D.Ciletti, Digital Design with an introduction to HDL, VHDL and Verilog, Sixth edition Pearson education
2. R. Anand, Digital System Design Using VHDL, Khanna Book Publishing Company.
3. R. Anand, Digital Electronics, Khanna Book Publishing Company.
4. R.P. Jain, ―Modern digital Electronics‖, Tata McGraw Hill, 4th edition, 2009.
5. Douglas Perry, ―VHDL‖, Tata McGraw Hill, 4th edition, 2002.
6. W.H. Gothmann, ―Digital Electronics- An introduction to theory and practice‖, PHI, 2nd edition ,2006.
7. D.V. Hall, ―Digital Circuits and Systems‖, Tata McGraw Hill, 1989

Course code	ECE-306			
Category	Engineering Science Courses			
Course title	VHDL - Hardware Description Language (P)			
Scheme and Credits	L	T	P	Credits
	0	0	2	1
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Preamble:

This course offers a comprehensive exploration of VHDL, covering its syntax, semantics, and practical applications in digital circuit design. Students will learn how to describe complex hardware systems at various levels of abstraction, from high-level behavioral modeling to low-level structural representation. Through hands-on exercises, learners will gain proficiency in writing, simulating, and synthesizing VHDL code, enabling them to create efficient and reliable digital systems. As technology continues to evolve, the ability to effectively utilize VHDL is essential for engineers involved in fields such as FPGA design, ASIC development, and embedded systems. By the end of this course, students will be equipped with the skills to tackle real-world design challenges, understand the intricacies of digital hardware, and contribute to innovative technological advancements.

Prerequisite: Nil.

Objectives of the course:

The students will learn:

4. The principles of digital design and the role of Hardware Description Languages (HDLs) in modeling and implementing digital systems, highlighting the differences between traditional programming languages and HDL;
5. Equip students with knowledge of the basic concepts of VHDL, including levels of abstraction, data types, syntax, and instantiation. Students will learn to implement various modeling techniques, such as switch-level, gate-level, and dataflow-level modeling, through practical examples;
6. Enable students to create and synthesize digital designs using User Defined Primitives (UDPs) and implement Finite State Machines (FSMs) in HDL.

Course Outcomes:

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

CO 1 Explain the fundamental concepts of digital design and the key differences between traditional programming languages and Hardware Description Languages (HDLs);

CO 2 Describe the various levels of abstraction supported by HDLs and demonstrate an understanding of data types, syntax, and the process of component declaration and instantiation in VHDL;

CO 3 Implement digital designs using different modeling techniques, such as gate-level and dataflow-level modeling, and create switch-level models to solve practical design problems;

CO 4 Analyze and design Finite State Machines (FSMs) using HDL, evaluating their performance and functionality in different applications;

CO 5 Develop and synthesize complete digital systems using FPGA and CPLD platforms, incorporating User Defined Primitives (UDPs) and effectively utilizing HDL to simulate and validate designs.

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	1			1	1		2	2	1
2		3	3	3	2	1			1	1		2	2	1
3		3	3	3	2	1			1	1		2	2	1
4		3	3	3	2	1			1	1		2	2	1
5		3	3	3	2	1			1	1		2	2	1

List of Experiments (Out of 15 Experiments students have to perform any 12 Experiments)

1. **Introduction to Digital Design & Hardware Descriptive Languages (HDL)**
   Objective: Understand the fundamentals of digital design and the role of HDLs in hardware description.
   Description: Introduction to digital design concepts like logic gates, circuits, and components; Compare and contrast programming languages (like C/C++) with hardware description languages (HDLs).
2. **Understanding the Basics of VHDL Syntax and Data Types**
   Objective: Learn the basic syntax and data types used in VHDL for digital system design.
   Description: Learn about data types like bit, std_logic, integer, and std_logic_vector; Write simple VHDL programs to describe basic logic gates.
3. **Switch-Level Modeling in VHDL**
   Objective: Learn switch-level modeling and implement simple digital circuits at the switch level using VHDL.
   Description: Model a basic AND gate, OR gate, and NAND gate using switches; Implement a 4-bit adder using switch-level models.
4. **VHDL Modeling at the Gate Level**
   Objective: Implement gate-level modeling of logic circuits in VHDL.
   Description: Write VHDL code for AND, OR, NOT, XOR, and NAND gates; Design a multiplexer and a decoder at the gate level.
5. **VHDL Dataflow Level Modeling**
   Objective: Implement dataflow modeling in VHDL, where the flow of data through the circuit is modeled.
   Description: Write a VHDL description for a 4-bit adder using dataflow modeling; Use concurrent assignment statements (e.g., <=) to describe the flow of signals and Implement a 2-to-1 multiplexer using dataflow modeling.
6. **Component Declaration and Instantiation in VHDL**
   Objective: Learn how to declare and instantiate components in VHDL to create modular designs.
   Description: Write a simple 2-input AND gate and use it in a higher-level design.
7. **Using Generics and Configurations in VHDL**
   Objective: Understand and apply generics and configurations in VHDL for flexible designs.
   Description: Create a parameterized 4-bit adder using generics; Use a configuration file to instantiate different types of components in a design.

8. **Introduction to Packages and Libraries in VHDL**
   Objective: Learn to use packages and libraries to organize and reuse VHDL code.
   Description: Write a simple VHDL package to define common constants and functions; Demonstrate how to use libraries like IEEE.STD_LOGIC_1164 and IEEE.STD_LOGIC_ARITH.
9. **Conditional and Sequential Statements in VHDL (If, Case, Loop)**
   Objective: Explore the use of if, case, and loop statements in VHDL for control flow in hardware designs.
   Description: Write a VHDL program using if statements for conditional logic; Use a case statement to design a simple multiplexer; Implement for, while, and loop statements for sequential logic, such as a counter.
10. **Implementation of Finite State Machines (FSM) in VHDL**
    Objective: Implement a finite state machine (FSM) using VHDL for a practical application.
    Description: Design a Mealy machine and a Moore machine in VHDL; Implement an FSM to control a traffic light system.
11. **User Defined Primitives (UDPs) in VHDL**
    Objective: Learn to define and use user-defined primitives (UDPs) in VHDL.
    Description: Create a UDP for a 2-input AND gate and use it in a larger design; Implement a UDP for custom logic functions and integrate it into a larger circuit design.
12. **Synthesis and Simulation of Combinational Logic Circuits**
    Objective: Synthesize and simulate a combinational logic circuit using VHDL.
    Description: Write VHDL code for a 4-to-16 line decoder and perform simulation.
13. **Synthesis and Simulation of Sequential Logic Circuits**
    Objective: Synthesize and simulate sequential logic circuits like flip-flops and counters.
    Description: Implement a JK flip-flop, T flip-flop, and D flip-flop in VHDL; Design a 4-bit counter and simulate its behavior using a clock signal.
14. **Hardware Modeling of ALU (Arithmetic Logic Unit)**
    Objective: Model an ALU using VHDL for basic arithmetic and logical operations.
    Description: Design an ALU that supports operations like AND, OR, XOR, addition, and subtraction; Implement the ALU using VHDL components like MUXes and adders.
15. **Hardware Modeling of a UART (Universal Asynchronous Receiver/Transmitter)**
    Objective: Design and model a UART for serial communication using VHDL.
    Description: Model a simple UART transmitter and receiver in VHDL; Implement a start bit, data bits, stop bit, and parity bit handling.

Text/Reference Books:

1. VHDL: Programming by Example by Douglas L. Perry
2. VHDL: A Comprehensive Introduction" by Bhaskar, A.
3. VHDL for Engineers by Kenneth L. Short
4. Digital Design and Computer Architecture" by David Harris and Sarah Harris
5. HDL Primer, By J. Bhaskar, Publication: PHI

4th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-401	Analog Circuits	3	0	0	3	30	70	100
2	ESC-402	Microcontrollers and Computer Architecture	3	0	0	3	30	70	100
3	ESC-403	Analog and Digital Communication	3	0	0	3	30	70	100
4	ESC-404	Microfabrication-I	3	0	0	3	30	70	100
5	BSC-405	Numerical Techniques	3	0	0	3	30	70	100
6	HSM-406	Management - Organizational Behavior	2	0	0	2	30	70	100
7	ESC-401P	Analog Circuits Lab	0	0	2	1	50	50	100
8	ESC-402P	Microcontrollers and Computer Architecture Lab	0	0	2	1	50	50	100
9	ESC-406P	Microfabrication I Lab	0	0	2	1	50	50	100
10	ESC-201P	Project Based Learning-2	0	0	4	2	50	50	100
Total Credits						22			1000

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

(e) Theory exams will be of 03 hours duration.

(f) 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	ECE-401			
Category	Engineering Science Courses			
Course title	Analog Circuits			
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 the fundamental principles of analog circuit design, focusing on the behavior and characteristics of various analog components such as resistors, capacitors, inductors, diodes, and transistors. Students will learn how to analyze and design essential analog circuits, including amplifiers, oscillators, filters, and power supplies. Emphasis will be placed on understanding circuit performance in real-world applications, with a focus on signal integrity, noise, and linearity. Through a combination of theoretical knowledge and practical hands-on experience, this course equips students with the skills necessary to tackle complex analog design challenges. As technology continues to evolve, a strong foundation in analog circuits remains essential for engineers working in fields such as telecommunications, audio processing, instrumentation, and consumer electronics. By the end of the course, students will have developed the analytical and design capabilities needed to create effective analog solutions for a wide range of applications.

Prerequisite: Basic Electrical Engineering, Mathematics-1 & 2, Fundamentals of Digital Circuits.

Objectives of the course:

The students will learn:

1. The fundamental principles of analog circuit design, including the behavior of essential components such as resistors, capacitors, inductors, diodes, and transistors;
2. The skills to analyze and design a variety of analog circuits, including amplifiers, oscillators, filters, and power supplies, using both theoretical approaches and practical tools;
3. Apply knowledge of analog circuits to real-world scenarios, enabling students to address challenges in areas such as signal processing, telecommunications, and instrumentation while considering factors like noise, linearity, and signal integrity.

Course Outcomes:

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

CO 1 Describe the characteristics and operation of various amplifier models;

CO 2 Implement design procedures for analog circuits based on specific performance specifications, including the estimation of voltage gain, input resistance, and output resistance, as well as conducting low-frequency analysis of multistage amplifiers;

CO 3 Examine the frequency response of single-stage and multistage amplifiers, assessing the effects of different classes of operation (Class A, B, AB, C) on power efficiency and linearity, while evaluating feedback topologies and their influence on circuit performance;

CO 4 Assess the performance of current mirrors and differential amplifiers, calculating metrics such as differential gain, common-mode gain, common-mode rejection ratio (CMRR), and input common-mode range (ICMR) to determine the suitability of designs for specific applications;

CO 5 Design and develop practical applications using operational amplifiers, including inverting and non-inverting amplifiers, integrators, differentiators, active filters, and oscillators, while also exploring digital-to-analog and analog-to-digital converters to create effective analog solutions.

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	1			1	1		2	2	2
2		3	3	3	2	1			1	1		2	2	2
3		3	3	3	2	1			1	1		2	2	2
4		3	3	3	2	1			1	1		2	2	2
5		3	3	3	2	1			1	1		2	2	2

Unit I

Diode Circuits & Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.

Unit II

High frequency transistor models: frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.

Unit III

Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP- AMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation.

Unit IV

OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines. Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators(phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators.

Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistorstring etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits.

NPTEL course: https://nptel.ac.in/courses/108106084

Text/Reference Books:

1. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022.
2. A.S. Sedra and K.C. Smith, Microelectronic Circuits, sixth edition, Oxford University Press
3. J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
4. J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.
5. P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
6. Paul R. Gray and Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition

<table>
<tr><td>Course code</td><td colspan="4">ECE- 402</td></tr>
<tr><td>Category</td><td colspan="4">Engineering Science Courses</td></tr>
<tr><td>Course title</td><td colspan="4">Microcontrollers and Computer Architecture</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>3</td><td>0</td><td>0</td><td>3</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>
</table>

Preamble:

This course provides a comprehensive exploration of the principles and practices underlying microcontroller design and computer architecture, equipping students with the knowledge and skills necessary to design and implement efficient computing systems. Students will delve into the architecture of microcontrollers, learning about their components, operation, and programming. The course covers key topics such as memory organization, input/output interfacing, and control mechanisms, enabling students to understand how microcontrollers interact with hardware and software. In addition, the course examines the architecture of computer systems, focusing on the interaction between hardware components, such as CPUs, memory, and storage, as well as the principles of instruction execution and data processing. Students will gain insights into various architectures, including RISC and CISC, and explore advanced concepts such as pipelining, cache memory, and system buses.

Pre-requisites: Programming Fundamentals, Computer Organization, Digital Electronics.

Objectives of the course: The students will learn:

1. Microcontroller architecture, including the functions of its core components, memory organization, and input/output interfacing, enabling them to grasp how microcontrollers operate in embedded systems;
2. Equip students with the skills to program microcontrollers effectively using appropriate programming languages, focusing on embedded systems development, real-time applications, and hardware-software integration;
3. Enable students to analyze and evaluate computer architecture concepts, including instruction set design, data processing mechanisms, and system performance optimization, fostering a solid foundation for designing and implementing efficient computing systems.

Course Outcomes:

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

CO1: Explain the fundamental concepts of computer architecture, including the functional units of a computer, the differences between Von Neumann and Harvard architectures, and the characteristics of CISC and RISC architectures;

CO2: Demonstrate the ability to perform basic assembly language programming for microprocessors, including writing programs that utilize data transfer operations, arithmetic operations, and branching techniques on the 8085 microprocessor;

CO3: Analyze and evaluate the internal architecture of microprocessors and microcontrollers, including the role of various registers, the instruction cycle, and the timing response of processor operations.

CO4: Assess the functionality and performance of interfacing components such as the 8255 programmable peripheral interface and the 8259A programmable interrupt controller, and evaluate their impact on system design and operation.

CO5: Develop and implement practical embedded system applications using the 8051 microcontroller, including interfacing with devices like LCDs, keyboards, and DACs, and programming these interactions in both assembly language and C.

.**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	1	-	1	-	-	-	1	-	-	1	1	3
2	3	3	1	-	1	-	-	-	1	-	-	1	1	1
3	3	2	2	-	1	-	-	-	2	-	-	1	1	1
4	3	2	2	-	1	-	-	-	2	-	-	1	1	2

Unit-I

Computer Arithmetic and Processor Basics Functional units of a computer, Von Neumann and Harvard computer architectures. Processor Architecture - General internal architecture, Address bus, Data bus, control bus. Register set - status register, accumulator, program counter, stack pointer, general- purpose registers. Processor operation instruction cycle, instruction fetch, instruction decode, instruction execute, Types of memory - RAM, ROM, Cache memory, Virtual memory, DMA Operation

Unit II

Introduction to Microprocessor, Microprocessor architecture and its operations, Memory, Input & output devices, Logic devices for interfacing, The 8085 MPU, Example of an 8085 based computer, Memory interfacing. Basic interfacing concepts, interfacing output displays, Interfacing input devices, Memory mapped I/O,

Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, Addressing modes, Writing assembly language programs, Programming techniques: looping, counting and indexing. Additional data transfer and 16 bit arithmetic instruction, Arithmetic operations related to memory, Logic operation: rotate, compare, counter and time delays. Subroutines. Interrupts

Unit III

Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly Language Programming - Addressing Modes, Instruction set (Detailed study of 8051 instruction set is required).

8255 Programmable peripheral interface, interfacing keyboard and seven segment display, 8254 (8253) programmable interval timer, 8259A programmable interrupt controller, Direct Memory Access and 8237 DMA controller.

Unit IV

Simple programming examples in assembly language: Interfacing with 8051 using Assembly language programming: LED, Seven segment LED display. Programming in C – Declaring variables, Simple examples – delay generation, port programming, code conversion. Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC -- with 8051 and its programming. 8051 Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially.

NPTEL course: https://nptel.ac.in/courses/106102157

Text/Reference Books:

1. Computer System Architecture, Mano M M , Prentice Hall India
2. 8085 Microprocessor Architecture, Applications and Programming, Ramesh S Gaonkar,

Course code	ECE- 403			
Category	Engineering Science Courses			
Course title	Analog and Digital Communication			
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 is designed to provide you with a solid foundation in the Communication, enabling individuals, organizations, and nations to exchange information and ideas. Analog and digital communication systems are crucial to the world's infrastructure, and understanding the principles, advantages, and limitations of each is essential for anyone working in the field of communication engineering. This course explores the fundamental concepts, techniques, and technologies underlying both analog and digital communication, providing a comprehensive foundation for students to design, analyze, and optimize modern communication systems. By the end of the course, students will be equipped with the knowledge to tackle real-world challenges in communication systems, whether they involve analog signal processing or the complexities of digital data transmission..

Prerequisite: Nil**.**

Objectives of the course:

The students will learn:

1. Recognize and classify various types of signals;
2. Learn the spectral characteristics of AM and FM signals and the effects of modulation on bandwidth;
3. students will be equipped with the theoretical knowledge and practical skills necessary to understand, design, and analyze both analog and digital communication systems in diverse real-world contexts.

Course Outcomes:

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

CO 1 Explain the concepts of signal representation in the time and frequency domains, and describe how modulation techniques such as AM, FM, PSK, and QAM are applied in communication systems;

CO 2 Apply the principles of modulation and noise analysis to assess the performance of communication systems under different conditions, including the effects of Gaussian noise and random processes on both analog and digital signals;

CO 3 Analyze the impact of noise on analog and digital modulation techniques, including evaluating the signal-to-noise ratio (SNR) and understanding the threshold effects in frequency modulation (FM) systems;

CO 4 Evaluate the trade-offs between different modulation techniques (e.g., PSK, FSK, QAM) for specific communication system requirements, considering factors such as bandwidth, power, error probability, and system complexity;

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

Unit-I

Signals, Systems, and Modulation Techniques: Types of signals & Basic signal operations, Linear Time-Invariant (LTI) systems and their properties, Frequency Domain Representation of Signals, Fourier Transform and its applications, Spectral analysis of signals, Bandwidth considerations and filtering, Principles of Amplitude Modulation (AM) Systems, Double Sideband (DSB) Modulation, Single Sideband (SSB) Modulation, Vestigial Sideband (VSB) Modulation, Comparison of AM, DSB, SSB, and VSB, Angle Modulation, Basic principles of Frequency Modulation (FM)-Phase Modulation (PM), Representation of FM and PM signals, Spectral characteristics of angle modulated signals

Unit-II

Noise in Communication Systems and Probability: Review of Probability and Random Processes, Random variables, probability distributions, Mean, variance, and autocorrelation, Stationary and ergodic processes, Properties of white noise, Gaussian noise in communication systems, Noise power spectral density and its impact, Noise in Amplitude Modulation Systems, Noise performance of AM systems, Signal-to-noise ratio (SNR) considerations, Noise in Frequency Modulation Systems, Pre-emphasis and de-emphasis, Threshold effect in FM and its implications for system design.

Unit-III

Pulse Modulation and Digital Communication Systems: Introduction to pulse modulation techniques, Sampling process: Nyquist theorem and sampling rate, Pulse Amplitude Modulation (PAM), Pulse Code Modulation (PCM) and Differential Pulse Code Modulation (DPCM), Delta Modulation and its advantages/disadvantages, Quantization noise and its effect on signal quality, Bit error rate (BER) and its relation to SNR in PCM, TDM principles and applications, Digital multiplexers and their role in communication systems, Phase Shift Keying (PSK), Frequency Shift Keying (FSK), Quadrature Amplitude Modulation (QAM), Continuous Phase Modulation (CPM) and Minimum Shift Keying (MSK), Trade-offs in digital modulation techniques.

Unit-IV

Detection, Synchronization, and Digital Demodulation: Elements of Detection Theory-Signal detection in noise, Optimum detection and decision rules, Maximum likelihood detection, Coherent Communication with Waveforms; Probability of error in coherent communication-Error performance and its optimization, Baseband Pulse Transmission; Inter-symbol Interference (ISI) and the Nyquist criterion for pulse shaping- Techniques for mitigating ISI and improving signal integrity, Digital Modulation Schemes and Demodulation; Optimum Demodulation of Digital Signals- Viterbi Receiver and Maximum Likelihood Sequence Detection, Equalization Techniques for combating channel distortions, Synchronization and Carrier Recovery; Clock synchronization in digital communication, Carrier phase recovery for coherent detection

Text/Reference Books:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems‖, Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers, 2004.
6. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.
7. R. Anand, Communication Systems, Khanna Book Publishing Company, 2011.

Course code	ECE-404			
Category	Engineering Science Courses			
Course title	Micro Fabrication 1			
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			

Unit 1

Introduction: History of IC's; Operation & Models for Devices of Interest: CMOS and MEMS. Electronic Materials: Crystal Structures, Defects in Crystals, Si, Poly Si, Si Crystal Growth. Clean room and Wafer Cleaning: Definition, Need of Clean Room, RCA cleaning of Si.

Unit 2

Oxidation: Dry and Wet Oxidation, Kinetics of Oxidation, Oxidation Rate Constants, Dopant Redistribution, Oxide Charges, Device Isolation, LOCOS, Oxidation System

Lithography: Overview of Lithography, Radiation Sources, Masks, Photoresist, Components of Photoresist Optical Aligners, Resolution, Depth of Focus, Advanced Lithography: E-beam Lithography, X-ray Lithography, Ion Beam Lithography.

Unit 3

Diffusion: Pre-Deposition and Drive-in Diffusion Modeling, Dose, 2-Step Diffusions, Successive Diffusion, Lateral Diffusion, Series Resistance, Junction Depth, Irvin's Curves, Diffusion System. Ion Implantation: Problems in Thermal Diffusion, Advantages of Ion Implantation, Applications in ICs, Ion Implantation System, Mask, Energy Loss Mechanisms, Depth Profile, Range & Straggle, Lateral Straggle, Dose, Junction Depth, Ion Implantation Damage, Post Implantation Annealing, Ion Channeling, Multi Energy Implantation

Unit 4

Thin Film Deposition: Physical Vapor Deposition: Thermal evaporation, Resistive Evaporation, Electron beam evaporation, Laser ablation, Sputtering

Chemical Vapor Deposition: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, Boundaries and Flow, Different kinds of CVD techniques: APCVD, LPCVD, Metalorganic CVD (MOCVD), Plasma Enhanced CVD etc.

Etching: Anisotropy, Selectivity, Wet Etching, Plasma Etching, Reactive Ion Etching. Overview of Interconnects, Contacts, Metal gate/Poly Gate, Metallization, Problems in Aluminum Metal contacts, Al spike, Electromigration, Metal Silicides, Multi-Level Metallization, Planarization, Inter Metal Dielectric

Text/Reference Books:

1. Silicon VLSI Technology, Plummer, Deal and Griffin ,1st Edition, Pearson Education,2009
2. Fundamental of Semiconductor Fabrication, Sze and May,2nd Edition, Wiley India, 2009

4. Silicon Process Technology, S K Gandhi,2nd Edition, Wiley India,2009

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

1. Elucidate the CMOS process flow
2. Analyze various critical processing steps in microfabrication
3. Appreciate the advanced methods involved in IC fabrication.
4. Analyze the advancements in CMOS process fabrication with scaling in technology.

Course code	ECE-405			
Category	Engineering Science Courses			
Course title	Numerical Techniques			
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			

UNIT I

SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

Solution of algebraic and transcendental equations — Fixed point iteration method — Newton Raphson method — Solution of linear system of equations — Gauss elimination method — Pivoting — Gauss Jordan method — Iterative methods of Gauss Jacobi and Gauss Seidel — Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II

INTERPOLATION AND APPROXIMATION

Interpolation with unequal intervals — Lagrange's interpolation — Newton's divided difference interpolation — Cubic Splines — Difference operators and relations — Interpolation with equal intervals — Newton's forward and backward difference formulae.

UNIT III

NUMERICAL DIFFERENTIATION AND INTEGRATION

Approximation of derivatives using interpolation polynomials — Numerical integration using Trapezoidal, Simpson?s 1/3 rule — Romberg's Method — Two point and three point Gaussian quadrature formulae — Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV

INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS

Single step methods — Taylor's series method — Euler's method — Modified Euler's method — Fourth order Runge — Kutta method for solving first order equations — Multi step methods — Milne's and Adams — Bash forth predictor corrector methods for solving first order equations.

Course code	ECE-405			
Category	Engineering Science Courses			
Course title	Management - Organizational Behavior			
Scheme and Credits	L	T	P	Credits
	2	0	0	2
Class work/ Practical	30 Marks			
Exam	70 Marks			
Total	100 Marks			
Duration of Exam	03 Hours			

Course Objective

To provide an understanding of the basic principles of organisational behaviour so as to acquaint the students with managerial skills and the required inputs with reference to human resource management.

Course Outcomes

CO1: To define and explain the basic concepts of organizational behaviour and motivation.

CO2: To explain the essential concepts of organisational conflicts, resolution of conflicts through negotiation, change management and organisational development.

CO3: To familiarize the various aspects of HR, to deal effectively with people resourcing and talent management and HR functions in an organization.

CO4: To understand the concepts of HRD, its role and importance in the success of organization.

CO5: To develop an understanding towards compensation management and industrial relations.

UNIT-I:

Introduction to Organisational Behaviour

Meaning and scope of organisational behaviour - Challenges and Opportunities – Foundations of Individual behaviour, Motivation - Theories (Maslow, ERG, Douglas McGregor two-factor theory), Group dynamics, Leaderships styles

UNIT-II:

Organisational Conflict and Change

Organizational Conflict - causes and consequences - conflict and negotiation, Organizational change, change management process, resistance to change, flexibility and crisis management – Organisational Development – concept and significance

UNIT-III:

Introduction to Human Resource Management

HRM: Meaning, definition and functions. Job Analysis, Job Design, Human Resource Planning - Recruitment and Selection - Sources of Recruitment - Selection process, Placement and Induction

UNIT-IV: Human Resource Development

Introduction to Human Resource Development: Concepts - Training and Development - methods of training, importance of Performance Appraisal, traditional and modern methods of performance appraisal, Job Evaluation - methods of Job Evaluation, Wage and Salary Administration

Compensation Management, Industrial Relations and Emerging HR Practices

Compensation – Concepts and Principles, Influencing Factors, Emerging Trends in Compensation – Methods of Payment – Incentives and Rewards, Managing Industrial Relations – Emerging trends and practices in human resource management

TEXT BOOKS

1. K. Aswathappa, Organizational Behaviour, 12thedition, Himalaya, 2016
2. Edwin B. Flippo, Personnel Management, 6thedition, TMH, 2013
3. P. Subba Rao, Management & Organizational Behavior, 2ndedition, Himalaya, 2014
4. C.B. Mamoria& VSP Rao, Personnel Management, 20thedition, Himalaya, 2015
5. Stephen P. Robins, Organisational Behaviour, 11th edition, PHI Learning / Pearson Education, 2008

Course code	ESC-401P			
Category	Engineering Science Courses			
Course title	Analog Circuit Lab (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			

Do any 12 experiments atleast 3 experiments from each section

CYCLE-I: Simulation Using Multisim/Virtual labs

1. Common Emitter Amplifier
2. Common Source Amplifier
3. Two-Stage RC-Coupled Amplifier
4. Current Shunt Feedback Amplifier
5. CE-CB Cascode Amplifier
6. RC Phase Shift Oscillator Using Transistors
7. Class A Power Amplifier
8. Complementary Symmetry Class B Power Amplifier
9. Wein Bridge Oscillator

CYCLE-II: Hardware Experiments

1. Class A Power Amplifier
2. Single Tuned Voltage Amplifier
3. Hartley and Colpitts Oscillator
4. Common Source Amplifier

CYCLE-III: Pulse Circuits

1. **Linear Wave Shaping**
    - RC Low Pass Circuit for Different Time Constants
    - RC High Pass Circuit for Different Time Constants
2. **Non-Linear Wave Shaping**
    - Transfer Characteristics and Response of Clippers:
        - Positive and Negative Clippers
        - Clipping at Two Independent Levels
3. **Clampers**
    - The Steady State Output Waveform of Clampers:
        - Positive Clampers
        - Negative Clampers

5th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-501	CMOS Integrated Circuits	3	0	0	3	30	70	100
2	ESC-502	Hardware Description Language - Verilog	3	0	0	3	30	70	100
3	ESC-503	Microfabrication-II	3	0	0	3	30	70	100
4	ESC-504	SOC Design 1: Design & Verification	3	0	0	3	30	70	100
5	ESC-505	Control Systems	3	0	0	3	30	70	100
6	ESC-506	Embedded Systems	3	0	0	3	30	70	100
7	ESC-502P	Hardware Description Language – Verilog Lab	0	0	2	1	50	50	100
8	ESC-503P	Microfabrication-II Lab	0	0	2	1	50	50	100
9	ESC-504P	SOC Design 1: Design & Verification Lab	0	0	2	1	50	50	100
10	ESC-506P	Embedded Systems Lab (P)	0	0	2	1	50	50	100
11	ESC-507	Project Based Learning-3	0	0	4	2	50	50	100
Total Credits						24			1100

Course code	ESC-501			
Category	Engineering Science Courses			
Course title	CMOS Integrated Circuits			
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			

Course Outcomes:

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

1. provide an overview of the digital IC design techniques
2. Understand the characteristics of CMOS inverter.
3. Analyze the static and dynamic characteristics of CMOS circuits
4. Design and implementation of combinational and sequential circuits
5. Evaluate the performance of CMOS circuits

Unit I:

Overview of VLSI Design: Historical perspective, overview of VLSI design methodologies, VLSI design flow, design hierarchy, concepts of regularity, modularity, and locality, VLSI design styles, design quality, packaging technology, CAD technology.

MOS Transistor Theory: Introduction to the metal oxide semiconductor (MOS) structure, Long- channel I-V characteristics, C-V characteristics, non-linear I-V effects, DC transfer characteristics.

Unit II:

Introduction to ASIC and SoC, Overview of ASIC flow, functional verification, RTL-GATE level synthesis, synthesis optimization techniques, pre-layout timing verification, static timing analysis, floor-planning, placement and routing, extraction, post layout timing verification, extraction, layout design rules, stick diagram, full-custom mask layout design.

Unit III:

MOS Inverter (Static Characteristics): Resistive-load inverter, inverter with n-type 16 MOSFET load, CMOS inverter

MOS Inverters (Switching Characteristics and Interconnects effects): Delay-time definitions, calculation of delay times, logical efforts, inverter design with delay constraints, estimation of interconnect parasitics, calculation of interconnect delay, Bus vs. Network-on Chip (NoC), switching power dissipation of CMOS inverters.

Unit IV:

Combination CMOS Logic Circuits: MOS logic circuits with depletion nMOS loads, CMOS logic circuits, complex logic circuits, CMOS transmission gates (pass gates), ratioed, dynamic and pass transistor logic circuits.

Sequential MOS logic circuits: Behaviour of bi-stable elements, SR latch circuits, clocked latch and flip-flop circuits, CMOS D-latch and edge-triggered flip-flop. Timing path, Setup time and hold time static, example of setup and hold time static, setup and hold slack, clock skew and jitter, Clock, reset and power distributions. Semiconductor Memories: Memory Design, SRAM, DRAM structure and implementations

Recommended Books:

1. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits” TMH 2003
2. Neil H. E. Weste and David. Harris Ayan Banerjee,, “CMOS VLSI Design” - Pearson Education, 1999.
3. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits” Pearson Education, 2003
4. Uyemura, “Introduction to VLSI Circuits and Systems” Wiley-India, 2006.
5. Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.
6. Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, “Essentials of VLSI Circuits and Systems” – PHI, EEE, 2005 Edition.
7. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, 2005

Course code	ESC-502			
Category	Engineering Science Courses			
Course title	Hardware Description Language: Verilog			
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			

Unit I:

Verilog: Overview of Digital Design with Verilog HDL, Concepts of CPLD and FPGA, Hierarchical Modeling, Basics of Verilog - Data Types, System Tasks and Compiler Directives, Modules and Ports, Gate Level Modeling-Gate Types, Gate Delays.

Unit II

Behavioral Modeling - Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, Multiway Branching, Loops, Sequential and Parallel Blocks, Tasks and Functions – Exercises. FSM based HDL design-Moore & Mealy machines.

Unit III

Useful modeling techniques- Procedural continuous assignments, overriding parameters, conditional compilation and execution, time scales, useful system tasks, Advance Verilog Topics- Timing and delays – types of delay models, path delay modeling, Timing checks, delay back-annotation, Switch level modeling – switch modelling elements, examples.

Unit IV

Logic Synthesis with Verilog HDL- What is logic synthesis, impact of logic synthesis, Verilog hdl synthesis, synthesis design flow, RTL to gates (Example, Verification of gate level net list, modeling tips for logic synthesis, examples of sequential circuit synthesis.

References:

1. Verilog HDL - Samir Palnitkar (Pearson)
2. Verilog HDL Synthesis, A Practical Primer – J Bhasker
3. Digital Design: With an Introduction to Verilog HDL - M. Morris Mano
4. Design Through Verilog HDL - B.Bala Tripura Sundari T.R. Padmanabhan
5. FSM based HDL Design –Peter Minns, lan Elliott(Wiley)

Course code	ESC-503			
Category	Engineering Science Courses			
Course title	Microfabrication II			
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			

Unit I

Clean Room Technology, Clean Room Classifications, Design concepts, Clean Room Installations and Operations, Automation related facility systems, Wafer Cleaning Technology - Basic Concepts, Wet cleaning, Dry cleaning.

Unit II

Conventional Rapid thermal processes, Requirement for thermal processes, Rapid thermal processes, Future trends. Dielectric and Poly silicon film deposition processes, Atmospheric pressure CVD and low pressure CVD based silicon oxide, LPCVD Silicon Nitrides, LPCVD Poly Si Films, Plasma assisted depositions. **Manufacturing Methods**: Epitaxial Silicon Deposition, Polycrystalline Silicon Deposition, Silicon Nitride Deposition, Silicon Dioxide Deposition, Al Deposition, Ti and Ti-W Deposition, W Deposition, TiSi2 and WSi2 Deposition, TiN Deposition, Cu Deposition.

Unit III

VLSI Process Integration, Fundamental considerations for IC Processing, building individual layer, integrating the process steps, miniaturizing VLSI circuits, NMOS IC technology, fabrication process sequence, special consideration for NMOS ICs, CMOS IC technology.

Modern CMOS Technology: Introduction, CMOS Process Flow, The Beginning - Choosing a Substrate, Active Region Formation, Process Option for Device Isolation - Shallow Trench, Isolation N and P Well Formation, Process Options for Active Region and Well Formation, Gate Formation. Tip or Extension (LDD) Formation, Source/Drain Formation, Contact and Local Interconnect Formation, Multi-Level Metal Formation.

Unit IV

Backend Technology: Introduction, Historical Development and Basic Concepts, Contacts, Interconnects and Vias, Dielectrics, Manufacturing Methods, Silicided Gates and Source/Drain Regions, First Level Dielectric Processing, Contact Formation, Global Interconnects, IMD Deposition and Planarization, Via Formation, Final Steps, Measurement Methods, Morphological Measurements, Electrical Measurements, Chemical and Structural Measurements, Mechanical Measurements.

Models and Simulation: Silicide Formation, Chemical-Mechanical Polishing, Reflow, Grain Growth, Diffusion in Polycrystalline Materials, Electromigration.

Reference books:

1. Silicon VLSI Technology Fundamentals, Practice and Modeling by Plummer, Deal and Griffin.
2. ULSI Technology by C.Y. Chang and S.M. Sze (McGraw Hill International).

Course code	ESC-505			
Category	Engineering Science Courses			
Course title	Control Systems			
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			

Unit I:

Introduction to control problem- Industrial Control examples. Transfer function. System with dead-time. System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electrohydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis.

Unit II:

Feedback control systems- Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feed-forward and multi- loop control configurations, stability concept, relative stability, Routh stability criterion. Time response of second-order systems, steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.

Unit III:

Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency-domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation and solution.

Unit IV:

State variable Analysis- Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.

Introduction to Optimal control & Nonlinear control, Optimal Control problem, Regulator problem, Output regulator, trekking problem. Nonlinear system – Basic concept & analysis.

Text/Reference Books:

1. Gopal. M., ―Control Systems: Principles and Design, Tata McGraw-Hill, 1997.
2. Ambikapathy A., Control Systems, Khanna Book Publications, 2019.
3. Kuo, B.C., ―Automatic Control System‖, Prentice Hall, sixth edition, 1993.
4. Ogata, K., ―Modern Control Engineering‖, Prentice Hall, second edition, 1991.
5. Nagrath & Gopal, ―Modern Control Engineering‖, New Age International, New Delhi

Course code	ESC-504			
Category	Engineering Science Courses			
Course title	SOC Design 1: Design & Verification			
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			

Unit 1: Fundamentals of SoC Design and Verilog RTL Design

Introduction to SoC Chip Design Flow: Overview of the complete SoC chip design flow, Introduction to EDA tools: Synopsys, Cadence, Siemens, and open-source alternatives, **Verilog-Based RTL Design**, In-depth study of Verilog syntax and constructs, Hands-on lab work on Verilog-based digital system design.

Unit 2: SoC IP Integration and Verification Techniques

Integration of Digital and Analog IPs in SoC Design: Understanding digital and analog IPs. Techniques for integrating diverse IPs into a single SoC. **RTL Verification using Simulation Methods** Simulation-based verification techniques. Practical exercises using EDA tools.

Unit 3: Advanced RTL Verification and Automation

RTL Verification using Formal Methods: Introduction to formal verification. Application of formal methods in RTL verification. **Scripting Languages for Chip Design Automation**: Introduction to scripting languages (TCL and Perl). Development of automation scripts for design tasks.

Unit 4: Prototyping, Validation, and Final Project

Rapid Prototyping with FPGAs and Emulation Hardware Validation: Rapid prototyping using FPGAs. Validation of designs using emulation hardware. **Project Work and Final Presentations** Individual or group projects demonstrating SoC design and verification skills. Final project presentations and review of key concepts.

Recommended Books:

1. Cem Unsalan, Bora Tar. *Digital System Design with FPGA: Implementation using Verilog and VHDL*. McGrawHill, First Edition.
2. Nekoogar, Farzad. *From ASICs to SOCs*. Prentice Hall Professional, 2003.
3. Wolf, Wayne. *Modern VLSI Design*. Pearson Education, 2002.
4. Chakravarthi, Veena. *A Practical Approach to VLSI System on Chip (SoC) Design*. Springer Nature, 2019.

Course code	ESC-506			
Category	Engineering Science Courses			
Course title	Embedded Systems			
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			

Unit I:

Introduction to Embedded systems: Motivation based on applications of embedded systems, Basics of Embedded systems, functional block.

Unit II:

Modeling of Embedded system: Mathematical modeling of physical systems to fit into embedded systems, Continuous Dynamics, Discrete Dynamics, Hybrid Systems, actor models, Composition of State Machines.

Unit III:

Microcontrollers, Sensors, Actuators, Basics of Microcontrollers, 8951, Arduino microcontroller development board, I/Os, Sensors, Actuators

Unit IV:

Interfacing between analog and digital blocks, signal conditioning, digital signal processing. sub-system interfacing, interfacing with external systems, user interfacing. Design tradeoffs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

Text/Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

Course Outcomes:

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

1. Suggest design approach using advanced controllers to real-life situations.
2. Design interfacing of the systems with other data handling / processing systems.
3. Appreciate engineering constraints like energy dissipation, data exchange speeds etc.

Microfabrication II Lab:

(Do any 10)

1. Familiarization with cleanroom environment, safety protocols.
2. Learn and perform RCA cleaning of silicon wafers to remove organic, inorganic, and metallic impurities.
3. Deposition of thin films by spin coating and characterize them using optical/surface analyser method.
4. Characterize and identify wafer properties using methods such as wafer resistivity and visual inspection.
5. Learn the vacuum evaporation process for thin metal film deposition and contact formation.
6. Study & Perform metallization by sputtering, focusing on deposition techniques for creating metallic contacts.
7. Perform oxidation of silicon wafers and measure the thickness of the resulting silicon dioxide layer.
8. Fabricate MS contacts both ohmic and schottky, then characterize their current-voltage (IV) characteristics.
9. Fabricate MOS devices and evaluate their electrical properties through capacitance-voltage (C-V) and IV measurements.
10. Studying the effect of annealing on device interface (MS contact and MOS device).
11. Utilize spin coating for deposition of resists, studying pre/post exposure bake.
12. Utilize photolithography to pattern device structures on wafers, using UV light exposure and resist development techniques.

Hardware Description Language: Verilog (Lab)

(Do any 10)

1. Verilog implementation of 8:1 Mux/Demux, Full Adder, 8-bit Magnitude comparator, Encoder/decoder, Priority encoder, D-FF, 4-bit Shift registers (SISO, SIPO, PISO, bidirectional), 3-bit Synchronous Counters, Binary to Gray converter, Parity generator.
2. Model in Verilog for a full adder and add functionality to perform logical operations of XOR, XNOR, AND and OR gates. Write test bench with appropriate input patterns to verify the modeled behaviour.
3. Write Verilog code for SR, D and JK and verify the flip flop.
4. Write Verilog code for 4-bit BCD synchronous counter.
5. Write Verilog code for counter with given input clock and check whether it works as clock divider performing division of clock by 2, 4, 8 and 16. Verify the functionality of the code.
6. Sequence generator/detectors, Synchronous FSM – Mealy and Moore machines.
7. Vending machines – Traffic Light controller, ATM, elevator control.
8. PCI Bus & arbiter and downloading on FPGA.
9. UART/ USART implementation in Verilog.
10. Realization of single port SRAM in Verilog.
11. Verilog implementation of Arithmetic circuits like serial adder/ subtractor, parallel adder/subtractor, serial/parallel multiplier.
12. Discrete Fourier transform/Fast Fourier Transform algorithm in Verilog.
13. Interface a DAC to FPGA and write Verilog code to generate Sine wave of frequency F KHz (eg. 200 KHz) frequency. Modify the code to down sample the frequency to F/2 KHz. Display the Original and Down sampled signals by connecting them to an oscilloscope.
14. Write Verilog code using FSM to simulate elevator operation. Opcode(2:0) ALU Operation Remarks 000 A + B Addition of two numbers Both A and B are in two's complement format 001 A – B Subtraction of two numbers 010 A + 1 Increment Accumulator by 1 A is in two's complement 011 A - 1 Decrement accumulator by 1 format 100 A True Inputs can be in any format 101 A Complement Complement 110 A OR B Logical OR 111 A AND B Logical AND
15. Write Verilog code to convert an analog input of a sensor to digital form and to display the same on a suitable display like set of simple LEDs, 7-segment display digits or LCD display.

SOC Design 1: Design & Verification Lab

(Do any 10)

1. Introduction to SoC Design Flow
2. Introduction to EDA Tools
3. Integration of Digital IPs in SoC Design
4. Design a clock divider circuit that generates 1/2, 1/3rd and 1/4thclock from a given input clock. Port the design to FPGA and validate the functionality through oscilloscope.
5. Interface a DAC to FPGA and write Verilog code to generate Sine wave of frequency F KHz (eg. 200 KHz) frequency. Modify the code to down sample the frequency to F/2 KHz. Display the Original and Down sampled signals by connecting them to an oscilloscope.
6. Simulate an analog IP block (e.g., DAC) with a digital system (like a controller) in a SoC
7. Perform RTL verification of a design (such as an adder or counter) using testbenches
8. Write a TCL script to automate the synthesis process of a small digital module
9. Develop a Perl script to automate the generation of Verilog testbenches
10. Synthesize an RTL design and deploy it on an FPGA for real-time validation
11. Interface a Stepper motor to FPGA and write Verilog code to control the Stepper motor rotation which in turn may control a Robotic Arm. External switches to be used for different controls like rotate the Stepper motor
    a. +N steps if Switch no.1 of a Dip switch is closed
    b. +N/2 steps if Switch no. 2 of a Dip switch is closed
    c. –N steps if Switch no. 3 of a Dip switch is closed etc.
12. Verilog 32-bit ALU and verify the functionality of ALU by selecting appropriate test patterns.
    a. Write test bench to verify the functionality of the ALU considering all possible input patterns
    b. The enable signal will set the output to required functions if enabled, if disabled all the outputs are set to tri-state
    c. The acknowledge signal is set high after every operation is completed

6th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	ESC-601	MOSFET Physics and Sub-Micron Devices	3	0	0	3	30	70	100
2	ESC-602	SOC Design 2: Chip Implementation with Physical Design Leading to Tape-Out	3	0	0	3	30	70	100
3	ESC-603	Semiconductor Equipment Design and Technology	3	0	0	3	30	70	100
4	ESC-604	Semiconductor Materials Synthesis and Characterization	3	0	0	3	30	70	100
5	PE-1	Program Elective-1	3	0	0	3	30	70	100
6	OE-1	Open Elective-1	3	0	0	3	30	70	100
7	ESC-605	Device Modeling using TCAD Lab	0	0	2	1	50	50	100
8	ESC-602P	SOC Design 2: Chip Implementation with Physical Design Leading to Tape-Out Lab	0	0	2	1	50	50	100
9	PE-1P	Program Elective-1 Lab	0	0	2	1	50	50	100
10	ESC-607P	Minor Project	0	0	4	2	50	50	100
Total Credits						23			1000

MOSFET Physics and Sub-Micron Devices

Unit I

SEMICONDUCTOR ELECTRONICS: Physics of Semiconductor Materials, Band Model of Solids Thermal-Equilibrium Statistics, Carriers in Semiconductors, Drift Velocity, Mobility and Scattering, Drift & Diffusion Current, Device: Hall-Effect.

Unit II

METAL-SEMICONDUCTOR CONTACTS and P-N JUNCTIONS: Metal-Semiconductor junctions, Current-Voltage Characteristics, Surface Effects. The pn junction, Step Junction, Linearly Graded Junction, Heterojunctions, Reverse-Biased p-n junctions and break down mechanism. Generation and Recombination.

Unit III

FIELD-EFFECT TRANSISTORS (MOSFETs): PHYSICAL EFFECTS AND MODELS: MOS Capacitor, Oxide and Interface Charge: Origin and Experimental Determination Charge Coupled Devices, non-volatile memory. Basic MOSFET behaviour, MOSFET scaling and short channel model. Devices: Complementary MOSFETs (CMOS), electric fields and velocity-saturation, basic leakage currents, channel length modulation, body bias effect, threshold adjustment, sub-threshold conduction .

Unit IV

Device Modeling Limitation of long channel analysis, short-channel effects: velocity saturation, device degradation, channel length modulation, body bias effect, threshold adjustment, mobility degradation, hot carrier effects, MOSFET scaling goals, gate coupling, velocity overshoot, high field effects in scaled MOSFETs, substrate current and effects in scaled MOSFETS.

Recommended Books

1. Corrado Di Natale. Introduction to Electronic Devices. Springer, 2023.
2. S. Salivahanan, N. Suresh Kumar.Electronic Devices and Circuits.McGrawHill, 2022.
3. Segio M. Rezende. Introduction to Electronic Materials and Devices. Springer, 2022
4. Sze, S. M., & Kwok, K. N. (2006). Physics of semiconductor devices (3rd ed.). Hoboken, NJ: Wiley

SOC Design 2: Chip Implementation with Physical Design leading to Tape-Out

Unit 1:

Introduction to Physical Design and EDA Tools: Introduction to Physical Design SoC Flow. Overview of the complete Physical Design SoC flow. Introduction to EDA Tools. Overview of Synopsys, Cadence, Siemens, and open-source alternatives. Standard Cell and Key Design Elements. Analysis of standard cells and essential design elements. Hands-on exercises using EDA tools.

Unit 2:

Logic & Physical Synthesis and Timing Analysis Logic & Physical Synthesis Application of logic synthesis techniques. Physical synthesis for placement and routing optimization. Timing Constraints and Analysis. Definition and implementation of timing constraints. Analysis of timing characteristics and mitigation strategies.

Unit 3:

Floor Planning, Placement, and Clock Tree Synthesis: Floor Planning and Placement. Development of floor plans for efficient chip layout. Optimization of chip placement for performance and area. Clock Tree Synthesis and Routing. Implementation of clock tree synthesis. Routing techniques for interconnections within the design.

Unit 4:

Timing Closure, Physical Design Verification, and Tape-Out: Timing Closure Techniques. Application of techniques to achieve timing closure. Addressing challenges in meeting timing requirements. Physical Design Verification, Tape-Out, and DFT/DFM Introduction: Methods for physical design verification. Overview of the tape-out process. Introduction to Design for Testability (DFT) and Design for Manufacturability (DFM) principles.

Recommended Books

1. Cem Unsalan, Bora Tar. Digital System Design with FPGA: Implementation using Verilog and VHDL. Mc-Graw-Hill, First Edition.
2. Nekoogar, Farzad. From ASICs to SOCs. Prentice Hall Professional, 2003.
3. Chakravarthi, Veena. SoC Physical Design. Springer Nature, 2022.
4. Kahng, Andrew. VLSI Physical Design: From Graph Partitioning to Timing Closure. Springer Science & Business Media, 2011.
5. Michael Keating, Synopsys. The Simple Art of SoC Design. Springer Science & Business Media, 2011.
6. Sait, Sadiq. VLSI Physical Design Automation. World Scientific, 1999.

Semiconductor Equipment Design and Technology

Course Contents:

Unit 1: Fundamentals of vacuum technology- nomenclature and definition, pressure regions, gas properties and laws, molecular processes and kinetic theory, gas flow calculations, technology of vacuum pumps- throughput, pumping speed, fore vacuum and high vacuum pumping, pump system design, diaphragm pumps, vacuum blowers, diffusion pumps, cryogenic pumps, turbomolecular pumps, pumps for ultra-high vacuum, vacuum measurements, types of gauges, mass analysis and spectrometry, mass flow control and measurement, vacuum valves, flanges and components, vacuum feedthroughs, vacuum seals, vacuum leak detectors, vacuum chambers and viewports, outgassing, vacuum applications such as sputtering, plasma etching, CVD, epitaxy, electron spectroscopies

Unit 2: **Plasma Science and Technology**

Plasma physics- Motion of individual electrons and ions in electric and magnetic fields- Single, collisionless, particles in DC and AC electric fields, Particle orbits in magnetic fields, Space charge and collective effects, Debye shielding, Plasma oscillations and plasma frequency, Plasma shielding and plasma sheaths, Response to DC, RF and microwave fields, Plasma potential, Characteristic electron and ion transit times.

Unit 3: Introduction to Plasma Reactors

Chamber pump systems, load locks, mass flow control, hazardouns gas handling, effluent control, Pressure gauges / control (Piranhi, thermocouple, ionization, baratron, convectron) Wafer chucks (Clamps/Electrostatic chucks) RF and microwave power sources and coupling- Power sources, matching networks, feedthroughs and coupling.

Unit 4: RF Capacitively and Inductively coupled plasmas:-

Spatial variations of plasma potential, electric field, charge density and energy, optical emission, Sheaths at powered, grounded and floating surfaces, parameters, models, matching networks, Ion bombardment - energy / time / frequency/ power dependencies

Applications in processes- etching, deposition, sputtering, ashing

Text/Reference Books:

1. V.V. Rao, T.B. Ghosh, K.L. Chopra,, Vacuum Science and Technology, Allied Publishers Ltd., New Delhi
2. Handbook of Vacuum Science and Technology- Dorothy M. Hoffman, Bawa Singh, John H. Thomas, III, Academic Press
3. Handbook of Vacuum Technology: Karl Jousten, Wiley
4. Plasma Etching: Fundamentals and Applications: 7 (Series on Semiconductor Science and Technology)- M. Sugawara, OUP Oxford
5. Plasma Etching in Semiconductor Fabrication- Russ Morgan, Elsevier
6. Fundamentals of Plasma Physics- J. A. Bittencourt, Springer India
7. Plasma Physics and Engineering- Alexander Fridman, Lawrence Kennedy, CRC Press

Semiconductor Materials Synthesis and Characterization

Course Contents:

Unit 1: Introduction to Semiconductor Materials and Crystallography: Introduction to Course. **Crystallographic Properties of Semiconductors**. Overview of crystallography and lattice structures in semiconductors. Materials Characteristics of Common Semiconductors. Structural, optical, and electronic properties of key semiconductor materials.

Unit 2: Epitaxial Growth and Thermal Oxidation of Semiconductors: Epitaxial Growth of Semiconductors. Techniques and principles of epitaxial growth for semiconductor materials. **Thermal Oxidation Kinetics of Si**. Oxidation processes in Si, kinetics, and applications in device fabrication. **Bulk and Epitaxial Growth Technologies**. Introduction to bulk growth methods, with emphasis on epitaxy for Si and III-V materials.

Unit 3: Deposition Techniques for Semiconductors, Metals, and Dielectrics: Chemical Vapor Deposition (CVD) Principles and applications of CVD for semiconductors, metals, and dielectrics. **Physical Vapor Deposition (PVD)**. Techniques in PVD for thin film growth and device applications. **Chemical Cleaning of Semiconductors**. Cleaning methods and preparation for high-quality semiconductor surfaces.

Unit 4: Characterization and Electrical Properties of Semiconductors: Electrical Properties of Semiconductors: Electrical characterization methods and properties of semiconductor materials. **Characterization Methods for Semiconductors**: Overview of structural, optical, and chemical characterization techniques: XRD (Bulk and thin film), Microscopy (Optical, SEM, TEM, SPM), UV-Visible spectroscopy, Photoluminescence, Raman spectroscopy. Evaluation and quality control processes in electronic and photonic applications.

Text/Reference Books:

1. **Semiconductor Material and Device Characterization** by Dieter K. Schroder
2. **Fundamentals of Semiconductor Fabrication** by Gary S. May and Simon M. Sze
3. **VLSI Fabrication Principles: Silicon and Gallium Arsenide** by Sorab K. Ghandhi
4. **Materials Science of Thin Films"** by Milton Ohring
5. **Handbook of Semiconductor Manufacturing Technology** by Yoshio Nishi and Robert Doering
6. **Springer Handbook of Nanotechnology** by Bharat Bhushan

Course Outcome:

1. Understand the Silicon extraction and purification process
2. Understand Crystallography of Si and various methods of growth
3. Understand key methods of physicochemical, morphological and analytical characterization techniques

PE1 Basket					
Sr. No.	**Course Code**	**Course Title**	**Semester**	**L: T: P**	**Credits**
1	PE1A	Analog IC Design	VI	3:0:0	3
2	PE1B	FPGA Programming	VI	3:0:0	3
3	PE1C	Quantum Computing	VI	3:0:0	3
4	PE1D	Digital Signal Processing in VLSI	VI	3:0:0	3

Analog IC Design

Unit 1

Introduction to MOSFETS, Simple MOSFET circuits, Threshold voltage model, Capacitance model, Mobility model, MOSFET basics, Basic current mirrors, Cascode current mirrors, Active current mirrors with large and small signal analysis, MOSFET in integrated circuits, Common mode properties.

Unit 2

Noise- Statistical characteristics of noise- Types of noise: significance of flicker and thermal. Analysis and representation of noise in single-stage amplifiers: CG, CS, CD (source follower) and cascode stage and noise in differential pairs. Representation of noise in circuits- Noise in singlestage amplifiers- Noise in differential pairs- Noise Bandwidth.

Unit 3

Feedback topologies (voltage-voltage, current-voltage, voltage-current, current-voltage) and the noise and the loading effect analysis, Negative feedback, Stability of negative feedback systems, Stability and frequency compensation: Specification analysis, multi-pole system, three-stage opamp, phase margin Frequency compensation, pole-zero doublet analysis.

Unit 4

Design of the CMOS operational amplifiers: One-stage opamps and two-stage opamps, Gain boosting techniques, folded cascode, telescopic amplifier, common mode feedback (CMFB) amplifier, Three-stage opamp architectures, opamp specifications analysis, Design of high-speed and high-gain amplifiers. CMOS amplifier Frequency response: Miller effect, common source (CS), common gate (CG), common drain (CD) stages, and cascode stage Analog layout techniques for MIM, MOM and fringe capacitor.

NPTEL course (if any): https://nptel.ac.in/courses/108106105.

Text/Reference Books:

1. “Design of Analog CMOS Integrated Circuits” by Behzad Razavi, McGraw Hill Education (1 September 2000).
2. CMOS Analog Circuit Design” by Phillip Allen and Douglas R. Holberg, OUP USA; Third Edition edition (1 September 2011).
3. “Operation and Modeling of the MOS Transistor” by Yannis Tsividis, Oxford University Press; 2 edition, June 26, 2003.
4. “Microelectronic Circuits-Theory & Applications” by A.S. Sedra and K.C. Smith, Adapted by A.N. Chandorkar, 6th Edition, Oxford, 2013.
5. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022.

FPGA Programming

Unit 1:

Introduction to FPGAs and Digital Design-Introduction to FPGA technology, its architecture, and applications in areas such as communications, signal processing, and embedded systems, Comparison of FPGAs with traditional processors and ASICs, The FPGA development flow: design entry, synthesis, place and route, bitstream generation, Understanding digital logic gates (AND, OR, NOT, NAND, NOR, XOR), Boolean algebra, and simplification techniques, Design of combinational logic circuits & sequential logic circuits

FPGA Architecture and Configuration-Study of FPGA internal architecture: CLBs (Configurable Logic Blocks), I/O blocks, interconnects, Configuration process and the role of bitstream files in FPGA programming.

Unit 2:

VHDL and Verilog Programming for FPGAs-Overview of VHDL syntax, data types, and operators, Structural, behavioral, and dataflow modeling in VHDL.

Verilog syntax, operators, and data types, Modeling styles in Verilog: behavioral, structural, and dataflow.

Unit 3: Digital Circuit Design on FPGAs

Combinational Circuit Design on FPGAs-Techniques for designing multiplexers, decoders, and arithmetic operations. Logic minimization techniques for combinational circuits. Mapping designs to FPGA architecture and verifying with simulation.

Sequential Circuit Design on FPGAs-Design of flip-flops, counters, shift registers, and FSMs.Techniques for designing and optimizing FSMs for FPGA implementation. Implementing synchronization techniques and clock domain crossing. Integration and Simulation of Digital Circuits on FPGAs

Connecting combinational and sequential circuits into larger FPGA systems-Simulating large designs and performing debug operations. Using simulation tools to verify integrated FPGA systems.

IP Cores and System-Level Design- Integration of pre-designed IP cores into FPGA projects.

Unit 4:

Real-World Applications of FPGAs-Case studies on the use of FPGAs in signal processing, communications, and embedded systems. Exploration of industry trends and emerging applications such as machine learning and AI acceleration using FPGAs.

Introduction to advanced FPGA development platforms (e.g., Vivado, Quartus). Debugging FPGA designs using logic analyzers and onboard debugging tools.

Project Development: Planning and implementing individual/group projects based on FPGA technology. Design problem definition, requirement analysis, and project planning. Troubleshooting and debugging complex FPGA-based systems.

Recommended Books

1. Rajewski, Justin. Learning FPGAs. “O’Reilly Media, Inc.,” 2017.
2. Monk, Simon. Programming FPGAs: Getting Started with Verilog. McGraw Hill Professional, 2016.
3. Pellerin, David. Practical FPGA Programming in C. Prentice Hall, 2005.
4. Bruno, Frank. FPGA Programming for Beginners. Packt Publishing Ltd, 2021.

Quantum Computing

Unit 1: Review of Quantum Mechanics and Motivation for Quantum Computation

Overview of Quantum Mechanics-Review of basic principles of quantum mechanics, Quantum states and operators, Introduction to the motivation behind quantum computing.

Qubit and Its Representation-Definition of the qubit and quantum state, Matrix representation of qubit states, Bloch sphere representation of qubits, Computational basis and unitary evolution of qubits.

Multi-Qubit States and Quantum Entanglement-Generalization to multi-qubit systems, The no-cloning theorem and its implications, Superdense coding, Conversion of pure states into Bell states, Bell inequalities and their role in quantum computation.

Protocols with Multi-Qubits-Quantum state swapping and teleportation protocols, Quantum gates, Walsh-Hadamard transformation and its importance in quantum computing.

Unit 2: Measurement, Density Operators, and Composite Systems

Quantum Measurement-Projective operators and their relationship with quantum measurement, Types of quantum measurements, Measurement outcomes and their impact on quantum systems.

Density Operators-Concept of ensemble and density operators in quantum systems,Pure and mixed quantum ensembles, Time evolution of quantum states, Post-measurement density operators and their use in quantum dynamics.

Composite Quantum Systems-The concept of composite systems in quantum mechanics, The partial trace and reduced density operator for composite systems, Schmidt decomposition and its application in entanglement theory, Purification and bipartite entanglement

Unit 3: Quantum Computation and Quantum Algorithms

Classical Computing with Qubits-Quantum mechanics' application in classical computation: A comparative study, Quantum parallelism: Harnessing multiple possibilities with quantum computing.

Quantum Algorithms-Deutsch's algorithm and its role in quantum computation, Deutsch-Josza algorithm.

Quantum Circuits and Quantum Gates-Basic quantum gates: X, Y, Z, Hadamard, and phase gates. Decomposition of quantum circuits using ABC (And, Branch, and Cut) decomposition, Gray codes and their application in quantum algorithms, Universal quantum gates and their significance in quantum computation.

Advanced Quantum Algorithms- Principle of deferred and implicit measurements in quantum circuits, Quantum Fourier transform (QFT) and its applications in quantum algorithms, Factoring algorithms and their role in breaking classical cryptographic systems (e.g., RSA encryption).

Unit 4: Quantum Error Correction, Physical Realization of Qubits, and Applications

Quantum Error Correction-Introduction to quantum error correction: Protecting quantum information from noise, Quantum error correction codes: Shor’s code, Steane code, and surface codes, Fault tolerance in quantum circuits and the threshold theorem.

Physical Realization of Qubits-Overview of different physical systems used to realize qubits: Superconducting qubits, trapped ions, photonic qubits, and quantum dots, Challenges in physical qubit construction and coherence times.

Applications of Quantum Computing-Quantum computing’s impact on classical cryptography: Role of prime factorization in RSA encryption, Quantum search algorithms, Current state of quantum computing and its potential applications in optimization, simulation, and AI.

Digital Signal Processing in VLSI

UNIT-I INTRODUCTION TO DSP SYSTEMS

Introduction To DSP Systems: Introduction; representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power systems

RETIMING, ALGORITHMIC STRENGTH REDUCTION Loop bound, iteration bound, Longest path matrix algorithm, Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application

UNIT-II FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel Recursive filters – Look-Ahead pipelining in first-order IIR filters.

UNIT-III BIT-LEVEL ARITHMETIC ARCHITECTURES

Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and Carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule.

UNIT-IV NUMERICAL STRENGTH REDUCTION

Numerical strength reduction – sub-expression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase Clocking, two-phase clocking, wave pipelining.

Text Books:

1. R. Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and implementation ", Wiley, Interscience, 2007
2. U. Meyer – Baese, " Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004. Reference

Mohammad Isamail and Terri Fiez, Analog VLSI signal and information processing, McGraw Hill, 1994

S.Y. Kung, H.J. White House, T. Kailath, VLSI and Modern Signal Processing, Prentice Hall, 1985

Web References:

1. https://drive.google.com/file/d/0BzoKWH8M1BoTb1d4SVNFSlZMdHM/view?usp=sharing
2. http://annaunivhub.blogspot.com/2015/05/vl7101-vlsi-signal-processing-notes.html E-Text
3. https://www.stuvia.com/doc/323898/vlsi-signal-processing-important-notes 2.
4. drive.google.com/file/d/0BzoKWH8M1BoTdUpldzR3QkY3QlU/view?usp=sharing MOOC

Course

1. https://onlinecourses.nptel.ac.in/noc16_ec13/preview
2. http://viplab.cs.nctu.edu.tw/course/VLSIDSP2015_Fall.php

7th Semester

S. No.	Course Code	Subject	L	T	P	Credits	Marks for Session	Marks for End-Term Exam.	Total
1	PE-2	Program Elective-2	3	0	0	3	30	70	100
2	PE-3	Program Elective-3	3	0	0	3	30	70	100
3	PE-3	Program Elective-4	3	0	0	3	30	70	100
4	OE-2	Open Elective-2	3	0	0	3	30	70	100
5	OE-3	Open Elective-3	3	0	0	3	30	70	100
6	HSM-5	Slot for HSM Course	3	0	0	3	30	70	100
7	XC-29	Major Project Phase 1	0	0	4	2	50	50	100
8	PE-1	Program Elective-2 Lab	0	0	2	1	50	50	100
9	PE-1	Program Elective-3 Lab	0	0	2	1	50	50	100
10	XC-28	Industry/Foundry visit/Survey Compulsory	0	0	2	1	50	50	100
Total Credits						23			1000

					PE2 Basket
1	PE2A	Device Modeling using TCAD	VII	3:0:0	3
2	PE2B	Mixed Signal Design	VII	3:0:0	3
3	PE2C	Low Power VLSI Design	VII	3:0:0	3
					PE3 Basket
1	PE3A	Design for Testability	VII	3:0:0	3
2	PE3B	IC Packaging	VII	3:0:0	3
3	PE3C	Verification Tools and Techniques	VII	3:0:0	3
					PE4 Basket
1	PE4A	Emerging Memory Devices	VII	3:0:0	3
2	PE4B	Biomedical Electronics	VII	3:0:0	3
3	PE4C	Memory Design	VII	3:0:0	3

Device Modeling using TCAD

Unit I

Metal Semiconductor contacts – idealized Metal, Semiconductor junction, current voltage characteristics of Schottky barrier, ohmic contacts, surface effects, MOS electronics, capacitance of the MOS system, non-ideal MOS system.

Basic MOSFET behavior, Channel length modulation, Body bias effect, Threshold voltage adjustment, Sub threshold conduction.

Unit II

Limitation of long channel analysis, short channel effects, mobility degradation, velocity saturation, drain current in short channel MOSFETS, MOSFET scaling and short channel model, CMOS devices, MOSFET scaling goals, gate coupling, velocity overshoot, high field effects in scaled MOSFETs, substrate current, hot carrier effects, effects of substrate current on drain current, gate current in scaled MOSFETS.

Unit III

Moore law, Technology nodes and ITRS, Physical & Technological Challenges to scaling, Nonconventional MOSFET – (FDSOI, SOI, Multi-gate MOSFETs).

Unit IV

Numerical Simulation, basic concepts of simulations, grids, device simulation and challenges. Importance of Semiconductor Device Simulators - Key Elements of Physical Device Simulation, Historical Development of the Physical Device Modeling.Introduction to the Silvaco ATLAS Simulation Tool, Examples of Silvaco ATLAS Simulations – MOSFETs and SOI.

References:

1. Device Electronics for Integrated circuits by muller and kammins.
2. Computational Electronics by DragicaVasileska and Stephen M. Goodnick.
3. Silicon Nanoelectronics – Shundri Oda & David Ferry, CRC Press.

Course Outcome:

1. Understand Basics of Vacuum Technology
2. Understand Basics of Plasma Technology
3. Ability to analyze vacuum and plasma based semiconductor equipment

Mixed Signal Design

Unit I

Building blocks for CMOS amplifiers: design of current mirrors, differential amplifiers, CMOS operational transconductance amplifiers: design of single ended telescopic cascode, folded cascode and two-stage amplifiers.

Unit II

Frequency compensation schemes: Miller compensation, Ahuja compensation and Nested Miller compensation.

Unit III

Design of fully differential amplifiers, discussion of common mode feedback circuits. Switched capacitor circuits, design of switched capacitor amplifiers and integrators, effect of opamp finite gain, bandwidth and offset, circuit techniques for reducing effects of opamp imperfections, switches and charge injection and clock feed-through effects.

Unit IV

Design of sample and hold and comparators. Fundamentals of data converters; Nyquist rate A/D converters (Flash, interpolating, folding flash, SAR, and pipelined architectures); Nyquist rate D/A converters - voltage, current and charge mode converters, hybrid, and segmented converters); Oversampled A/D and D/A converters.

Design of PLL's and DLL's and frequency synthesizers.

Text/Reference Books:

1. R. Gregorian and Temes - Analog MOS integrated circuits for signal processing.
2. R.Gregorian - Introduction to CMOS opamps and comparators.
3. D.Johns and K.Martin - Analog integrated circuit design.
4. B.Razavi - Monolithic Phase-locked loops and clock recovery circuits: Theory and design

Low Power VLSI Design

Unit I

Basics of MOS circuits: MOS Transistor structure and device modeling MOS Inverters MOS Combinational Circuits - Different Logic Families.

Sources of Power dissipation: Dynamic Power Dissipation Short Circuit Power Switching Power Gliching Power Static Power Dissipation Degrees of Freedom.

Unit II

Supply Voltage Scaling Approaches: Device feature size scaling Multi-Vdd Circuits Architectural level approaches: Parallelism, Pipelining Voltage scaling using high-level transformations Dynamic voltage scaling Power Management

Unit III

Switched Capacitance Minimization Approaches: Hardware Software Tradeoff Bus Encoding Two's complement Vs Sign Magnitude Architectural Optimization Clock Gating Logic styles.

Unit IV

Leakage Power minimization Approaches: Variable-threshold-voltage CMOS (VTCMOS) approach, multi-threshold-voltage CMOS (MTCMOS) approach Power gating Transistor stacking Dual-Vt assignment approach (DTCMOS)

NPTEL Course (if any): https://nptel.ac.in/courses/106105034.

Text/Reference Books:

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgrag Hill.
2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley
3. A. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995.
4. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.
5. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Interscience, 2000.

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

1. Capability to recognize advanced issues in VLSI systems, specific to the deep-submicron silicon technologies.
2. Students able to understand deep submicron CMOS technology and digital CMOS design styles.
3. To design chips used for battery-powered systems and high-performance circuits.

Design for Testability in VLSI Systems

UNIT I: Fundamentals of Design for Testability

Introduction to Design for Testability: Importance in modern electronic systems, Historical background and evolution, Key concepts: Fault models, testing methodologies, and standards

Built-In Self-Test (BIST) Techniques: Principles and architecture of BIST, Benefits and limitations, BIST simulations and practical exercises

UNIT II: Scan-Based Testing and Fault Analysis

Scan Chains and Serial Testing: Design and use of scan chains, Optimization techniques for better coverage, Design and test of scan chains

Fault Modeling and Simulation: Types of faults (stuck-at, bridging, etc.), Simulation tools and fault coverage analysis, Fault simulation exercises using CAD tools

UNIT III: Strategies and Standards in Testability

Design for Testability (DFT) Strategies: Techniques for enhancing testability, Real-world case studies and successful implementations, DFT-aware circuit design and testing

Industry Standards in Testability: Overview of IEEE standards (e.g., 1149.1 JTAG), Compliance, certification, and validation processes, Testing for standard compliance

UNIT IV: Emerging Trends and Practical Implementation

Advanced Topics in DFT: Emerging trends in DFT (e.g., AI in testing, low-power DFT), Future challenges and opportunities

Recommended Textbooks:

1. Tripathi, Suman. *Advanced VLSI Design and Testability Issues.* CRC Press, 2020.
2. Wang, Laung-Terng. *VLSI Test Principles and Architectures.* Morgan Kaufmann, 2006.
3. Huhn, Sebastian. *Design for Testability, Debug and Reliability.* Springer Nature, 2021.

IC Packaging

UNIT I: Fundamentals of IC Packaging

Introduction to IC Packaging Technologies: Significance and role of packaging in electronics, Historical evolution of packaging technologies, Packaging types: Through-hole, Surface-Mount, Ball Grid Array (BGA)

Packaging Materials and Interconnection Techniques: Materials used in semiconductor packaging, Wire bonding, flip-chip, and solder bump technologies

UNIT II: Performance and Integrity Considerations

Thermal Management in IC Packaging: Principles of thermal conduction and dissipation, Cooling methods and heat sink strategies,

Case Studies: Real-world thermal solutions in packaging

Signal and Power Integrity: Signal integrity issues in high-speed designs, Power distribution and decoupling techniques, Simulation of signal and power integrity challenges

UNIT III: Packaging Strategies, Reliability, and Trade-offs

Packaging Types and Trade-offs: Comparative analysis: Through-hole, SMT, and BGA, Mechanical, electrical, and thermal trade-offs

Project: Design a packaging solution with justified trade-offs

Reliability in IC Packaging: Failure mechanisms and reliability factors, Testing and validation methods (e.g., thermal cycling, vibration), Design Reliability testing experiments

UNIT IV: Advanced Technologies and Capstone Project

Advanced Topics in IC Packaging: Emerging technologies: 2.5D/3D packaging, fan-out wafer-level packaging, Innovations in materials and interconnect methods

Recommended Books:

1. John H. Lau. *Semiconductor Advanced Packaging.* Springer, 2021.
2. King-Ning Tu, Chih Chen, Hung-Ming Chen. *Electronic Packaging Science and Technology.* Wiley, 2022.

Verification Tools and Techniques

UNIT I: Fundamentals of Digital Verification

Introduction to Verification in Digital Design: Importance of verification in the design lifecycle, Functional verification concepts and terminology, Overview of simulation-based verification

Simulation Tools and Basic Verification Techniques: Hands-on with tools like ModelSim and VCS, Writing testbenches, generating stimulus, analyzing output

UNIT II: Formal Methods and Advanced Verification

Formal Verification Principles: Concepts of formal verification, model checking, and theorem proving, Comparison of formal vs. simulation methods, formal verification on small hardware designs

Advanced Verification Strategies: Constrained-random testing and test automation, Assertion-based and coverage-driven verification approaches

UNIT III: Tools and Languages for Verification

Industry-Standard Verification Tools: Overview and comparison of tools like Questa, VCS, JasperGold Functionalities such as coverage analysis, waveforms, and debugging

SystemVerilog for Verification: Key SystemVerilog features for testbench development, Classes, constraints, interfaces, assertions, and functional coverage

UNIT IV: Real-World Verification Practice

Case Studies and Applications Real-world examples of verification challenges, Analysis of verification plans, failure cases, and resolutions, Apply verification flow on real-world design problem

Recommended Books:

1. Douglas Perry. *Applied Formal Verification.* McGraw Hill, 2005.
2. Graham Birtwistle. *VLSI Specification, Verification and Synthesis.* Springer, 2012.
3. Thomas Kropf. *Introduction to Formal Hardware Verification.* Springer, 2013.
4. Erik Seligman. *Formal Verification.* Elsevier, 2023.

Bio-Medical Electronics

Unit I

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals - Basic components of a biomedical system- Cardiovascular systems- Respiratory systems -Kidney and blood flow - Biomechanics of bone - Biomechanics of soft tissues - Basic mechanics of spinal column and limbs - Physiological signal.

Unit II

Sensors and Transducers: Signal Acquisition, Transduction, Tactics, and Signal Processing for Improved Sensing, Electrodes: Limb electrodes –floating electrodes – pregelled disposable electrodes,needle, surface electrodes, Microelectrodes, Strain Gauges, Quartz Pressure Sensors, Matching Sensors to Circuits, Temperature, Capacitive, and Inductive Transducers.

Bioelectric Amplifiers: Signal Processing Circuits, Practical Op-Amps, Isolation Amplifiers Chopper Stabilized Amplifiers,

Unit III

Electrocardiographs: The Heart as a Potential Source, The ECG Waveform, The Standard Lead System, Other ECG Signals, The ECG Preamplifier ECG Readout Devices, ECG Machines, ECG Maintenance/Troubleshooting.

Physiological Pressure and Other Cardiovascular Measurements and Devices: Physiological Pressures, Pressure Measurements, Blood Pressure Measurements Oscillometric, and Ultrasonic Noninvasive Pressure Measurements.

Pressure Amplifier Designs, Ac Carrier Amplifiers, Systolic, Diastolic, and Mean Detector Circuits, Pressure Differentiation (dP/dT) Circuits, Practical Problems in Pressure Monitoring, Step-Function Frequency Response Test, Defibrillator Circuits, Pacemakers.

Medical Ultrasonography: Ultrasound Transducers, Absorption, and Attenuation of Ultrasound Energy, Biological Effects of Ultrasound, Doppler Effect, Transcutaneous Doppler Flow Detector, Flowmeters, Ultrasonic Blood Pressure Measurement.

Text/Reference Books:

1. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi, 2 Edition, 2003.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment and Technology, 4th edition. Upper Saddle River, New Jersey: Prentice-Hall, 2001.
3. Sabrie Soloman, 3D Bioprinting Revolution, Khanna Publishing House, 2020.

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

1. An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the result to improve processes.
2. Have adequate knowledge about different types of Electrodes, Transducers, and Amplifiers.
3. Understand the important and modern methods of imaging techniques

Emerging Memory Devices

UNIT I: Introduction and Core Memory Technologies

Introduction to Emerging Memory Technologies: Traditional vs. emerging memory types, Evolution and trends in memory development, Overview of RRAM, PCM, MRAM

Resistive Random-Access Memory (RRAM): Operational principles and switching mechanisms, Advantages, limitations, and use cases

UNIT II: Phase Change and Magnetic Memories

Phase Change Memory (PCM): Material properties and phase transition principles, Applications in high-performance storage systems, Integration and scaling challenges

Magnetic RAM (MRAM): Spin-transfer torque and magnetic tunnel junctions, Real-time and non-volatile memory applications

UNIT III: Alternative Technologies and System Integration

Other Emerging Memory Technologies: Ferroelectric RAM, Memristors, and hybrid memories, Comparative analysis of emerging memory types

Integration Challenges and Compatibility: Design and system-level integration barriers, Reliability, endurance, and power considerations

UNIT IV: Experimental Analysis and Applications

Performance Evaluation of Emerging Memories: Endurance, retention, switching speed, energy efficiency

Recommended Textbooks:

1. Ielmini, Daniele. *Resistive Switching*, Springer, 2016.
2. Zhou, Ye. *Advanced Memory Technologies: Functional Materials and Devices*, Royal Society of Chemistry, 2023.
3. Redaelli, Andrea. *Phase Change Memory*, Springer, 2018.
4. Yu, Shimeng. *Resistive Random Access Memory (RRAM)*, Springer Nature, 2022.
5. Tang, Denny**.** *Magnetic Memory Technology*, Wiley, 2021.

Memory Design

UNIT I: Fundamentals of Memory Systems:

Introduction to Memory Design: Role of memory in digital systems, Overview of memory types (SRAM, DRAM, Flash, emerging types), Memory hierarchy and applications

Static Random-Access Memory (SRAM): SRAM cell structure and operation, Bit-cell stability, read/write operations, Array organization and peripheral circuits

UNIT II: Dynamic and Flash Memory Design

Dynamic Random-Access Memory (DRAM): DRAM cell operation and refresh concepts, DRAM array architecture and decoding schemes, Timing analysis and optimization techniques

Flash Memory: NAND vs. NOR flash architectures, Programming, erasing, and endurance, Wear leveling and error correction codes (ECC), Flash memory design challenges and trends

UNIT III: Timing and Power Considerations

Timing and Signal Integrity in Memory Design: Setup/hold time, clock-to-Q delay, Signal degradation and noise considerations, Bus loading and interconnect effects, Timing analysis using simulation tools

Power Optimization Techniques: Active vs. standby power, Clock gating, power gating, and leakage reduction, Design strategies for low-power memory circuits, Power analysis using memory design tools

UNIT IV: Emerging Technologies

Emerging Memory Technologies: RRAM, PCM, MRAM, and FeRAM, Device principles, benefits, and integration challenges, Comparison with conventional memories, Design and analysis of a custom memory subsystem, Integration of performance, timing, and power aspects

Recommended Textbooks:

1. Itoh, Kiyoo. *VLSI Memory Chip Design.* Springer, 2013.
2. Tanović, Sabina. *Designing Memory.* Cambridge University Press, 2019.
3. Campardo, Giovanni. *VLSI-Design of Non-Volatile Memories.* Springer, 2005.
4. Singhee, Amith. *Extreme Statistics in Nanoscale Memory Design.* Springer, 2010.
5. Yu, Shimeng. *Resistive Random Access Memory (RRAM).* Springer, 2022.
6. Kim, Chulwoo. *High-Bandwidth Memory Interface.* Springer, 2013.

Open Elective Courses:

OE1 Basket					
Sr. No.	**Course code**	**Course Title**	**Semester**	**Hrs /Week**	**Credits**
1	OE1A	AI & ML for VLSI CAD	VI	3:0:0	3
2	OE1B	MEMS and NEMS	VI	3:0:0	3
3	OE1C	Vacuum Technology	VI	3:0:0	3
OE2 Basket					
1	OE2A	Introduction to MEMS	VII	3:0:0	3
2	OE2B	AI Circuits	VII	3:0:0	3
3	OE2C	Nano Science & Technology	VII	3:0:0	3
OE3 Basket					
1	OE3A	Solar Photovoltaic Technology	VII	3:0:0	3
2	OE3B	Flexible & Organic Electronics	VII	3:0:0	3
3	OE3C	Computational Techniques	VII	3:0:0	3

AI and ML for VLSI CAD

UNIT I: Introduction to AI and ML in VLSI CAD

Overview of AI and ML in VLSI CAD: Importance and applications of AI and ML in VLSI design; Key concepts of AI and ML, including supervised and unsupervised learning; Introduction to **neural networks**, **decision trees**, and their relevance in CAD tools; Basic principles and terminologies of AI/ML algorithms.

UNIT II: Pattern Recognition and Optimization Techniques

Pattern Recognition in VLSI CAD: How AI can be applied to pattern recognition in IC design; Feature extraction and classification techniques for layout design; Case studies and real-world applications of pattern recognition.

Optimization Techniques with ML: Optimization algorithms such as genetic algorithms, simulated annealing, and particle swarm optimization; Applications of ML for optimizing VLSI CAD tools: area, timing, power, and signal integrity optimization.

UNIT III: Design Rule Checking and Layout Generation with ML

Design Rule Checking with ML: Enhancing Design Rule Checking (DRC) with machine learning models (classification, regression); Using ML for identifying violations and proposing fixes; Case studies on ML-based DRC optimization.

Automated Layout Generation: AI/ML techniques for automatic layout generation: improving area, power, and signal integrity; Considerations in the automated layout design process.

UNIT IV: Performance Prediction and Final Project

Performance Prediction with ML Models: Developing ML models to predict key VLSI circuit performance parameters: power, speed, reliability; Techniques for validating and assessing the accuracy of ML models; Real-world case studies on performance prediction in VLSI CAD.

Final Project and Review

Final Project: Students will implement AI/ML techniques in a VLSI CAD tool, addressing one or more of the following: routing, layout design, DRC, or performance prediction; Review of key course concepts and applications; Discussion on the future trends and challenges of AI/ML in VLSI CAD.

Recommended Textbooks:

1. **Joobbani, R.** *An Artificial Intelligence Approach to VLSI Routing.* Springer Science & Business Media, 2012.
2. **Sait, Sadiq.** *VLSI Physical Design Automation.* World Scientific, 1999.
3. **Kumar, Abhishek.** *Machine Learning Techniques for VLSI Chip Design.* John Wiley & Sons, 2023.
4. **Elfadel, Ibrahim.** *Machine Learning in VLSI Computer-Aided Design.* Springer, 2019.
5. **Lu, Bing.** *Layout Optimization in VLSI Design.* Springer Science & Business Media, 2001.
6. **Kahng, Andrew.** *VLSI Physical Design: From Graph Partitioning to Timing Closure.* Springer Nature, 2022.
7. **Ren, Haoxing.** *Machine Learning Applications in Electronic Design Automation.* Springer Nature, 2023.

MEMS & NEMS (Microelectromechanical Systems)

UNIT I: Introduction and Its Applications

Introduction to MEMS & NEMS: Definition, significance, and applications of MEMS in various industries (e.g., automotive, healthcare, electronics). Historical context and evolution of MEMS technology. Key concepts: sensing, actuation, and microfabrication principles. MEMS design and modeling software tools.

UNIT II: MEMS Design and Fabrication Techniques

Design Principles in MEMS: Key design considerations: size, power, and performance; Design methodologies and optimization strategies.

Fabrication Techniques: Bulk micromachining, surface micromachining, and LIGA; Fabrication materials for MEMS devices; Silicon-based MEMS and alternate fabrication methods.

UNIT III: Sensing, Actuation, and Simulation of MEMS Devices

Sensing Mechanisms in MEMS: MEMS accelerometers, pressure sensors, and temperature sensors; MEMS energy harvesters and microfluidics applications.

Actuation Mechanisms: Electrostatic, piezoelectric, and thermal actuators; Integrating actuators into MEMS devices for real-world applications.

Modeling and Simulation: Introduction to MEMS modeling and simulation tools.

UNIT IV: Advanced MEMS Integration, Testing, and Emerging Trends

MEMS Integration and System Design: System-level integration of MEMS sensors/actuators into larger systems (e.g., embedded systems); Packaging methods for MEMS devices: Flip-chip bonding, hermetic sealing, and MEMS testing; MEMS testing, reliability, and failure analysis.

Emerging Trends in MEMS Technology: Advanced applications and interdisciplinary research in MEMS (e.g., biomedical MEMS, RF MEMS); Integration of MEMS with emerging technologies (e.g., IoT, smart systems).

Recommended Textbooks:

1. **Tai-Ran Hsu.** *MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering.* John Wiley & Sons Inc., 2020.
2. **Zhuoqing Yang.** *Advanced MEMS/NEMS Fabrication and Sensors.* Springer, 2022.
3. **Vikas Choudhary, Krzysztof Iniewski.** *MEMS: Fundamental Technology and Applications (Devices, Circuits, and Systems).*
4. **Markku Tilli, Mervi Paulasto-Kröckel, Teruaki Motooka, Veikko Lindroos.** *Handbook of Silicon-Based MEMS Materials and Technologies.* Elsevier, 2021.
5. **SEMI University Course on MEMS.**

Vacuum Technology in Semiconductor Fabrication

UNIT I: Introduction to Vacuum Technology and Basic Principles

Introduction to Vacuum Technology: Overview of vacuum technology in semiconductor fabrication; Introduction to the role of vacuum in VLSI and semiconductor processes; Fundamental concepts of gases and vacuum.

Kinetic Theory of Gases: Basic principles of gas behavior in vacuum; Implications for vacuum technology and its relevance in semiconductor fabrication.

Pressure Units, Ranges, and Gas Flow Regimes: Understanding pressure units and their ranges; Gas flow regimes: molecular, viscous, and transitional; Mean free path and its significance in vacuum systems.

Surface Phenomena and Vacuum Production Terminology: Surface interactions in vacuum environments: adsorption, desorption, and outgassing; Principles of vacuum production and understanding the terminology.

UNIT II: Vacuum Pumps and Materials

Vacuum Pumps - Principles and Types: Overview of roughing and oil-sealed rotary mechanical pumps; Introduction to Root pumps and their role in vacuum systems.

High Vacuum Pumps: Operation principles of diffusion pumps, cryogenic pumps, and turbomolecular pumps; Applications of high vacuum pumps in semiconductor manufacturing.

Vacuum Materials, Hardware, and Fabrication Techniques: Selection of materials and hardware for vacuum systems; Cleaning processes and surface treatment in vacuum systems; Fabrication techniques for vacuum chambers and components.

Vacuum System Design and Operation: Design considerations for medium, low, and high vacuum systems; Throttled high vacuum systems and their applications in semiconductor processes.

UNIT III: Vacuum Measurement and Troubleshooting

Total Pressure Measurement Techniques: Methods and instruments for measuring total vacuum pressure: capacitive manometers, pirani gauges, and more; Understanding the importance of accurate pressure measurement in vacuum systems.

Partial Pressure Measurement and RGAs: Techniques for measuring partial pressures in vacuum systems; Introduction to Residual Gas Analyzers (RGA) and their operation; Application of RGAs for monitoring and controlling vacuum quality.

Interpreting RGA Spectra and Specifications: Analyzing RGA data for process optimization; Differential pumping and non-high vacuum applications.

Vacuum Environments in VLSI Processing: Role of vacuum technology in VLSI and semiconductor manufacturing processes; Case studies on vacuum applications in etching, deposition, and doping processes.

Leakage Detection, Troubleshooting, and Prevention: Common vacuum system issues: leaks, contamination, and pump failure; Strategies and techniques for identifying and addressing vacuum leaks; Troubleshooting common vacuum system problems in semiconductor fabrication.

UNIT IV: Advanced Vacuum Systems

Extreme and Ultra-high Vacuum Systems: Characteristics of extreme and ultra-high vacuum systems; Applications and challenges of ultra-high vacuum systems in advanced semiconductor manufacturing processes.

References:

1. **Wolf, S., & Tauber, R.N.** *Silicon Processing for the VLSI Era* (specific chapter on Vacuum Technology for VLSI Manufacturing).
2. **Naik, Pramod.** *Vacuum Science, Technology & Applications.*
3. **Hablanian, Marsbed H.** *High Vacuum Technology.*
4. **Punj, Anshuman.** *Vacuum Technology Simplified.*

AI Circuits

Unit 1: Introduction to AI Circuit Design and Design Methodologies

Overview of AI Circuit Design: Introduction to the intersection of AI and integrated circuit design; Significance of AI circuit design in modern technology and its evolution; Key concepts: AI algorithms, hardware acceleration, neural network architectures, and their role in AI circuit design.

Design Methodologies for AI Applications: Principles of design methodologies tailored for AI circuits; Exploring techniques for optimizing AI circuits in terms of efficiency, performance, and power consumption.

Unit 2: Neuromorphic Computing and AI Hardware Accelerators

Neuromorphic Computing: Introduction to neuromorphic computing and its relevance in AI circuit design; Exploring the biological inspiration behind neuromorphic systems and their advantages in AI applications.

Hardware Accelerators for AI: Study of hardware accelerators like GPUs, TPUs, and custom ASICs, designed for machine learning and AI tasks; In-depth exploration of AI-specific accelerators and their architectures for speeding up AI computations (e.g., convolutional neural networks).

Unit 3: Parallel Processing Architectures for AI Circuits

Parallel Processing in AI: Principles of parallel processing architectures in AI circuits; Design considerations for parallelism in AI applications: multi-core systems, SIMD (Single Instruction, Multiple Data), and MIMD (Multiple Instruction, Multiple Data).

Challenges in Parallelism for AI: Understanding the challenges of parallel processing, such as synchronization, load balancing, and memory bottlenecks; Real-world applications of parallelism in AI, including deep learning and large-scale data processing.

Unit 4: Optimization and Advanced Topics in AI Circuit Design

Optimization of AI Circuits: Techniques for optimizing AI circuits in terms of speed, power, and efficiency; Power efficiency in AI circuits: balancing computational performance and energy consumption for AI tasks.

Advanced Topics and Emerging Trends: Exploring advanced components and techniques in AI circuit design, such as in-memory computing, energy-efficient neuromorphic systems, and emerging hardware architectures; Study of the latest trends in AI circuit design and their potential future applications.

Recommended Books:

1. **Vivienne Sze** - *Efficient Processing of Deep Neural Networks* (Morgan & Claypool, 2020)
2. **Mohammad Baker** - *In-Memory Computing Hardware Accelerators for Data-Intensive Applications

Nanoscience and Nanotechnology

Unit I Background to Nanoscience:

Defination of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challengs of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties.

Unit II Types of nanostructure and properties of nanomaterials: One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.

Unit III Application of Nanomaterial: Ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane based application, polymer based application.

Unit IV Nanobioelectronics Nanoelectronic biosensor, Nanowire, CNT and graphene based biosensors, DNA based biosensors, protein based biosensors, materials for biosensor applications, quantum dot based bioimaging, DNA based logic and computing elements

References:

1. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
4. Processing & properties of structural naonmaterials - Leon L. Shaw, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

Solar Photovoltaic Devices and Solar Cells

Unit 1: Introduction to Solar Radiation and Semiconductor Physics

Introduction and Solar Radiation Fundamentals: Overview of solar energy and its importance in renewable energy generation; Fundamental concepts of solar radiation: Solar spectrum, solar constant, and radiation intensity; Methods of solar radiation measurement and energy collection; Impact of geographic location, time, and weather on solar radiation.

Basic Physics of Semiconductors: Introduction to semiconductors: intrinsic and extrinsic semiconductors; Energy bands, conduction, and valence bands; Doping and the creation of p-type and n-type semiconductors; The role of semiconductors in photovoltaic devices.

Unit 2: Carrier Transport and Semiconductor Junctions

Carrier Transport, Generation, and Recombination in Semiconductors: Charge carrier movement in semiconductors: Drift, diffusion, and recombination; Carrier generation and recombination processes: Minority and majority carriers; Shockley-Read-Hall recombination and Auger recombination; Impact of temperature on carrier transport and recombination.

Semiconductor Junctions: The physics of semiconductor junctions (p-n junctions); Formation of the depletion region and the electric field; Current-voltage characteristics of a p-n junction; The role of semiconductor junctions in solar cell operation (photovoltaic effect).

Unit 3: Solar Cell Technology

Essential Characteristics of Solar Photovoltaic Devices: Efficiency metrics of solar cells: Conversion efficiency, fill factor, and open-circuit voltage; I-V characteristics and their relationship to efficiency; Factors influencing solar cell performance: Light absorption, carrier collection, and recombination losses; Overview of solar cell testing and performance characterization.

First Generation Solar Cells: Crystalline silicon solar cells: Monocrystalline, polycrystalline, and amorphous silicon; Process of fabrication and manufacturing of first-generation solar cells; Advantages and limitations of silicon-based solar cells; Efficiency trends and commercial viability of first-generation cells.

Unit 4: Advanced Solar Cell Technologies

Second Generation Solar Cells: Thin-film solar cells: Materials (CdTe, CIGS, a-Si) and their properties; Manufacturing techniques for second-generation solar cells: Deposition and fabrication methods; Advantages, challenges, and applications of thin-film technology; Comparison of second-generation solar cells with first-generation cells.

Third Generation Solar Cells: Overview of third-generation solar cell technologies: Organic solar cells, perovskite solar cells, and multi-junction cells; The concept of multi-junction solar cells and tandem solar cells for higher efficiency; The potential of perovskite and organic materials in reducing costs and improving efficiency.

Recommended Texts and References:

1. **P. S. P. S. R. Prabhu, Solar Energy** - A comprehensive book on solar energy, including fundamental physics and photovoltaic technology.
2. **C. S. Solanki, Solar Photovoltaic Technology and Systems** - Covers solar photovoltaic technology, system integration, and applications.
3. **S. R. A. Naeem, Photovoltaic Systems** - Detailed exploration of photovoltaic system components and their operation.
4. **J. Nelson, Physics of Solar Cells** - In-depth treatment of the physics behind solar cell operation, carrier transport, and materials.
5. **M. Green, High-Efficiency Solar Cells** - Focuses on the development of high-efficiency solar cells and emerging technologies.

Organic and Printed Flexible Electronics

Unit I: Introduction to Organic Electronics

History of conductive semiconductors and organic semiconductors and devices, Economics and future market potential of organic electronic devices, Materials: Organic Semiconductors & Characterization, Overview of various printing technologies. Organic sensors (bio & chemical), Future market opportunities.

Unit II: Charge Transport, Interfaces, and Organic Thin Film Deposition.

Energy Levels: Ionization Energy, Electron Affinity, HOMO/LUMO, Carrier Mobility, Charge Transport, Materials with Organic Electronics Devices: Substrates: Metal Substrates, Flexible Substrates: Thin Metals, Plastics, Polymers, Shape Memory Polymers, Etc., Biodegradable Substrates, Encapsulation Considerations. Electrodes and organic semiconductor interfaces, Fabrication techniques: Spin Coating, Printing, Thermal Evaporation, CVD, Atomic Layer Deposition (ALD), Organic device Electrodes: Transparent Conducting Polymers.

Unit III: Applications of Organic Semiconductors

OFETs:- History OFETs vs. Inorganic Thin-Film Transistors (TFTs), OFET: Device Structures and Operation, Electrical Characterization of OFETs: Current-Voltage (I-V) Characteristics.

OLEDs: Introduction, Comparison between OLEDs and other display technologies (LCD, LED, etc.) OLED Applications: Flexible Display, Passive-Matrix Tiling, Active-Matrix Tiling, OLEDs: Display Structure, Device Principles and Device Architectures: Light Emission from the Bottom and Top of the OLED Device, Stacked OLEDs (RGB, White OLEDs)

OPVs: Introduction, Why OPVs: Introduction, Comparison with Silicon Solar Cell Technology, OPV Fundamentals, Measurement Considerations: AM1.5, Solar Lamps, Lab Testing Vs. Environmental Testing, OPV: Structure and Architecture

Unit IV: Printing Technologies

Overview of Various Printing Technologies, Printing technologies for organic electronics: inkjet printing, screen printing, gravure printing, etc., Advantages, challenges, and applications of printed organic electronics. Case studies and industry applications of printed organic electronic devices. Future Market Opportunities and Sustainability

Recommended Books:

1. "Organic Electronics: Materials, Processing, Devices, and Applications" by Franky So.
2. "Introduction to Organic Electronic and Optoelectronic Materials and Devices" by Sam-Shajing Sun.
3. "Organic Thin Film Transistor Integration: A Hybrid Approach" by Ana Claudia Arias.Friend, R. H., & McNeill, C. R. (2007).
4. Organic Electronics: Materials, Manufacturing, and Applications. Wiley-Interscience.
5. M. Pope & C. E. Swenberg (1999). Electronic Processes in Organic Crystals and Polymers. Oxford University Press.
6. B. Kippelen & J. L. Bredas (2009). Organic Photovoltaics. Springer.
7. T. Forrest (2004). The Path to the Light: Organic Electronics. Science.
8. Organic and Printed Electronics Handbook (2021), edited by P. Choudhury. Springer.

Numerical Methods and MATLAB for Engineering Applications

Unit 1: Introduction to MATLAB and Basic Numerical Methods

Introduction to MATLAB: Overview of MATLAB and its applications in numerical methods; MATLAB environment: commands, functions, scripts, and data structures; Basic programming tips in MATLAB: loops, conditionals, vectors, matrices, and functions.

Initial-Value Problems in Ordinary Differential Equations (ODEs): Formulation of initial-value problems in ODEs; Basic one-step numerical methods: Euler's method, Modified Euler's method, and Heun's method; Multistep numerical methods: Adams-Bashforth and Adams-Moulton methods.

Runge-Kutta Methods: Introduction to Runge-Kutta methods: RK4, adaptive step-size methods. Derivation and application of Runge-Kutta methods.

Unit 2: Root-Finding and Linear Systems

Nonlinear and Linear Equations: Root-finding methods: Bisection method, Secant method, and Newton's method; Convergence and efficiency of iterative methods.

Root Finding by Iterative Methods: Fixed-point iteration method; Newton's method for solving nonlinear equations.

Direct Methods for Linear Systems: Gaussian elimination, LU decomposition, and matrix factorization; Applications in solving linear systems.

Iterative Methods for Linear Systems: Jacobi method, Gauss-Seidel method, and Conjugate Gradient method; Comparison of direct and iterative methods.

Unit 3: Boundary Value Problems and Partial Differential Equations

Boundary Value Problems in Ordinary Differential Equations (BVPs): Formulation and solution of BVPs for ODEs; Finite difference method for solving BVPs.

Finite Element Methods (FEM) for BVPs: Introduction to finite element methods for solving BVPs; Comparison of finite difference and finite element methods.

Shooting Methods for BVPs: Overview of the shooting method for solving BVPs; Numerical solution using the shooting method.

Unit 4: Initial-Boundary Value Problems for Partial Differential Equations

Introduction to Partial Differential Equations (PDEs): Basic properties of PDEs: types, classification, and characteristics; Methods of solving PDEs: analytical vs. numerical methods.

Methods of Lines and Finite Difference Methods for PDEs: Method of lines for solving parabolic, elliptic, and hyperbolic PDEs; Finite difference methods for solving 1D and 2D PDEs.

Finite Element and Finite Volume Methods for PDEs: Overview of finite element and finite volume methods for solving PDEs.

Basic References

1. David Kincaid and Ward Cheney, "Numerical Analysis: Mathematics of Scientific Computing," Brooks/Cole (1991).
2. Geoffrey D. Smith, "Numerical Solution of Partial Differential Equations: Finite-Difference Methods," Oxford University Press (1986).
3. John H. Mathews and Kurtis D. Fink, "Numerical Methods Using MATLAB," Prentice Hall (1998).
4. Lloyd N. Trefethen and David Bau, III, "Numerical Linear Algebra," SIAM (1997).
5. William F. Ames, "Numerical Methods for Partial Differential Equations," Academic Press (1977).
6. William H. Press, Brian P. Flannery, Saul A. Teukolsky, and William T. Vetterling, "Numerical Recipes: The Art of Scientific Computing," Cambridge University Press (1986).
7. Richard H. Pletcher, John C. Tannehill, and Dale A. Anderson, "Computational Fluid Mechanics and Heat Transfer," CRC Press (2013).