UPES

UNIVERSITY OF TOMORROW

School of Advanced Engineering

B. Tech in Electrical Engineering

Specialisation: **Wearable Devices, Microelectronics, 5G & 6G Technology, Industrial Drives, AI & ML Applications**

Programme Handbook

2023-27

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1.0 Abbreviations

Cat	-	Category
Cr	-	Credits *(A credit is equivalent to one lecture hour/ one hour of tutorial/ two hours of Laboratory)*
L	-	Lecture
T	-	Tutorial
P	-	Practical
ENGG	-	Engineering Sciences (including General, Core)
HUM	-	Humanities (including Languages, Social Sciences, and others)
SCI	-	Basic Sciences (including Mathematics)
PRJ	-	Project Work (including Seminars, Dissertation, and Internships)
PE	-	Program Elective (includes Specialization courses)
TC	-	Total Credits
AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering-Artificial Intelligence
BIO	-	Biology
CCE	-	Computer Science and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics
UE	-	University Elective (includes Signatory, Exploratory and Open Electives)

2.0 Vision and Mission of the University:

Vision of UPES

To be an Institution of Global standing for developing professionally competent talent contributing to nation building.

Mission of UPES

- Develop industry-focused professionals with an international outlook.
- Foster effective outcome-based education system to continually improve teaching-learning and research.
- Inculcate integrative thought process among students to instill lifelong learning.
- Create global knowledge eco-system through training, research & development, and consultancy.
- Practice and promote high standards of professional ethics and develop harmonious relationship with environment and society.

3.0 Vision and Mission of the School of Advanced Engineering

Vision of SoAE

To be a forerunner in engineering education by delivering excellent engineering graduates fortified with sound knowledge and integrity, by performing cutting-edge research and by innovating new technologies to benefit the nation and the world at large.

Mission of SoAE

- To develop industry focused engineers with expertise in the areas of oil and gas, energy, infrastructure, transportation, electronics, automotive design and aviation.
- To sustain a strong focus on delivering excellent engineering and science education by providing an exposure to the concurrent research and industry trends and by employing innovative pedagogy tools/ techniques.
- To promote research, technology incubation and entrepreneurship to address the most pressing needs of our society and nation.
- To maintain a professional and ethical environment conducive to the intellectual growth of faculty and students, fostering communication, dialogue and sharing of ideas.
- To strengthen our linkages with academic institutes worldwide, industry and alumni network for evolving our programs towards better student outcomes.

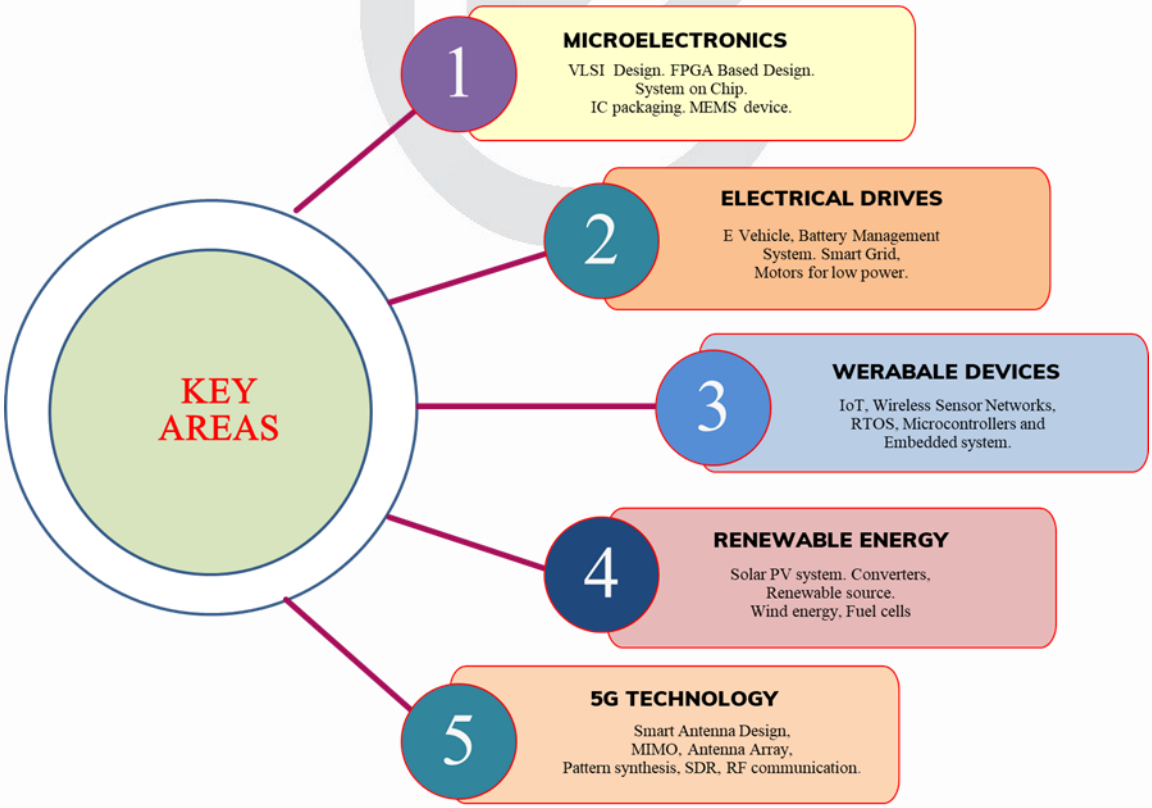
4.0 About the Cluster/ Department/ Centre

The Electrical Cluster envisages instilling the principles of engineering and technical application in Electrical Engineering, Electronics Engineering, Computer Engineering, and Robotics Engineering. The curriculum focuses on intensive classroom teaching, project-based learning, projects, internships, and research-based learning. The Electrical cluster offers two undergraduate degree programs such as B. Tech Electronics and Computer Engineering and B. Tech Electrical Engineering. In the post-graduate program, M. Tech Robotics

Engineering is offered by the cluster. The cluster is focused on providing holistic development of undergraduate and postgraduate students through real-time project-based learning. We ensure that the students are future-ready to meet the demands of the ever-changing industry needs. The curriculum is framed to include the specialization in AI & ML, Microelectronics, E-Vehicle and Industrial Drives, Wearable Devices, and 5G & 6G technology. This will equip the students with additional skills to shape the nation and individuals in the coming years.

Research Focus

The research focus of the cluster is aligned with the current trends and national missions. The key areas are as shown below.



5.0 Programme Overview

The B. Tech. in Electrical Engineering program offered by UPES School of Advanced Engineering is designed to provide students with a comprehensive understanding of electrical, electronics, embedded systems, and communication technologies. The program's focus on international perspectives ensures that students are exposed to global best practices, preparing them to excel in a competitive and interconnected world.

The primary objective of the program is to enhance students' core knowledge and skills in electrical and electronics engineering, enabling them to design secure, reliable, and reconfigurable systems. This emphasis on robust system design equips graduates to address real-world challenges faced by industries today. The program also aims to produce competent engineers with a diverse skill set, making them suitable for a wide range of industries.

One of the key features of the B. Tech. in Electrical Engineering program is the flexibility it offers in terms of specializations. Students have the option to choose from various specialized areas, including Industrial drives, AI & ML applications, Wearable devices, 5G & 6G technology, and Nanoelectronics. This strategic choice allows students to align their studies with their specific interests and enables them to meet the industry's evolving demands.

6.0 Programme Educational Objectives

PEO 1. Graduates will have the scientific and technical knowledge for a successful career in industries.

PEO 2. Graduates will have competency to meet challenges and advancements in the focused areas of electrical, electronics and cyber physical systems.

PEO 3. Graduates will have higher-order thinking and leadership skills to become technology leaders and entrepreneurs of tomorrow.

PEO 4. Graduates will contribute to the welfare of society and environment by taking sound professional and responsible technical decisions.

7.0 Programme Outcome and Programme Specific Outcomes

Programme Outcomes

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. 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.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. 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.
11. 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.

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

Programme Specific Outcomes

- **PSO1:** Model, simulate and analyze Electrical and Electronics subsystems for various industrial applications.
- **PSO2:** Provide real time solutions for electrical, electronics, and electric-mobility problems with modern software tools.

8.0 Academic Integrity Policy

a. University Integrity Policy

b. Course integrity policy

9.0 Overview of Credit Allocation/ Credit Break up

Category-wise Credit distribution

Category	Number of Credits
Major Core (MC)	76
Basic Sciences - Core (SCI)	13
Engineering Sciences - Core (ENGG)	12
Major Elective (ME)	15
Signature courses (SC)*	9
Life Skill Courses (LSC)*	9
Exploratory Courses (EC)*	18
Humanities (HUM)	
Projects (PRJ)	13
Mandatory Non-Credit Courses (NCC)	0
Total	165

* Electives

- Major core subjects include those subjects that are mandatory to all similar programmes and program specific courses. To be eligible for the degree, students must successfully finish each of the courses.
- Major elective courses provide the students the opportunity to study courses that are more complex and specialized, in their field of specialization.

Major Core					**Total number of Credits: XX Credits**
Course Code	**Course Title**	**L**	**T**	**P**	**TC**
MATH 1026	Mathematics I	3	1	0	4
PHYS- 1020	Physics I	3	1	0	4
MATH1050	Engineering Mathematics I	3	1	0	4
PHYS1002	Physics	3	1	0	4
CSEG1008	Object Oriented Programming	3	0	0	3
ECEG1004	Basic Electrical and Electronics Engineering	3	0	0	1
CSEG1108	Object Oriented Programming Lab	0	0	2	1
ECEG1104	Basic Electrical and Electronics Engg Lab	0	0	2	1
PHYS1102	Physics Lab	0	0	2	1
ECEG1011	Analog Electronics I	3	1	0	4
MATH1051	Engineering Mathematics II	3	1	0	4
MEPD1003	Workshop Practices	0	0	2	2
MECH1001	Engineering Graphics	0	0	2	2
CSEG1015	Digital Logic and Computer Design	0	0	2	3
ECEG1007	Electronics Workshop	2	0	0	1
ECEG2060	Measurement and Instrumentation	3	0	0	3
ECEG2014	Analog Electronics II	3	0	0	3
ECEG2045	Signals and Systems	3	0	0	3
ECEG2061	Network Theory	3	1	0	4

ECEG2114	Analog Electronics II lab	0	0	2	1
ECEG2007	Electromagnetic Field Theory	3	0	0	3
ECEG2037	Digital System Design	3	0	0	3
ECEG2009	Control System Engineering	3	1	0	4
	Communication System	3	0	0	3
ECEG2137	Digital System Design lab	0	0	2	1
SLLS0202	Control System Engineering Lab	0	0	2	1
EPEG3053	Electrical Machines	3	0	0	3
ECEG3013	Microprocessors and Microcontrollers	3	0	0	3
EPEG3054	Industrial Power Electronics	3	0	0	3
EPEG3153	Electrical Machines lab	0	0	2	1
EPEG3055	Power Electronics Lab	0	0	2	1
ECEG3130	Microprocessors and Microcontrollers Lab	0	0	2	1
EPEG3055	Advanced Electrical Machines	3	0	0	3
EPEG3056	Modern Control System	3	0	0	3
ECEG3084	Embedded Systems and IoT	3	0	0	3
	Advanced Electrical Machines Lab	0	0	2	1
ECEG3184	Embedded Systems and IoT lab	0	0	2	1
	Specialization Course II	3	0	0	3
ECEG4066	Industrial Communication and Networking	3	0	0	3
ECEG4033	E-Vehicle	3	0	0	3
ECEG4133	E-Vehicle lab	0	0	2	1
ECEG3083	Power System	3	0	0	3
	Specialization Course II	3	0	0	3
	Specialization Course III	3	0	0	3
PROJ4139	Major Project I				2
INDT4104	Industrial Internship				1
	Specialization Course IV	3	0	0	3
	Specialization Course V	3	0	0	3
EPEG4046	Switchgear and Protection	3	0	0	3
PROJ4140	Major Project II				7
				Total Credits	

Humanities (HUM)		**Total Number of Credits: X Credits**			
Course Code	**Course Title**	**L**	**T**	**P**	**TC**
SLSG0102	Critical Thinking	2	0	0	2
SSEN0101	Environment and Climate Change	2	0	0	2
SLLS0101	Living Conversations	2	0	0	2
SSEN0102	Environment and Climate Change	2	0	0	2
SLLS0201	Design Thinking	2	0	0	2
SLLS0202	Working with Data	2	0	0	2
SLSG0104	Technologies of Future	2	0	0	2
SLLS0103	Leadership & Teamwork	2	0	0	2
EPEG3055	Start you own Start-up	2	0	0	2
				Total Credits	**18**

Projects (PRJ)		**Total Number of Credits: X Credits**			
Course Code	**Course Title**	**L**	**T**	**P**	**TC**
PROJ3149	Capstone I				2
PROJ3150	Capstone II				2
PROJ4140	Major Project I				7
PROJ4140	Major Project II				7
				Total Credits	

Mandatory Non-Credit Courses					Total Number of Credits: X Credits
Course Code	**Course Title**	**L**	**T**	**P**	**TC**
	Social Internship				0
	Industrial visit				0
				Total Credits	

Major Electives

Course Code	Course Title	L	T	P	TC

10.0 Programme Structure

The term "Program Structure" refers to a list of courses (Core, Elective, and Open Elective) that make up an academic program, describing the syllabus, credits, hours of instruction, assessment and examination systems, minimum number of credits necessary for program graduation, etc.

Sample: B. Tech Electrical Engineering

Semester I:

Semester I							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Life Skills	SLSG0102	Critical Thinking	2	0	0	2
2	Life Skills	SSEN0101	Environment and Climate Change	2	0	0	2
3	Major	MATH1050	Engineering Mathematics I	3	1	0	4
4	Major	PHYS1002	Physics	3	1	0	4
5	Major	CSEG1008	Object Oriented Programming	3	0	0	3
6	Major	ECEG1004	Basic Electrical and Electronics Engineering	3	0	0	1
7	Major	CSEG1108	Object Oriented Programming Lab	0	0	2	1
8	Major	ECEG1104	Basic Electrical and Electronics Engg Lab	0	0	2	1
9	Major	PHYS1102	Physics Lab	0	0	2	1
			Total				**21**

Semester II							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Signature Course	SLLS0101	Living Conversations	2	0	0	2
2	Life Skills	SSEN0102	Environment and Climate Change	2	0	0	2
3	Major	ECEG1011	Analog Electronics I	3	1	0	4
4	Major	MATH1051	Engineering Mathematics II	3	1	0	4
5	Major	MEPD1003	Workshop Practices	0	0	2	2
6	Major	MECH1001	Engineering Graphics	0	0	2	2
7	Major	CSEG1015	Digital Logic and Computer Design	0	0	2	3
8	Major	ECEG1007	Electronics Workshop	2	0	0	1
			Total				**20**

Semester III							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Exploratory		Exploratory 1	3	0	0	3
2	Life Skill	SLLS0201	Design Thinking	2	0	0	2
3	Major	ECEG2060	Measurement and Instrumentation	3	0	0	3
4	Major	ECEG2014	Analog Electronics II	3	0	0	3
5	Major	ECEG2045	Signals and Systems	3	0	0	3
6	Major	ECEG2061	Network Theory	3	1	0	4
7	Life Skill		Social Internship				0
8	Major	ECEG2114	Analog Electronics II lab	0	0	2	1
9	Programming courses	ECEG2062	Simulation Design -I	0	0	2	1
			Total				**20**

Semester IV							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Signature Course	SLLS0202	Working with Data	2	0	0	2
2	Exploratory		Exploratory 2	3	0	0	3
3	Major	ECEG2007	Electromagnetic Field Theory	3	0	0	3
4	Major	ECEG2037	Digital System Design	3	0	0	3
5	Major	ECEG2009	Control System Engineering	3	1	0	4
6	Major	ECEG2042	Communication System	3	0	0	3
7	Major	ECEG2137	Digital System Design lab	0	0	2	1
8	Major	SLLS0202	Control System Engineering Lab	0	0	2	1
9	Programming courses	ECEG2063	Simulation Design -II	0	0	2	1
			Total				**21**

Semester V							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Life Skills	SLSG0104	Technologies of Future/Meta 101	2	0	0	2
2	Life Skills	SLLS0103	Leadership & Teamwork	2	0	0	2
3	Exploratory		Exploratory 3	3	0	0	3
4	Major	EPEG3053	Electrical Machines	3	0	0	3
5	Major	ECEG3013	Microprocessors and Microcontrollers	3	0	0	3
7	Major	EPEG3054	Industrial Power Electronics	3	0	0	3
8	Major	EPEG3153	Electrical Machines lab	0	0	2	1
9	Major	EPEG3055	Power Electronics Lab	0	0	2	1
10	Major	ECEG3130	Microprocessors and Microcontrollers Lab	0	0	2	1
11	Cap-Interdisc	PROJ3149	Capstone I				2
			Total				**21**

Semester VI							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Signature Course	EPEG3055	Start you own Start-up	2	0	0	2
2	Exploratory		Exploratory 4	3	0	0	3
3	Major	EPEG3055	Advanced Electrical Machines	3	0	0	3
4	Major	EPEG3056	Modern Control System	3	0	0	3
5	Major	ECEG3084	Embedded Systems and IoT	3	0	0	3
6	Major		Advanced Electrical Machines Lab	0	0	2	1
7	Major	ECEG3184	Embedded Systems and IoT lab	0	0	2	1
8	Major		Specialization Course II	3	0	0	3
9	Cap-Interdisc	ECEG4066	Capstone II				2
10			Industrial visit				0
			Total				**21**

Semester VII							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Exploratory		Exploratory 5	3	0	0	3
2	Major	ECEG4066	Industrial Communication and Networking	3	0	0	3
3	Major	ECEG4033	E-Vehicle	3	0	0	3
4	Major	ECEG4133	E-Vehicle lab	0	0	2	1
5	Major	ECEG3083	Power System	3	0	0	3
7	Major		Specialization Course II	3	0	0	3
8	Major		Specialization Course III	3	0	0	3
9	Major	PROJ4139	Major Project I				2
10	Major	INDT4104	Industrial Internship				1
			Total				**22**

Semester VIII							
	Category		**Course**	**L**	**T**	**P**	**Credits**
1	Exploratory		Exploratory 6	3	0	0	3
2	Major		Specialization Course IV	3	0	0	3
3	Major		Specialization Course V	3	0	0	3
4	Major	EPEG4046	Switchgear and Protection	3	0	0	3
5	Major	PROJ4140	Major Project II				7
			Total				**19**

Specialization Tracks

The students enrolled in B. Tech. Electrical Engineering (4 year) would have an option to specialize in one the following emerging areas:

The student must complete a minimum of XX credits in the chosen area of specialization.

1. Wearable Devices
2. **Microelectronics**
3. **5G and 6G Technology**
4. **Industrial Drives**
5. **AI and ML Applications**

The student must complete a minimum of XX credits in the chosen area of specialization.

List of elective courses in specialization tracks:

Track 1: Wearable Devices							
	Semester	**Course Code**	**Course**	**L**	**T**	**P**	**Credits**
1	6th	ECEG3085P	Advanced Microcontrollers	3	0	0	3
2	7th	ECEG4067P	Sensor and Interfacing	3	0	0	3
3	7th	ECEG4070P	Ubiquitous Computing	3	0	0	3
4	8th	CSEG4029P	Real Time Operating System	3	0	0	3
5	8th	ECEG4076P	Wearable Technology	3	0	0	3

Track 2: Microelectronics							
	Semester		**Course**	**L**	**T**	**P**	**Credits**
1	6th	ECEG3086P	VLSI Technologies	3	0	0	3
2	7th	ECEG4068P	FPGA based System Design	3	0	0	3
3	7th	ECEG4071P	IC Fabrication and Packaging	3	0	0	3
4	8th	ECEG4042P	Nanoelectronics Devices	3	0	0	3
5	8th	ECEG4077P	System on Chip Design	3	0	0	3

Track 3: 5G and 6G Technology							
	Semester		**Course**	**L**	**T**	**P**	**Credits**
1	6th	ECEG3087P	EM Waves and Antennas	3	0	0	3
2	7th	ECEG4069P	Cellular and Mobile Communication	3	0	0	3
3	7th	ECEG4072P	Next Generation Communication Technolohy	3	0	0	3
4	8th	ECEG4074P	Satellite System Engineering	3	0	0	3
5	8th	ECEG4078P	Vehicular Communication	3	0	0	3

Track 4: Industrial Drives							
	Semester		**Course**	**L**	**T**	**P**	**Credits**
1	6th	ECEG3088P	Advanced Microcontrollers & Interfacing	3	0	0	3
2	7th	ECEG4070P	Advanced Electrical Drives	3	0	0	3
3	7th	ECEG4073P	Industrial Converters	3	0	0	3
4	8th	ECEG4075P	Nonlinear Control System	3	0	0	3
5	8th	ECEG4079P	Hybrid Electric Vehicle	3	0	0	3

Track 5: AI and ML Applications							
	Semester		**Course**	**L**	**T**	**P**	**Credits**
1	6th	ECEG3089P	Statistics & Data Science	3	0	0	3
2	7th	CSEG4117P	Soft Computing Techniques	3	0	0	3
3	7th	CSAI4005P	Artificial Intelligence	3	0	0	3
4	8th	CSBD4004P	Deep Learning	3	0	0	3
5	8th	CSEG4006P	Natural Language Processing	3	0	0	3

List of elective courses in specialization tracks

Major Elective XX Credits						
Track 1 : Advanced Manufacturing						
Cat	**Course Code**	**Course Title**	**L**	**T**	**P**	**TC**
		Rapid Prototyping and Tooling	3	0	0	3
		CAD and Digital Manufacturing	3	0	0	3
Track 2 : Thermofluidic systems						
		Wind and small hydro energy system	3	0	0	3
		Solar Energy Systems	3	0	0	3

Mechanical Minor course requirement list

Students from other departments in the university have the option to take a minor degree from the Mechanical stream. The list of course requirements to obtain a Mechanical minor degree is as follows. Total credit for minor requirement is minimum twenty-one.

Mandatory Courses- XX Credits*			
Course Code	**Course Name**	**credit**	**Prerequisite**
	Thermodynamics		Physics, Chemistry
	Material Sciences		Physics and Chemistry
*If a student has completed 'n' number of equivalent credits among the above three courses, as a part of major curriculum then 'n' number of credits should be taken extra from the optional courses			
Optional Courses- XX Credits**			

	Refrigeration and air conditioning		Thermodynamics
**Equivalent courses in the student's major discipline will not be counted towards minor requirement. Apart from these equivalent courses, the student has to complete optional course requirement			

11.0 List of Electives

A. Programme Electives

- Specialization (Name of the subjectives) Minor

  If all courses from any basket are completed by the student, he/she receives a minor.

Minor							
Electronics Engineering							
	Semester		**Course**	**L**	**T**	**P**	**Credits**
1	2nd/4th/6th	ECEG1011	Analog Electronics 1	3	0	0	3
2	3rd/5th/7th	ECEG2014	Analog Electronics 2	3	0	0	3
3	4th/6th/8th	ECEG2037	Digital System Design	3	0	0	3
4	4th/6th/8th	ECEG2042	Communication System	3	0	0	3
5	4th/6th/8th	ECEG3049	VLSI Design	3	0	0	3
6	3rd/5th/7th	ECEG3013	Microprocessor and Microcontroller	3	0	0	3
7	3rd/5th/7th	ECEG3084	Embedded System and IoT	3	0	0	3
8	4th/6th/8th	ECEG3074	Data Communication and Networks	3	0	0	3
			TOTAL				**24**

B. University Electives

- Signature Courses- School for Life Courses/ Life Skill Courses

  Below is the list of courses offered as Signatory courses.

- Exploratory Courses

  If the student takes up courses from different baskets, that is regarded as an exploratory course.

  List of Exploratory courses to be included below.

- Open Elective

  List of open elective courses to be included below.

12.0 Course Syllabus/ Course Plans

SEMESTER I

Course Code	Course name	L	T	P	C
	Critical Thinking and Writing	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To introduce the essential tools and approaches of critical thinking.
2. To realize how several factors hinders the process of critical thinking and how to overcome them.
3. To understand and the various components and conventions of critical writing and create appropriate documents.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Understand the importance of Critical Thinking in the process of decision making.
CO 2	Differentiate amongst the various tools and approaches of critical thinking; look at the world around objectively and critically
CO 3	Critically analyze any text and communicate the inferences drawn after analysis; introspect and reflect on their thought processes; draw logical conclusions and identify the errors in reasoning
CO 4	Articulate written documents demonstrating critical approaches with clear, structured and quality writing.
CO 5	Apply critical thinking to any provided information. Identify, understand and define the various arguments in different contexts

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	-	1	-	1	1	-	-	-	-	-	-	-
CO 2	2	2	1	-	-	1	1	-	-	-	-	-	-	-
CO 3	2	1	1	-	-	-	1	-	-	-	-	-	-	-
CO4	2	-	1	-	-	1	1	-	-	-	-	-	-	-
CO5	3	2	-	2	-	-	-	-	-	-	-	-	-	-

Average	2	1.2	1	1.2	-	1	1	-	-	-	-	-	-	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **02 Lecture Hours**

Food for Thought: What is Critical Thinking? Introduction to the course, its importance and its application in life. Focus is given on the Trolly problem and how it can never be solved.

Unit II: **02 Lecture Hours**

Learning how to learn:

Cognition and Metacognition: The highlight of this unit would be learning strategies and the development of Bloom's Taxonomy. This lecture-based class will focus on education and learning challenges faced by students across South Asia and how to over come them.

Unit III: **02 Lecture Hours**

How to not judge a book by its cover: Cognitive biases: Flagging the problems with assumptions in our everyday functioning, this class will highlight the various kinds of biases and how it effects our understanding of issues when it comes to problem solving.

Unit IV: **08 Lecture Hours**

Writing to read: Introduction to various aspects of writing and highlighting how one is different from the other. Understanding of capital letters and syntaxes will be another focus of these classes.

Unit V: **02 Lecture Hours**

"…but why?": The Social, The Historical, and the Political Aspects of Reasoning: Introduction to inductive and deductive reasoning and its relevance when understanding how information is passed on to.

Unit VI: **04 Lecture Hours**

"Agree to disagree": Explanation, Justification, Persuasion: Explanation, Justification, Persuasion is three distinct critical thinking tools to convey information, support arguments, or influence others in various contexts.

Unit VII: **02 Lecture Hours**

Fact, Truth, and Misinformation: Based in accuracy and reliability of information, this unite with focus on assertion of statement that can be objectively verified and proven to be true or false depending upon the situation. It is important to be critically evaluate information to differentiate one from the other.

Unit VIII: **02 Lecture Hours**

Critical Consumption: Focusing on critical media consumption, this unit focuses on the contemporary forms of information consumption. It involves being actively aware if potential biases, misinformation, and the credibility of sources in the age of digital media.

Unit IX: 02 Lecture Hours

POV: Perspective Taking: This unit focuses on the Cognitive and empathetic process in which an individual tries to understand and empathise with the thoughts, feelings, beliefs, and experiences of the other person or group from their point of view. Perspective taking is an important aspect of empathy and interpersonal communication aiding critical thinking.

Unit X: 02 Lecture Hours

Ethical Dilemma: The focus of this unit will be on the complex moral decision that involves conflicting values, principles, or interests. In such instances there is no clear or obvious choice to arrive at a conclusion.

Textbooks

1. Vaughn, Lewis (2005). The Power of Critical Thinking: Effective Reasoning About Ordinary and Extraordinary Claims. New York: Oxford University Press USA.
2. Hughes, William (2015). Critical thinking: an introduction to the basic skills. Tonawanda, NY: Broadview Press. Edited by Katheryn Doran & Jonathan Allen Lavery.
3. West, Andrew (2014). Ubuntu and Business Ethics: Problems, Perspectives and Prospects. Journal of Business Ethics 121 (1):47-61.

Reference Books

1. Yu, Shiyang & Zenker, Frank (2020). Schemes, Critical Questions, and Complete Argument Evaluation. Argumentation 34 (4):469-498.
2. Davies, Richard (2020). In Defence of a Fallacy. Studia Semiotyczne 34 (2):25-42.
3. Lumer, Christoph (2019). Recognizing Argument Types and Adding Missing Reasons. In Bart J. Garssen, David Godden, Gordon Mitchell & Jean Wagemans (eds.), Proceedings of the Ninth Conference of the International Society for the Study of Argumentation (ISSA). [Amsterdam, July 3-6, 2018.]. Amsterdam (Netherlands): pp. 769-777

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	50	20	30	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Environment Sustainability and Climate Change	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To Develop a critical understanding of the nature, cause and impact of human activities on the environment.
2. Critically engage with concepts of ecosystems, biodiversity and sustainability.
3. Research, analyse, identify problems, develop insights, and frame sustainable solutions to living issues faced by the global and local communities.
4. Learning by doing, engaging, exploring and experimenting

Course Outcomes

On completion of this course, the students will be able to

CO 1	Understand the concepts of ecology, sustainability, climate change and environment related to everyday life.
CO 2	Distinguish and relate different types of biodiversity and natural resources and their impact on sustainable development.
CO 3	Analyse various aspects of environment and adopt eco-friendly technologies to facilitate conservation and regeneration of natural resource.
CO 4	Build environmental awareness through a wide range of curricular and co-curricular activities at the University and later in a professional/vocational practice.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 2	2	1	0		1	0	0		0	0		0	0	0
CO 3	3	1	0	1	2	0	0	1	0	0	2	0	0	0
CO4	2	2	0	1	1	0	0	1	0	0	1	0	0	0
Average	2.25	1.3	0	1	1.3	0	0	1	0	0	1.5	0	0	0

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 04 Lecture Hours

Humans and the Environment: The man-environment interaction: Humans as hunter-gatherers; Mastery of fire; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change.

The emergence of environmentalism: Anthropocentric and eco-centric perspectives (Major thinkers); The Club of Rome- Limits to Growth; UN Conference on Human Environment 1972; World Commission on Environment and Development and the concept of sustainable development; Rio Summit and subsequent international efforts.

Unit II: 06 Lecture Hours

Natural Resources and Sustainable Development: Overview of natural resources: Definition of resource; Classification of natural resources- biotic and abiotic, renewable and non-renewable.

Biotic resources: Major type of biotic resources- forests, grasslands, wetlands, wildlife and aquatic (fresh water and marine); Microbes as a resource; Status and challenges.

Water resources: Types of water resources- fresh water and marine resources; Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges; Water scarcity and stress; Conflicts over water.

Soil and mineral resources: Important minerals; Mineral exploitation; Environmental problems due to extraction of minerals and use; Soil as a resource and its degradation.

Energy resources: Sources of energy and their classification, renewable and non-renewable sources of energy; Conventional energy sources- coal, oil, natural gas, nuclear energy; Non-conventional energy sources- solar, wind, tidal, hydro, wave, ocean thermal, geothermal, biomass, hydrogen and fuel cells; Implications of energy use on the environment.

Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs.

Unit III: 06 Lecture Hours

Environmental Issues: Local, Regional and Global: Environmental issues and scales: Concepts of micro-, meso-, synoptic and planetary scales; Temporal and spatial extents of local, regional, and global phenomena.

Pollution: Impact of sectoral processes on Environment, Types of Pollution- air, noise, water, soil, municipal solid waste, hazardous waste; Transboundary air pollution; Acid rain; Smog.

Land use and Land cover change: land degradation, deforestation, desertification, urbanization.

Biodiversity loss: past and current trends, impact.

Global change: Ozone layer depletion; Climate change.

Unit IV: **06 Lecture Hours**

Conservation of Biodiversity and Ecosystem: Biodiversity and its distribution: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories.

Ecosystems and ecosystem services: Major ecosystem types in India and their basic characteristics- forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance.

Threats to biodiversity and ecosystems: Land use and land cover change; Commercial exploitation of species; Invasive species; Fire, disasters and climate change.

Major conservation policies: in-situ and ex-situ conservation approaches; Major protected areas; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation; Gender and conservation.

Unit V: **06 Lecture Hours**

Environment Pollution and Health: Understanding pollution: Production processes and generation of wastes; Assimilative capacity of the environment; Definition of pollution; Point sources and non-point sources of pollution.

Air pollution: Sources of air pollution; Primary and secondary pollutants; Criteria pollutants- carbon monoxide, lead, nitrogen oxides, ground-level ozone, particulate matter and sulphur dioxide; Other important air pollutants- Volatile Organic compounds (VOCs), Peroxyacetyl Nitrate (PAN), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); Indoor air pollution; Adverse health impacts of air pollutants; National Ambient Air Quality Standards.

Water pollution: Sources of water pollution; River, lake and marine pollution, groundwater pollution; water quality Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life.

Soil pollution and solid waste: Soil pollutants and their sources; Solid and hazardous waste; Impact on human health.

Noise pollution: Definition of noise; Unit of measurement of noise pollution; Sources of noise pollution; Noise standards; adverse impacts of noise on human health.

Thermal and Radioactive pollution: Sources and impact on human health and ecosystems.

Unit VI: **06 Lecture Hours**

Climate Change Impact Adaptation and Mitigation: climate change from greenhouse gas emissions– past, present and future; Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events; Importance of 1.5 °C and 2.0 °C limits to global warming; Climate change projections for the Indian sub-continent.

Impacts, vulnerability and adaptation to climate change: Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Impacts on animal species, agriculture, health, urban infrastructure; the concept of vulnerability and its assessment; Adaptation vs. resilience; Climate-resilient development; Indigenous knowledge for adaptation to climate change.

Mitigation of climate change: Synergies between adaptation and mitigation measures; Green House Gas (GHG) reduction vs. sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; National and international policy instruments for mitigation, decarbonizing pathways and net zero targets for the future; Energy efficiency measures; Renewable energy sources; Carbon capture and storage, National climate action plan and Intended Nationally Determined Contributions (INDCs); Climate justice.

Unit VII: 06 Lecture Hours

Environment Management: Introduction to environmental laws and regulation: Constitutional provisions- Article 48A, Article 51A (g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution control.

Environmental management system: ISO 14001

Life cycle analysis; Cost-benefit analysis

Environmental audit and impact assessment; Environmental risk assessment

Pollution control and management; Waste Management- Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme

Unit VIII: 06 Lecture Hours

Environment Treaties and Legislation:

1. An overview of instruments of international cooperation; bilateral and multilateral agreements; conventions and protocols; adoption, signature, ratification and entry into force; binding and non-binding measures; Conference of the Parties (COP)

2. Major International Environmental Agreements: Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing; Convention on International Trade in Endangered Species of 6ild Flora and Fauna (CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India’s status as a party to major conventions

3. Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules; Ramsar sites; Biosphere reserves; Protected Areas; Ecologically Sensitive Areas; Coastal Regulation Zone; Status phase-out of production and consumption of Ozone Depleting Substances by India; National Green Tribunal; Some landmark Supreme Court judgements

Major International organisations and initiatives: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN),World Commission on Environment and Development (WCED), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC), and Man and the Biosphere (MAB) programme.

Unit IX: 30 Lecture Hours

Living Lab Case Studies and Field Work: The students are expected to be engaged in some of the following or similar identified activities:

Discussion on one national and one international case study related to the environment and sustainable development.

Field visits to identify local/regional environmental issues, make observations including data collection and prepare a brief report.

Documentation of campus biodiversity.

Campus environmental management activities such as solid waste disposal, water management, and sewage treatment.

Reference books

1. Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press.
2. Headrick, Daniel R. (2020) Humans versus Nature- A Global Environmental History, Oxford University Press.
3. William P.Cunningham and Mary A. (2015) Cunningham Environmental Science: A Global Concern, Publisher (Mc-Graw Hill, USA)
4. Gilbert M. Masters and W. P. (2008). An Introduction to Environmental Engineering and Science, Ela Publisher (Pearson)
5. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.University Grants Commission 11.
6. William P. Cunningham and Mary A. (2015). Cunningham Environmental Science: A global concern, Publisher (Mc-Graw Hill, USA)
7. Bhagwat, Shonil (Editor) (2018) Conservation and Development in India: Reimagining Wilderness, Earthscan Conservation and Development, Routledge.
8. Masters, G. M., & Ela, W. P. (2008). Introduction to environmental engineering and science (No. 60457). Englewood Cliffs, NJ: Prentice Hall.
9. Miller, G. T., & Spoolman, S. (2015) Environmental Science. Cengage Learning.
10. Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/standards/
11. Ahluwalia, V. K. (2015). Environmental Pollution, and Health. The Energy and Resources Institute (TERI).University Grants Commission 13

12. Denle A., Azadi H., Arbiol J. (2015). Global assessment of technological innovation for climate change adaptation and mitigation in developing world, Journal of Environmental Management, 161 (15): 261-275.

13. Richard A. Marcantonio, Marc Lame (2022). Environmental Management: Concepts and Practical Skills. Cambridge University Press.University Grants Commission 15

14. UNEP (2007) Multilateral Environmental Agreement Negotiator's Handbook, University of Joensuu, ISBN 978-952-458-992-5

15. Ministry of Environment, Forest and Climate Change (2019) A Handbook on International Environment Conventions & Programmes. https://moef.gov.in/wp-content/uploads/2020/02/convention-V-16-CURVE-web.pdf

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Engineering Mathematics I	3	1	0	4
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable the students, apply matrix theory in engineering problems.
2. To help the students develop the skills related to multivariate calculus.
3. To enable the students, understand the application of vector calculus in engineering problems.
4. To enable students, approximate the function of one variable by infinite series.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Find the solution of a system of linear equations.
CO 2	Apply the techniques to handle the functions of several variables for calculus.
CO 3	Demonstrate the basic concepts of vector calculus with relevant applications.
CO 4	Find the infinite series approximation of a periodic and non-periodic function of one

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	1	1	0	0	0	0	0	0	1	0	0
CO 2	3	3	2	1	1	0	0	0	0	0	0	1	0	0
CO 3	3	3	2	1	1	0	0	0	0	0	0	1	0	0
CO4	3	3	2	1	1	0	0	0	0	0	0	1	0	0
Average	3	3	2	1	1	0	0	0	0	0	0	1	0	0

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 09 Lecture Hours

Matrices: Elementary transformation, Inverse of matrix, linearly independent vectors, rank of a matrix, solution of system of linear equations, Eigenvalues and Eigenvectors, characteristic equation, Cayley-Hamilton Theorem, Diagonalization of matrices, Orthogonal transformation and quadratic to canonical forms.

Unit II: 12 Lecture Hours

Multivariable Calculus: Partial derivatives, Euler's Theorem and its Applications, total derivative, Jacobians, extrema of functions of two variables, Method of Lagrange multipliers. Beta and gamma function, Multiple Integration: double and triple integrals, change of order of integration, change of variables, Applications: areas, volumes, center of mass and Gravity (constant and variable densities).

Unit III: 15 Lecture Hours

Vector Calculus: Vector and scalar functions and fields, Gradient of a scalar field, Directional derivative; Divergence and curl of a vector field. Line Integrals, Path Independence of Line Integrals; Surface Integral; Volume Integral, Applications of Green's theorem, Gauss' divergence theorem & Stoke's theorem.

Unit IV: 09 Lecture Hours

Fourier Series and Transform: Taylor's and Maclaurin's series, Periodic Functions, Fourier Series expansion of functions of period 2l, Half Range Sine and Cosine series, Fourier transform.

Textbooks

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley Publications. ISBN: 9788126531356.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 2000. ISBN: 8174091955
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publications. ISBN: 9788184875607.
4. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill. ISBN: 9780071070089.

Reference Books

1. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010. ISBN: 978-81-318-0803-0
2. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", Pearson, 2002. ISBN: 978-0201531749
3. T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008. ISBN: 978-0-07-061678-3

4. D. Poole, “Linear Algebra: A Modern Introduction”, Brooks/Cole, 2005. ISBN: 978-1285463247

5. V. Krishnamurthy, V. P. Mainra and J. L. Arora, “An introduction to Linear Algebra”, Affiliated East-West press, 2005. ISBN: 9780071070591

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	50	20	30	100

Detailed breakup of Internal Assessment

Course Code	Course name		L	T	P	C
	Physics		3	1	0	4
Total Units to be Covered:		Total Contact Hours:				
Prerequisite(s):			Syllabus version:			

Course Objectives

1. To explore Fiber optics and Lasers' fundamentals and their applications to modern communication systems.
2. To comprehend the effect of electric and magnetic field in materials and apply Maxwell's equations to understand EM wave propagation.
3. To construct a quantum mechanical model to explain the behavior of a system at the microscopic level.
4. To understand the fundamentals of crystal structure and X-rays diffraction and to familiarize with the basics of solar photovoltaics and their applications in solar industries.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Learn the principles of physical optics, lasers and fiber optics and their applications in various devices.
CO 2	Comprehend the properties of dielectric and magnetic materials under the influence of electric and magnetic fields.
CO 3	Understand the behavior of microscopic objects using fundamentals of Quantum Mechanics.
CO 4	Employ photovoltaics fundamentals in understanding the functioning of various devices used in electronics and solar photovoltaics industries and to explore different types of crystals structures and use X-ray diffraction technique to understand their details.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	1	0	0	0	0	0	0	0	0	0	1	0	0
CO 2	3	2	0	0	0	0	0	0	0	0	0	1	0	0
CO 3	3	3	0	0	0	0	0	0	0	0	0	1	0	0
CO4	3	3	0	0	0	0	0	0	0	0	0	1	0	0
Average	3	2.25	0	0	0	0	0	0	0	0	0	1	0	0

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**

3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 12 Lecture Hours

Introduction to interference and examples; concept of diffraction, Fraunhoffer and Fresnel diffraction, diffraction grating and its characteristics. Polarization: Introduction, polarization by reflection, polarization by double refraction, circular and elliptical polarization, optical activity. Fibre Optics: Introduction, total internal reflection, numerical aperture and various optical fibre parameters, step and graded index fibres, losses in optical fibres. Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping; types and applications of lasers, He-Ne laser.

Unit II: 12 Lecture Hours

Overview of Electrostatics and Magnetostatics, electric current and the continuity equation, laws of magnetism. Ampere's & Faraday's laws. Maxwell's equations, Electromagnetic waves and Poynting Vector in free space. Electric Polarization, permeability and dielectric constant, internal fields, Clausius-Mossotti equation, applications of dielectrics. Magnetization, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

Unit III: 12 Lecture Hours

Introduction to Quantum Mechanics, photoelectric effect, Compton Effect, Pair production & Annihilation, De-Broglie waves, phase and group velocities, Uncertainty principle and its applications, Wave function and its interpretation, Normalization, Linearity and superposition, expectation values, operators, Eigen values & Eigen functions, Schrodinger time independent & dependent wave equations, Particle in a 1-D box.

Unit IV: 09 Lecture Hours

Introduction to Solid State Physics, single crystals and polycrystalline forms, Lattice, Basis and crystal structure, Translational symmetry and basis Vectors, Unit Cell (primitive and non-primitive), Bravais lattices, Miller indices, sc, bcc, and sodium chloride structures, closed packed structures (fcc and hcp), Reciprocal lattice, X-ray diffraction, Bragg's law.

Photovoltaic effect, irradiance, solar radiation and spectrum of sun, solar cells, basic structure and characteristics, solar cell arrays, PV modules.

Textbooks

1. Malik H.K, Singh A.K. (2011) Engineering Physics, TMH, New Delhi. ISBN: 9780070671539.
2. Beiser A. (2002) Concepts of Modern Physics, McGraw Hill Education. ISBN: 9780070495531.
3. Sadiku M.N.O. (2007) Elements of Electromagnetics, Oxford University Press. ISBN: 0195300483.
4. Pillai S.O. (2015) Solid State Physics, New Age International Pvt Ltd. ISBN: 978-8122436976.

Reference Books

1. Griffith D.J. (2012) Introduction to Electromagnetics, PHI Learning, 4th edition, ISBN: 9780138053260.
2. Kittel C. (2012) Introduction to Solid State Physics, Willey. ISBN: 978-8126535187.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	50	20	30	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Object Oriented Programming	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To help the students to learn the basics of C programming language.
2. To enable students to develop programming skills.
3. To give the students basic and intermediate knowledge about the C programming language and data structure.
4. To enable students, develop programs of intermediate level in C programming language.
5. To make students aware about the concept of data structures.
6. To enable students to implement the concept of data structure using C programming language.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Demonstrate a clear understanding of the basic C programming concepts.
CO 2	Use functions, storage class specifiers, pointers and dynamic memory allocation.
CO 3	Implement the basic data structures like arrays, structures, linked lists, stacks and queues
CO 4	Analyze the complexities associated with sorting/searching algorithms and demonstrate a clear understanding of the file handling concepts.
CO 5	Develop solutions for real life problems.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	-	2	1	-	-	-	-	-	-	-	1	1	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-	2	-
CO 3	1	1	2	1	-	-	-	-	-	-	-	2	3	-
CO 4	1	1	1	-	-	-	-	-	-	-	-		1	-
CO 5	1	2	3	2	-	-	-	-	-	-	-	2	3	-
Average	1	1.25	2	1.25	-	-	-	-	-	-	-	1.6	2	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

Program Development Steps: Algorithm / pseudo code, flowchart, program development steps, structure of C program, A Simple C program, identifiers, basic data types and sizes, constants, variables, arithmetic, relational and logical operators, increment and decrement operators, conditional operator, bit-wise operators, assignment operators, expressions, type conversions, conditional expressions, precedence and order of evaluation. Input-output statements, statements and blocks, if and switch statements, loops- while, do-while and for statements, break, continue, go to and labels, command line arguments.

Unit II: 08 Lecture Hours

Arrays: Declaration, definition, arrays and functions, two-dimensional and multi-dimensional arrays, multi-dimensional storage representation. Designing structured programs, Function basics, parameter passing, storage classes- extern, auto, register, static, scope rules, standard library functions, recursive function.

Unit III: 10 Lecture Hours

Pointers: Initialization of pointer variables, pointers and function arguments, address arithmetic, Character pointers and functions, pointers to pointers, dynamic memory managements functions, array with functions. Derived types- structures- declaration & definition, nested structures, arrays of structures, structures and functions, pointers to structures, self-referential structures, accessing structure members using pointers, unions, typedef.

Unit IV: 10 Lecture Hours

Data Structures: Introduction to data structures, representing stacks and queues in C using arrays, linked lists: operations, Stack and Queue implementation using Linked list, infix to post fix conversion, postfix expression evaluation, doubly linked lists, circular lists, polynomial representation & operations.

Unit IV: 07 Lecture Hours

Searching & Sorting: Linear and binary search methods, sorting – Bubble sort, Selection sort, Insertion sort, Quick sort. Input and output – concept of a file, text files and binary files, streams, standard I/O, Formatted I/O, file I/O operations.

Textbooks

1. Data Structures with C (Schaum's Outline Series) by Seymour Lipschutz.
2. Let us C Solutions by Yashavant P. Kanetkar

Reference Books

1. Programming in ANSI C Book by E. Balagurusamy
2. Ellis Horowitz and SartazSahni, "Data Structure using C".

3. P.K. Sinha and P.K. Sinha, “Computer Fundamentals”.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	50	20	30	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Basic Electrical & Electronics Engineering	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable students, understand the fundamental semiconductor devices.
2. To enable students understands the logical operations and network theory.
3. To enable students, acquire knowledge about electrical machine and transformer.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Employ electronic and electrical components and devices to solve the Engineering problems.
CO 2	Analyze and make simple circuits and Systems of Electrical and Electronics Engineering, Interpret the logics used in the Circuits and Systems.
CO 3	Design the electrical system with discrete components and to understand the specifications of industrial equipments.
CO 4	Design the electronics system with discrete components and to understand the specifications of industrial equipment.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	1	-	-	-	-	-	-	-	1	2	2
CO 2	2	2	2	1	1	-	-	-	-	-	-	1	1	2
CO 3	3	3	2	-	1	-	-	-	-	-	-	1	1	2
CO4	3	3	2	-	1	-	-	-	-	-	-	1	2	2
Average	2.5	2.5	2	0.5	1	-	-	-	-	-	-	1	1.5	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **16 Lecture Hours**

Semiconductor Devices: Diode: Fundamental Characteristics of diode: Formation of P-N junction, I-V characteristics, half-wave and full-wave rectifier circuits, Zener and Avalanche breakdown; diode applications in clipper and clamper, Zener diode: voltage regulator.

Transistor: Construction and operation, Transistor amplifying action, Amplification factors; Limits of operation, Applications of transistor, DC-Biasing: Fixed bias, Emitter bias, Voltage divider bias.

Unit II: 07 Lecture Hours

Boolean Algebra: Number system and codes, Minimization techniques: Boolean logic operations, Basic laws of Boolean algebra, De Morgan's Theorems; Logic gates: AND, OR, NAND, NOR and realization. Implementation of Adder and subtractor, Two, three and four variables Karnaugh-map (K-map)

Unit III: 10 Lecture Hours

Network Theory: Voltage and current sources (conversion), Kirchoff current and voltage laws, Network theorems (DC/AC): Superposition, Thevenin's and Maximum Power Transfer theorem, star-delta transformations.

Unit IV: 12 Lecture Hours

AC Circuits and Electrical Machines: Representation of sinusoidal waveforms, peak and RMS values, phasor representation. Elementary analysis of single-phase ac circuits R, L, C, series/parallel RLC circuits and Resonance conditions. DC machines: working Principle transformer, losses in transformers & efficiency; Classification of motors (AC & DC), characteristics & applications of DC Motors.

Textbooks

1. Principle of Electronics by V.K. Mehta & Rohit Mehta 2018, S. Chand
2. Basic Electrical Engineering, V.K. Mehta, 2018, S. Chand.
3. Digital Circuits & Logic Design by Salivahanan: Vikas Publishing House.
4. Basic Electronics by Santiram Kal, 2013: PHI.

Reference Books

1. NPTEL Lectures –will be available - \\10.2.1.33 (intranet)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	50	20	30	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Object Oriented Programming Lab	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable students to develop problem solving skills.
2. To give the students' knowledge about the C programming language.
3. To make students aware about the concept of basic data structures.
4. To enable students to implement the sorting/searching algorithms and file handling.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Demonstrate problem solving using data types, functions, storage class specifiers and pointers.
CO 2	Implement elementary data structures like arrays, structures, union etc.
CO 3	Implement Stack, Queue, Linked Lists.
CO 4	Use searching and sorting algorithms and file handling.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	1	-	-	-	-	-	-	-	2	3	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	2	3	-
CO 3	1	1	2	1	-	-	-	-	-	-	-	2	3	-
CO 4	1	1	2	1	-	-	-	-	-	-	-	2	3	-
Average	1	1	2	1	-	-	-	-	-	-	-	2	3	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

List of Experiment

Experiment No. 1

Basics of Problem Solving and Sequential Logic: To develop skills in problem solving tools (algorithm and flowchart) and C language standard I/O & fundamental data types.

Experiment No. 2

Conditional Branching: To demonstrate the use of conditional constructs in problem solving (applying if, if-else, if-else-if ladder, nested-if, switch-case statements).

Experiment No. 3

Looping: To demonstrate the use of iterative looping constructs in problem solving (applying while, do-while, for statements).

Experiment No. 4

Functions and Pointers: To implement solutions using functions, pointers and recursive looping.

Experiment No. 5

1D Arrays and Strings: To show the use of Arrays and working with strings.

Experiment No. 6

2D Arrays and Searching: To demonstrate the use of 2D arrays in working with matrices, and to implement linear search.

Experiment No. 7

Structure: To apply the concept of structure and experiment on nested and array of structures.

Experiment No. 8

Union and Dynamic Memory Allocation: To implement the concept of union and experiment on dynamic memory allocation.

Experiment No. 9

Stack Data Structure: To demonstrate use of arrays to implement Stack operations and applications of Stack.

Experiment No. 10

Queue Data Structures: To demonstrate use of arrays to implement Queue operations and types of Queues.

Experiment No. 11

Link List Data Structure and its Applications: To experiment the concept of pointers, structure and dynamic memory allocation to realize linked list, its types and application.

Experiment No. 12

Sorting and File Handling: To implement the concept of files and file operations.

Textbooks

1. Seymour Lipschutz, “Data Structures with C (Schaum's Outline Series)”.
2. Yashavant P. Kanetkar, “Let us C”.

Reference Books

1. E. Balagurusamy, “Programming in ANSI C”.
2. Ellis Horowitz and SartazSahni, “Data Structure using C”.
3. P.K. Sinha and P.K. Sinha, “Computer Fundamentals”.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Evaluation
Weightage (%)	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Basic Electrical and Electronics Lab	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Understand the characteristics of the basic electronic components like diode and transistor and electric fuse.
2. Develop the application-based circuits using switch, Rectifier, Diode and transistor and logic gates also.
3. Design DC-Power supply by using Rectifiers and Adders & Subtractor by using Logic Gates.
4. Apply laws to solve the DC & AC network Circuits using R, L, C circuits.
5. Study the Constructional features, operation and characteristics of Electrical Machines.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Understand the functionality of electronics and electrical components.
CO 2	Analyze and interpret the data obtained during experiments of Electrical and Electronics circuits.
CO 3	Evaluate the results of the experiments based on different fundamental theorems/laws.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	1	-	-	-	-	-	-	-	2	3	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	2	3	-
CO 3	1	1	2	1	-	-	-	-	-	-	-	2	3	-
Average	1	1	2	1	-	-	-	-	-	-	-	2	3	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

List of Experiment

Experiment No. 1

To study various electronic components (diode, resistor, transistor, capacitors, ICs, etc) and measuring instruments.

Experiment No. 2

To study the voltage and current measurement using volt-meter and ammeter connections in simple electrical circuit.

Experiment No. 3

To plot V-I characteristics of PN junction diode.

Experiment No. 4

To verify Thevenin's Theorem.

Experiment No. 5

To study half-wave and full-wave rectifier circuit.

Experiment No. 6

To verify Superposition Theorem

Experiment No. 7

To study the characteristics of NPN transistor in CE configuration.

Experiment No. 8

To verify the Maximum Power Transfer Theorem

Experiment No. 9

To study the characteristics of NPN transistor in CB configuration.

Experiment No. 10

To study the phenomenon of resonance in L-C-R series circuit

Experiment No. 11

Implementation of Half and Full Adder digital circuits.

Experiment No. 12

To study the phenomenon of resonance in LCR parallel circuits.

Textbooks

1. Principle of Electronics by V.K. Mehta & Rohit Mehta 2018, S. Chand
2. Basic Electronics By Santiram Kal, 2013: PHI.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Evaluation
Weightage (%)	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Physics Lab	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

6. To impart hand-on skills in performing experiments, data acquisition and interpretation of the data.
7. To design the circuits and study about various experimental procedures involved.
8. Significance of the experimental results to understand and verify theoretical formulation and prediction.
9. To develop curiosity and creative ability through experimentation and investigation based on the virtual experiments.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Demonstrate the dual nature of light by verifying the various phenomena associated with it
CO 2	Apply the concepts of electromagnetics to study the various electrical and magnetic properties of Materials
CO 3	Evaluate and compare the universal constants by using the principle of modern physics.
CO 4	Design virtual Physics based experiments to illustrate the Photoelectric Effect.
CO 5	Inculcate good presentation skills.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 4	-	-	3	-	2	-	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Average	**-**	**3**	**3**	**3**	**2**	**-**		**-**	**-**	**3**	**0**	**1**	**-**	**-**

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

List of Experiment

Experiment No. 1

To determine the frequency of AC mains by using a sonometer.

Experiment No. 2

To study the Hall effect and hence determine the Hall coefficient (Rh) and carrier density (n) of a given semiconductor material.

Experiment No. 3

(a) To study the induced emf as a function of velocity of the magnet passing through the coil (Faraday's Law).

(b) To study the charge delivered due to electromagnetic induction.

Experiment No. 4

To study the variation of magnetic field with distance along the axis of a current carrying circular coil and hence estimate the radius of the coil.

Experiment No. 5

To study the variation of magnetic field with distance along the axis of a current carrying circular coil and hence estimate the radius of the coil.

Experiment No. 6

To determine the wavelength of a given light by forming Newton's Rings.

Experiment No. 7

To determine the wavelength of a given light by using a Diffraction grating in its normal incidence position.

Experiment No. 8

Study of both the current - voltage characteristic and the power curve to find the maximum power point (MPP) and efficiency of a solar cell.

Experiment No. 9

To find the Planck's constant by using LEDs.

Experiment No. 10

Presentation related to any science concept.

Textbooks

3. H. Singh, Practical Physics, S. Chand & Company LTD., ISBN: 8121904692.
4. S. L. Kakani, S. Kakani, Applied Physics-Theory & Practicals, Viva Books, ISBN: 9788130924892.
5. C. L. Arora, Practical Physics, S. Chand & Company LTD., ISBN: 9788121909099, 8121909090.

Reference Books

4. Gupta, Kumar, Practical Physics, Pragati Prakashan, ISBN: 9789386633569.

5. I. Prakash, R. Krishna, A. K. Jha, Practical Physics, Kitab Mahal, ISBN: 8122504167, 9788122504163

6. P. R. Sasi Kumar, Practical Physics, Prentice Hall of India Pvt Ltd, ISBN: 9788920344341

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Evaluation
Weightage (%)	100

Detailed breakup of Internal Assessment

SEMESTER II

Course Code	Course name	L	T	P	C
	Living Conversations	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Encourage critical self-reflection to develop empathy and clarity of expression for the exchange of individual and organizational ideas and information.
2. Enable qualities of deep listening and clear and concise communication skills.
3. Apply and practice varied platforms and tools of communication both formal and informal.
4. Appreciate and practice collaborative communication in a given environment and context

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the importance of being an empathetic communicator and the role of clarity in the expression.

CO 2 Use and Analyse communication strategies and theories, as well as how they are practiced in the professional and social environment

CO 3 Demonstrate appropriate tools to improve one's ability to express, listen, and understand people in a given situation and context.

CO 4 Articulate responses both verbally and non-verbally for group and individual work undertaken by self and by others, in the execution of the project/coursework.

CO 5 Practice and Employ communication skills to engage ethically in independent and life-long learning in the broader context.

CO-PO Mapping

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

Average	-	1.2	0.6	0.6	2	0.6	0.8	0.6	-	-	-	-	-	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **04 Lecture Hours**

Basics of Communication: Introduction to the course, Importance, use and its application in life (personal as well as professional), Basics of Communication with Practical Examples (need – principles - process – model), Introducing Types of Communication (Verbal & non-verbal), Types of non-verbal communication & its importance in overall communication.

Unit II: **06 Lecture Hours**

Setting Communication Goals & Avoiding Breakdowns: Communication goals, creating value in conversations, Internal & external factors impacting our conversations, Communication breakdowns and how to address them.

Unit III: **02 Lecture Hours**

Listening for Improved Understanding: Critical thinking and writing: Importance, Active & Passive listening, Barriers, Benefits, Features & Examples of Active Listening, Verbal and non-verbal signs of active listening skills, Tools & Tips for Practicing Active Listening.

Unit IV: **06 Lecture Hours**

Non-verbal Communication: Introduction to Non-Verbal Communication, Areas of nonverbal communication, Functions and influence of nonverbal communication, Basics of Body Language, Common Gestures, Body Language Mistakes, Improving Your Body Language, Voice Modulation.

Unit V: **04 Lecture Hours**

Public Speaking and Presentation Skills: Public Speaking vs. Presentations, The Essentials of Effective Presentation, Content Development, Confidence Building, Best Practices, Virtual Presentation.

Unit VI: **02 Lecture Hours**

Communication Styles: Recognizing your style and the styles of others, closing communication gaps, being flexible without compromising one's identity.

Unit VII: **02 Lecture Hours**

Cross-cultural Communication: Navigating beyond boundaries: Developing greater sensitivity to cultural differences, building greater accountability and trust on virtual teams, uncovering hidden assumptions, Recognizing filters in oneself and others.

PROJECT WORK and Submission **04 Lecture Hours**

Textbooks

1. Hargie, Owen (ed.) (2018). The Handbook of Communication Skills. Routledge. London.
2. Anderson, Peter & Guerrero, Laura. Handbook of Communication and Emotion. 1st Edition. Elsevier.
3. Bordia Crossman, Bretag. Communication Skills. Tata Macgraw Hill.
4. Tuhovsky, Ian. The Science of Effective Communication.
5. Murphy, Herta, Thomas, Jane P. Effective Business Communication. Tata MacGraw Hill

Reference

1. Patterson, Kerry et al. (2011) Crucial Conversations Tools for Talking When Stakes Are High. MacMillan. Switzerland.
2. A Theory of Goal-Oriented Communication: https://www.researchgate.net/publication/220138297_A_Theory_of_Goal- Oriented Communication
3. Effective Communication http://www.free-management-ebooks.com/dldebk/dlcm-effective.htm
4. Active Listening http://www.free-management-ebooks.com/dldebk/dlcm-active.htm
5. TED Talks: https://www.ted.com/playlists/211/the_art_of_meaningful_conversa

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	20	30	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Environment & Climate Change	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Analog Electronics I	3	1	0	4
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To help the learners to develop the ability to design the amplifiers circuits.
2. To enable students to design the circuits and use them in real time applications.
3. To give students a perspective to appreciate the importance of transistors (BJT & FET)
4. To enable students, acquire knowledge required for develop hardware of real time embedded systems.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the characteristics and features of analog devices.

CO 2 Analyse the transistor biasing circuits for stabilizing the operating point.

CO 3 Apply transistor models for low-frequency amplifiers.

CO 4 Design the multistage amplifier using analog devices.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	-	-	1	-	-	-	-	-	3	3	1
CO 2	3	3	3	2	1	1	-	-	-	-	-	3	3	1
CO 3	3	3	3	2	1	1	-	-	-	-	-	3	3	1
CO 4	3	-	3	2	1	1	-	-	-	-	-	3	3	1
Average	3	3	3	2	1	1	-	-	-	-	-	3	3	1

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **12 Lecture Hours**

BJT Amplifiers: DC biasing, Stability factor, Practical Circuit of Transistor Amplifier, Classification of Amplifiers. Eber Moll's Model, Thermal runaway, Graphical Analysis of CE amplifier, h-parameters, equivalent circuit and analysis, Miller's theorem.

Practical Circuit of Transistor Amplifier, Classification of Amplifiers. Eber Moll's Model, Thermal runaway, Graphical Analysis of CE amplifier, h-parameters and equivalent circuit, h-Models for CB, CE, and CC configurations and their Interrelationship, Computation of Zi, ZO, AV, AI and Comparison of the three Configurations. High frequency models of BJT, Frequency Response Curve and band width, Upper and Lower cut-off frequency, Voltage gain at lower and upper cut off frequency, Miller's theorem.

Unit II: 12 Lecture Hours

Field Effect Transistor (FET): Introduction, FET Verses BJT, Construction and Operation of JFET, Static/Drain and Transfer Characteristics, FET parameters: DC and AC resistance, Trans conductance, Amplification factor, FET Biasing: Self, Fixed and Voltage divider Biasing, FET as MOSFET: Introduction, Construction, Operation and characteristics, Depletion MOSFET (IGFET), Enhancement MOSFET, Comparisons between N-Channel and P-Channel MOSFET.

Unit III: 11 Lecture Hours

FET Amplifiers: FET small-signal model, FET Amplifiers: CS, CD, CG Amplifiers, Equivalent Circuits, and Computation of Input and Output impedance, Voltage gain, FET AC Equivalent Circuit, JFET fixed-bias configuration, JFET self-bias configuration, JFET voltage-divider configuration.

Unit IV: 10 Lecture Hours

Multistage Amplifiers: Multistage Transistor Amplifiers, Gain bandwidth Product, Two Stage RC Coupled Amplifier at Low and high frequencies, Cascade and Cascade Amplifiers, Darlington Pair, Emitter Follower, Source Follower Concept, Emitter Follower Darlington pair.

Textbooks

1. Robert L. Boylestad, Louis Nashelsky (2009) Electronics Devices & Circuits, Pearson- R.L Boylstad. ISBN: 978-8131727003

Reference Books

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer (2017) Analysis and Design of Analog Integrated Circuits, Wiley. ISBN:978-1118078891

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Engineering Mathematics II	3	1	0	4
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To help the students master the techniques to solve ordinary differential equation.
2. To help the students understand the basic theory of function of a complex variable.
3. To make the students apply the theory of contour integration using residue calculus.
4. To enable the students, solve specific classes of partial differential equations.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Apply techniques to solve linear ordinary differential equations.

CO 2 Explain the concept of analyticity and integration of a complex function.

CO 3 Find the series representation of a complex function and to evaluate special integrals using calculus of residues.

CO 4 Solve homogeneous partial differential equations with constant coefficients and its applications in one-dimensional heat and wave equations.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	1	1	-	-	-	-	-	-	1	-	-
CO 2	3	3	2	1	1	-	-	-	-	-	-	1	-	-
CO 3	3	3	2	1	1	-	-	-	-	-	-	1	-	-
CO 4	3	3	2	1	1	-	-	-	-	-	-	1	-	-
Average	3	3	2	1	1	-	-	-	-	-	-	1	-	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 11 Lecture Hours

Ordinary Differential Equations: Exact differential equation and equations reducible to exact, Linear Differential Equations with Constant Coefficients, Cauchy-Euler Differential Equations,

Solution of Second Order Differential Equations (when a part of complementary function is known, by reduction to Normal Form, by changing the Independent Variable and by Variation of Parameters).

Unit II: 12 Lecture Hours

Complex Variables-I: Functions of a complex variable, Notion of limit, continuity and differentiability, Analytic function, Necessary & sufficient conditions for analyticity (Cauchy-Riemann equations), Harmonic function, harmonic conjugate and orthogonal families, construction of an analytic function, Milne Thomson method, Line integral and independence of path, Cauchy's theorem, Cauchy-Goursat theorem for simply and multiply connected domain, Cauchy's integral formula and its applications.

Unit III: 11 Lecture Hours

Complex Variables-II: Power series, Taylor's and Laurent's series, Zeros and singularities of a function, residues, Cauchy Residue Theorem, Evaluation of definite integral $\int_0^{2\pi} F(\cos\theta, \sin\theta)d\theta$, Evaluation of improper integrals $\int_{-\infty}^{\infty} \frac{p(x)}{q(x)}dx$ and $\int_{-\infty}^{\infty} \frac{p(x)}{q(x)}e^{iax}dx$; evaluation of $\int_{-\infty}^{\infty} \frac{p(x)}{q(x)}dx$ and $\int_{-\infty}^{\infty} \frac{p(x)}{q(x)}e^{iax}dx$ with poles on real axis (semicircular contour), Conformal mapping, Linear mapping, inversion, Bilinear transformation.

Unit IV: 11 Lecture Hours

Partial Differential Equations: Formation of partial differential equation (PDE) and classification of PDEs, Lagrange's Method, Solution of homogeneous linear PDE with constant coefficients, method of separation of variables, solution of one-dimensional heat and wave equation.

Textbooks

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, ISBN: 9788184873221.
2. E. Kreyszig, Advanced Engineering Mathematics, Wiley Publications, ISBN: 9780470458365.
3. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand Publications.
4. ISBN: 9789385676161.
5. M. D. Raisinghania, Advanced Differential Equations, S. Chand Publications. ISBN: 9788121908931

Reference Books

1. D. G. Zill, Advanced Engineering Mathematics, Jones and Bartlett Learning, ISBN: 9789384323271.
2. S. L. Ross, Differential Equations, Wiley Publications. ISBN: 9788126515370
3. D. G. Zill and P. D. Shanahan, A first course in Complex Analysis with Applications, Jones & Bartlett Learning, ISBN: 9789380108193.
4. I. N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill Book Company.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Workshop Practices	0	0	2	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To impart knowledge and skill of components in the field of basic workshop practices.
2. To deal with different hand and machine tools required for manufacturing simple components.
3. To impart the knowledge regarding the various basic manufacturing processes required in day-to-day life.
4. To familiarize the students with the properties and selection of different engineering material.
5. To impart knowledge of dimensional tolerances with different manufacturing processes.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the basics of manufacturing processes used in engineering workshop.

CO 2 Identify basic workshop hand and machine tools.

CO 3 Fabricate simple models by using different Manufacturing processes.

CO 4 Compare conventional and advanced manufacturing processes

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	-	1	-	-	-	1	-	-	-	-	-	-	-
CO 2	1	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	3	-	-	-	2	-	-	2	-	-
CO 4	1	-	-	-	2	-	-	-	-	-	-	-	-	-
Average	1	-	1	-	2.5	-	1	-	2	-	-	2	-	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **04 Lecture Hours**

Manufacturing Methods, Forming process –hot working and cold working processes – types. Machining Advanced manufacturing processes- introduction to non-conventional machining processes and their needs.

Unit II: **02 Lecture Hours**

Fitting operations & power tools, limits, fits and tolerance. Types of power tools.

Unit III: **02 Lecture Hours**

Metal casting patterns-types, allowances, molding sand-its properties, types of molds and cores, melting equipment.

Unit IV: **03 Lecture Hours**

Welding (arc welding & gas welding), brazing, Gas welding.

Unit V: **01 Lecture Hours**

Carpentry Types of woods, defects of wood, seasoning of wood, types of carpentry tools. Additive manufacturing –additive v/s subtractive manufacturing, need, advantages and applications of additive manufacturing, introduction to 3 D printing.

List of Experiment

Experiment No: 01

Prepare lab layout of the workshop with layout of all shops: carpentry, fitting, machine, welding, smithy, sheet metal and foundry shop.

Experiment No: 02

To fabricate a T-lap joint of given dimensions using common carpentry tools.

Experiment No: 03

To fabricate a cross lap joint of given dimensions using common carpentry tools.

Experiment No: 04

To develop a square fitting model of given dimensions by using fitting tools.

Experiment No: 05

To learn lathe operation and develop a step turning model of given dimensions by using lathe machine.

Experiment No: 06

To develop a model of given dimension by using facing, turning, grooving, parting and knurling operations.

Experiment No: 07

To learn welding operation and develop a T- joint, V-butt joint and Lap joint using electric arc welding process.

Experiment No: 08

To develop a rectangular tray in sheet metal shop using various hand tools for working with sheet metal

Experiment No: 09

To develop a chisel using common smithy hand tools.

Experiment No: 10

To develop a cope and drag mould in foundry shop.

Textbooks

1. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers.
2. Engineering Practices Lab Manual, Jeyapoovan, Saravana Pandian, Vikas publishers
3. Dictionary of Mechanical Engineering, GHF Nayler, Jaico Publishing House

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	End Sem	Total
Weightage (%)	50	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Engineering Graphics	0	0	2	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Introduction to engineering design and its place in society.
2. Exposure to the visual aspects of engineering design.
3. Exposure to engineering graphics standards.
4. Exposure to solid modelling.
5. Exposure to computer-aided geometric design.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Remember the conventions of engineering graphics such as types of lines, dimensioning, method of projection etc.

CO 2 Demonstrate understanding of fundamental concepts of engineering graphics.

CO 3 Apply knowledge of orthographic and isometric projections to solve problems related to points, lines, planes, and solids.

CO 4 Develop and model basic engineering components

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	2	3	-	-	-	-	2	-	1	-	-
CO 2	3	3	3	2	3	-	-	-	-	2	-	1	-	-
CO 3	3	3	3	2	3	-	-	1	-	2	-	1	-	-
CO 4	3	3	3	2	3	-	-	1	2	2	-	1	-	-
Average	3	3	3	2	3	-	-	1	2	2	-	1	-	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 02 Lecture Hours

Fundamental of engineering graphics and projection: Principles of Engineering Graphics and their significance, usage of Drawing instruments; Sheet layout, sketching, Lines, Lettering and Dimensioning rules.

Unit II: 04 Lecture Hours

Orthographic Projections: Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Types of planes, Projection of planes parallel to one of the references. Projections of planes inclined to one of the reference planes and perpendicular to the other.

Unit III: 04 Lecture Hours

Projection of solids and section of solids: Introduction and types of solid, Projections of solids in simple positions, inclined to both planes. Introduction and Section of prisms, Pyramids, Cylinder, Spheres, Cones.

Unit IV: 02 Lecture Hours

Isometric projection: Introduction of isometric axes, lines and planes, Isometric drawing of different objects.

Unit V: 02 Lecture Hours

Development of surface and perspective projection: Development of surfaces of right, regular solids – development of prisms, cylinders, pyramids, cones and their parts. Principle of perspective projections, Definition of perspective elements.

Unit VI: 01 Lecture Hours

Computer graphics: Engineering Graphics Software; - Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly;

Textbooks

1. Bhatt, N. D. “Engineering Drawing”, Charol Publication
2. Gill, P. S. “Engineering Drawing”, Kataria Publication
3. Dhawan, R. K. “Engineering Drawing”, S Chand

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	End Sem	Total
Weightage (%)	50	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Digital Logic and Computer Design	0	0	2	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable students, understand codes and logical operations.
2. To enable students understands and realize combinational circuits.
3. To develop understanding of Computer Models, ALU and its usage.
4. To conceptualize the understanding of Control Unit design, Memory, IPC, Control Design.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the operation of fundamental logical circuits and computer architecture.

CO 2 Analyse the combinational circuits.

CO 3 Apply the digital logic for the control and functional unit.

CO 4 Interpret the memory hierarchy and its performance and Interface I/O devices.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	2	-	-	-	-	-	-	-	-	3	2
CO 2	3	3	3	2	-	-	-	-	-	-	-	-	3	2
CO 3	3	3	3	2	-	-	-	-	-	-	-	-	3	2
Average	3	3	3	2	-	-	-	-	-	-	-	-	3	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

Codes and Logic realisation: Weighted & Non-weighted codes, Sequential codes, self-complementing codes, Error correcting code, minimization of SOP and POS expressions, K-Maps, Quine Mc Clusky (Tabulation) Method, Variable Entered Maps, Realizing Logic Function with Gates, Multilevel Universal Gates.

Unit II: **10 Lecture Hours**

Combinational circuit: 4-bit Parallel Binary adder/Subtractor, Look Ahead carry adder, Serial adder, BCD adder. Code converters, Parity bit generator/Checker, Magnitude Comparators. Decoder 2x4, 3 to 8-line decoder, BCD to Seven segment decoder. Encoders: Octal to binary and Decimal to BCD encoder. Multiplexer 2x1, 4x1, 8x1, 16x1 demultiplexers, Multiplexer as Universal Logic Function Generator, Boolean function realization using Multiplexers, Decoder with enable input, Multiplier and Divider

Unit III: **10 Lecture Hours**

Computer Design: Evolution of Computer Systems, Von Neumann Architecture, Moore's Law, Floating point representation, Memory System types, Computer Organization and Design, Instruction Codes, Op-Code, Computer registers, Computer Instructions, CPU stack Organization, Instruction Formats, Instruction types, Timing and control, Instruction and Instruction sequencing, Instruction Cycle, Memory Reference Instructions, Addressing modes, Program Control, Types of Interrupts.

Unit IV: **07 Lecture Hours**

Control Unit Design: Introduction, Instruction Interpretation & Execution, Control Transfer, Fetch Cycle, Micro programmed Control, Control Memory, Micro programmed vs. Hardwired Control Unit, Nano Programming, Superscalar processing.

Unit V: **08 Lecture Hours**

Memory Organization : Memory Locations & Addresses, Semiconductor Memory, Static and Dynamic Memory, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Secondary Memories: Optical Magnetic Tape, Magnetic Disk and Controllers.

Textbooks

1. "Computer System Architecture", 3rd edition, M. Morris Mano, Pearson Publications.
2. Morris M Mano (2001) Digital Design ISBN-13: 978-0130621214

Reference Books

1. Computer Organization and Architecture", Sixth Edition, William Stallings, Pearson Publications.
2. "Fundamental of Digital electronics", second edition, A. Anand Kumar, PHI publications
3. "Computer Organization and Architecture", Third Edition, John P. Hayes, TATA McGraw-Hill.
4. G. K. Kharate (2012) Digital Electronics: Oxford publication, ISBN 13: 780198061830
5. Thomas L. Floyd (2015) Digital Fundamentals, 11th Edition, ISBN-13: 978-0132737968

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Electronics Workshop	2	0	0	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable students, understand the fabrication process of single side and double side PCB.
2. To enable students understands design process of analog circuits.
3. To give students a perspective to design varying duty cycle waveforms.
4. To enable students, acquire knowledge about design of digital circuits.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the fabrication process and continuity test of single side and double side PCB.

CO 2 Design circuits to produce varying duty cycle waveforms using timer IC and operational amplifier

CO 3 Design analog and digital circuits with discrete components with specifications catering to industrial requirements.

CO 4 Design small projects using sensors, logic gates and other discrete components.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	2	2	2	2	-	-	-	2	3	3	2
CO 2	3	2	3	2	2	2	2	-	-	-	2	3	3	2
CO 3	3	2	3	3	2	2	2	-	-	-	2	3	3	2
CO 4	3	2	3	3	2	2	2	-	-	-	2	3	3	2
Average	3	2	3	3	2	2	2	-	-	-	2	3	3	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

List of Experiment

Experiment No. 1

To fabricate single side and double-sided PCB.

Experiment No. 2

To perform continuity test on PCB using multi-meter.

Experiment No. 3

To study and design DC regulated Power Supply.

Experiment No. 4

To study and generate varying duty cycle pulses using 555 Timer IC.

Experiment No. 5

To study and generate triangular and square wave using operational amplifier.

Experiment No. 6

To study and design obstacle detection system using IR sensor.

Experiment No. 7

To study and design digital lock using logic gate IC.

Experiment No. 8

To study and implement digital counter and shift register using flip flops.

Experiment No. 9

To implement seven segment display using logic gate.

Experiment No. 10

To design differential amplifier using transistors.

Textbooks

1. Electronics Devices and Circuits, Boylestad & Nashelsky 10th edition: PEARSON
2. Principle of Electronics, V.K. Mehta & Rohit Mehta 2018, S. Chand
3. Basic Electrical Engineering, V.K. Mehta, 2018, S. Chand.
4. Basic Electronics, Santiram Kal, 2013: PHI
5. Digital Circuits & Logic Design, Salivahanan: Vikas Publishing House.

Reference Books

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Evaluation
Weightage (%)	100

Detailed breakup of Internal Assessment

SEMESTER III

Course Code	Course name	L	T	P	C
	Exploratory 1	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Design Thinking	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

This course aim to inspire the essential element of creativity, the ability to take an abstract idea and create something with it. The course stresses on innovation by creative problem-solving process, keeping humans at the centre.

The objectives of this course are to:

1. Understand human centred design/problem solution
2. explore and apply design thinking process by using tools that are collaborative, innovative and effective
3. Develop a framework for solving complex problems
4. Learning by doing, engaging, exploring and experimenting

Course Outcomes

On completion of this course, the students will be able to

1. Understand the concepts and processes of Design Thinking related to everyday life and human centric solution to problem

2. Recollect concepts necessary for design solutions through objective structured thinking

3. Apply Design Thinking concepts and processes to problem situations faced – professional and personal.

Skills and Attributes:

1. Use a range of basic reflective practice techniques of design thinking through self-reflection, experimentation and exploration
2. Use design thinking process across a wide range of curricular and co-curricular activities at the University and later in a professional/vocational practice
3. Choose and employ appropriate practice tools in the execution of a project/coursework.
4. Critique and articulate responses to group and individual work undertaken by self and by others.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	1	1	-	-	-	-	-	-	1	-	-

CO 2	3	3	2	1	1	-	-	-	-	-	-	1	-	-
CO 3	3	3	2	1	1	-	-	-	-	-	-	1	-	-
CO 4	3	3	2	1	1	-	-	-	-	-	-	1	-	-
Average	3	3	2	1	1	-	-	-	-	-	-	1	-	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

This is a hands-on project driven course that may look to integrate learning from other courses in the students selection of signature courses for identification/problem definition and ideation. The content will be driven more by practice rather than definitive text book-based theory learning. Broadly the areas that will be covered are:

1. Understanding human centred design through identifying needs
2. Interviews and empathy building techniques
3. Observations and insights
4. Definition, dissections and discussions
5. Ideation
6. Prototypes development
7. Experimenting and viability
8. Feedback, critiques and feed forward
9. Solutions and variations

Teaching and Learning

The teaching and learning experience follow a Hybrid blended learning model which incorporates f2f modalities with online learning.

Range of modes of direct contact teaching and learning methods used on this course

1. Large and small group discussions
2. Classroom exercises,
3. Peer critiquing
4. Direct observation
5. Experimentation and reflections

Range of modes of online teaching and learning methods used on this course

Online tutorials (including Coursera courses)

1. Documentation and journaling

2. Reading / reviewing Resources
3. Reading / Reviewing & Commenting - Peer critiquing
4. Writing reflections/ critique

Total contact hours: 30 hours (not including online learning)

Range of modes of other direct teaching and learning methods used on this course

1. Directed reading and research
2. Internet based resources and online prepared resources

Textbooks

Reference Books

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	MEASUREMENT AND INSTRUMENTATION	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Understanding Measurements and Instrumentation.
2. Construction of various measuring Instruments
3. Understanding and application of primary & secondary Sensors.
4. Digital Instrumentation and signal amplifiers / converters.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Demonstrate understanding of basic measurement principles, concepts, and terminology used in instrumentation.

CO 2 Analyze & compare the construction of various measuring Instruments.

CO 3 Apply transducers, sensors and measurement techniques to design and implement experimental setups for various engineering applications.

CO 4 Evaluate and critically assess the selection, calibration, and performance of measurement instruments in specific applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	1	-	1	-	-	-	-	-	-	-	2	2
CO 2	3	2	1	3	-	-	-	-	-	-	-	-	2	2
CO 3	3	2	2	3	2	2	-	-	-	-	-	-	2	2
CO 4	3	2	3	3	1	2	-	-	-	-	-	-	2	2
Average	3	2	1.75	3	1.33	2	-	-	-	-	-	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **14 Lecture Hours**

Measuring Instruments: Classification, Absolute and secondary instruments, indicating instruments, balancing and damping, constructional details, characteristics, errors in measurement, Ammeters, voltmeters: (DC/AC) PMMC, MI, Electrodynamometer type, induction type wattmeter, single phase and three phase wattmeter, compensation, Energy meters: AC. Induction type single phase and three phase energy meter, compensation, creep, error, testing, Frequency Meters: Vibrating reed type, electrical resonance type, Power Factor Meter.

Unit II: 08 Lecture Hours

Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications.

Galvanometers: General principle and performance equations of D' Arsonval Galvanometers, Vibration Galvanometer and Ballistic Galvanometer.

Unit III: 14 Lecture Hours

DC/AC Bridges: General equations for bridge balance, measurement of self-inductance by Maxwell's bridge, Hay's bridge, Owen's bridge, measurement of capacitance by Schering bridge, errors, Wagner's earthing device, Kelvin's double bridge.

Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Torque meters, inductive torque transducers, electric tachometers, photo-electric tachometers, Hall Effect Transducer, Flow meters.

Unit IV: 09 Lecture Hours

Sensor: Primary Sensors, Secondary Sensors, Sensor communication protocols, IOT, SCADA,

Digital Meters: Electronic Voltmeter: Transistor Voltmeter, Digital Frequency meter: Digital ammeter, Digital Ohm Meter. Digital Multi-meter, Accuracy of measurement,

Textbooks

1. A Course in Elec. & Electronics Measurements & Instrumentation: A K. Sawhney
2. Modern Electronic Instrumentation and Measurement Techniques: Helfrick & Cooper
3. Electrical Measurement and Measuring Instruments - Golding & Wadis

Reference Books

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill International Edition.
2. Golding EW and Wides FC, Electrical Measurements and Measuring Instruments, Wheeler Publications.
3. BC Nakra and KK Chowdary, Instrumentation Measurement and Analysis, TMH, New Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Analog Electronics II	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To help the learners to develop the ability to design the feedback amplifiers.
2. To enable students to design the amplifiers circuits using OP- Amps, used in biomedical application.
3. To give students a perspective to appreciate the importance of timer ICs and regulators.
4. To enable students acquire knowledge required for develop small hardware circuits for some application like power supply design etc.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the concept of feedback circuits.

CO 2 Apply the concept of feedback in amplifiers and oscillators

CO 3 Analyse the operations of different ICs used in analog circuits.

CO 4 Design and implementation of circuits with the help of operational amplifiers for different applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	3	2	1	-	-	-	-	-	3	2	2
CO 2	3	3	3	3	2	1	-	-	-	-	-	3	2	2
CO 3	3	3	3	3	2	1	-	-	-	-	-	3	2	2
Average	3	3	3	3	2	1	-	-	-	-	-	3	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 08 Lecture Hours

Feedback Amplifiers: Principle of Feedback Amplifier, Positive and Negative Feedback, Properties of Negative Feedback, Amplifier Topologies, Negative Feedback Types: Voltage

series, Voltage Shunt, Current series, Current Shunt, Advantage of Negative Feedback, Ideal Feedback amplifier, Effect of feedback on amplifier Bandwidth and stability.

Unit II: **06 Lecture Hours**

Oscillators: Sinusoidal oscillator: Phase shift oscillators, Wien Bridge oscillator: Resonant circuit oscillators: LC Colpitt & LC Hartley, Amplitude Frequency and phase stability analysis of all Oscillators, Crystal oscillator.

Unit III: **10 Lecture Hours**

Operational Amplifiers and its Application: Ideal op-amp characteristics, 741 op-amp IC Specification, Inverting and Non Inverting amplifier, OP-amp as adder, Subtractor, Differentiator, Integrator Circuit, Differential Amplifier, Active load, Level Shifter, Current Mirror, I-V and V-I Conversion(CCVS, VCCS, VCVS), Peak detector, Comparator circuit, Sample and Hold Circuit, Schmitt Trigger, Precision rectifier, Signal Generator: Square Wave Generator, Pulse Generator, Triangular Wave Generator, Saw Tooth Wave generator, Instrumentation Amplifier, Log and Antilog Amplifier, Active Filters: Introduction to filtering: Frequency response, Characteristics and terminology, Active versus passive filter, first and Second order low pass active filter, Higher order filters. High pass active filter, Band pass filter, Band reject filter, higher order filters.

Unit IV: **15 Lecture Hours**

Applications of Op-Amp: Timer and Regulator: IC-555 Timer, Internal Circuit, IC-555 Timer as A stable Multivibrator and Monostable Multivibrator Voltage Regulators: OP-AMP Regulators, IC Regulators, Fixed Voltage Regulators (78/79, XX), 723, Characteristics and Applications, SMPS.

Analog and Digital interface circuits: A/D, D/A Converters and types, S/H circuits and multiplexers and demultiplexers Switches, OTA, 556 PLL IC, PLL Fundamentals, PLL Applications.

Unit V: **06 Lecture Hours**

Power Amplifiers: Power Amplifiers: Harmonic Distortion in Amplifiers, Power Amplifiers and types, Voltage verses Power Amplifier, Class A, B, AB, C, Push Pull Amplifiers

Textbooks

1. Robert L. Boylestad, Louis Nashelsky (2009) Electronics Devices & Circuits, Pearson-R.L Boylstad. ISBN: 978-8131727003.

Reference Books

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer (2017) Analysis and Design of Analog Integrated Circuits, Wiley. ISBN:978-1118078891.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Signal and Systems	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To help the learners develop the ability to understand signal classification.
2. To enable students analyse continuous and discrete time signals.
3. To give the students a perspective to appreciate the role of various mathematical transforms.
4. To enable students acquire understanding of linear time invariant system.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand different types of signals and systems.

CO 2 Analyse continuous and discrete time signals and systems through Fourier transform

CO 3 Interpret continuous and discrete time signals and systems through Laplace and Z-transform.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	2	1	-	-	-	-	-	-	3	2	2
CO 2	3	3	2	2	1	-	-	-	-	-	-	3	2	2
CO 3	3	3	2	2	1	-	-	-	-	-	-	3	2	2
Average	3	3	2	2	1	-	-	-	-	-	-	3	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 09 Lecture Hours

Definition and classification of signals: Continuous and Discrete Time Signals, Periodic & Non-periodic Signal, Deterministic and Random Signals, Energy & Power Signals, Analog and Digital Signals: sUnit step, Unit Ramp, Unit Impulse signal, Exponential signal, Sinusoidal signal, Even & Odd signal, Classifications of Systems: Linear & Non-linear, Stable & Unstable.

Static (Memory less) & Dynamic (Memory), Causal & Non-causal, Time invariant & Time variant, Invertible and Non-Invertible Systems. Discrete Time systems: Adder, Constant multiplier, Signal multiplier, Unit delay block, Unit advance block.

Unit II: **07 Lecture Hours**

Continuous time Fourier transform: Fourier series representation of Periodic signals, Representation of Fourier series in Exponential form, Frequency spectrum, Properties of Continuous time Fourier series, Parseval's theorem, Continuous Time Fourier Transform (CTFT), Magnitude and Phase spectrum, Properties and Theorems of CTFT, Energy and Power Spectral Density, Fourier transform of some common functions, convolution Integral, Hilbert transform.

Unit III: **09 Lecture Hours**

Discrete time Fourier transform: Fourier transform representation of aperiodic discrete time signals, Periodicity of DTFT, Properties of DTFT, Fourier transform of periodic signals, Signal transmission through LTI System, Ideal and Practical filters, Energy spectral Density, Power Spectral Density, Sampling Theorem and Proof, Signal Reconstruction and Concept of Aliasing Application of signal and system in communication.

Unit IV: **10 Lecture Hours**

Linear time invariant continuous time system and analysis: Transfer function and Impulse response, Block diagram representation and Reduction technique, Convolution integral, State variable techniques, State equations for Electrical networks, State equations from transfer functions. Properties of LTI systems. Analysis of first order and second order systems, continuous-time system analysis using LT, system functions of CT systems, poles and zeros, Frequency Response, First Order ad Second order continuous time system.

Unit V: **10 Lecture Hours**

Laplace and Z Transform: Introduction to Laplace Transform, Region of Convergence, Existence of Laplace Transform, Unilateral and Bilateral Laplace Transform, Relation between Fourier and Laplace Transform, Laplace transform of commonly used signals, Properties of Laplace Transform, Inversion of Unilateral and Bilateral Laplace Transform, Solution of Differential Equations using Laplace Transform, Introduction to Z Transform, One sided, Two Sided, Bilateral, Region of Convergence, Z Transform Properties and Theorems, Z Transform of some common signals, Inverse Z Transform, Solution of difference equations using one-sided Z Transform, s- to z-plane mapping, Analysis and Characterization of LTI System using Laplace and Z Transform.

Textbooks

1. Oppenheim, A. V., Willsky, A. S., & Hamid, S. (1997). Signals and Systems, (2nd Edition). Prentice-Hall, ISBN-13: 978-0138147570.
2. Lathi, B. P. (2009). Principles of Linear Systems. Oxford University Press, ISBN 13: 9780198062271.

Reference Books

1. Kumar, A. (2013). Signals and Systems, PHI Learning Pvt. Ltd, ISBN 13: 9788122436273.
2. Hsu, H. P. Schaum's Outlines of Signals and Systems. (1995). McGraw-Hill, ISBN: 0-07-030641-9.
3. Roberts, M. J. (2008) Fundamentals of Signals and Systems, McGraw hill Edition, ISBN-13: 978-0073309507.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	NETWORK THEORY	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Identify active and passive components in the circuit and solve Network Theorems.
2. Design reciprocal and symmetrical network in Two Port Network and compute response of network functions using Laplace transform.
3. Apply graph theory to solve the branch currents, branch voltages and node voltages for a given circuit.
4. Design Network using synthesis based on passive element.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Reduce the circuit complexity by applying the theorems to solve the network.

CO 2 Apply graph algorithms and mathematical methods to analyze network structures and properties.

CO 3 Analyse the networks behaviour in time domain, frequency domain and calculate the stability.

CO 4 Design the passive filters and attenuators.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO 2	3	3	3	2	-	1	-	-	-	-	-	-	2	2
CO 3	-	3	3	1	-	1	-	-	-	-	-	-	2	2
CO 4	3		3	2	-	1	-	-	-	-	-	-	3	3
Average	3	3	3	1.75	-	1	-	-	-	-	-	1	2.25	2.25

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **05 Lecture Hours**

Network Theorems: Nodal analysis, Milliman Theorem, Tellegan theorem, Reciprocity Theorem, Transient response.

Unit II: 08 Lecture Hours

Network Graph Theory: Introduction, Concept of Network Graph, Terminology Used in Network Graph, Properties of Tree in a Graph, Formation of Incidence Matrix, Properties of Incidence Matrix, Number of Tree in a Graph, Fundamental Cut set Matrix and its properties, Fundamental tie set Matrix and its properties.

Unit III: 08 Lecture Hours

Network functions: Introduction, Driving Point Impedance and Admittance Transfer function, Voltage and Current Transfer Ratio, concepts of pole and zeros, time domain analysis using pole zero diagram, Concept of Stability of a System from Pole Zero Concept, Necessary condition of Stability of a Network Function, Hurwitz Polynomial, Properties of Hurwitz Polynomials,

Unit IV: 12 Lecture Hours

Two Port Networks: Introduction of z parameters, y parameters, hybrid (h) parameter, ABCD parameters, condition of reciprocity and symmetry in two-port parameter presentation, conversion of parameters like ABCD to h etc., Interrelationship between parameters of two port networks, Expression of input and output impedance in terms of two port parameter, ladder network, lattice network, Image impedance.

Unit V: 12 Lecture Hours

Synthesis of Passive Networks: Positive Real Function, Concept and properties of LC, RC and RL network, Network Synthesis by Foster form I and II and Cauer form I and II, Filters-Introduction to passive filters, classification of filters, constant K and m-derived filters like LPF, HPF, Band pass filter and stop band filter.

Textbooks

1. S P Ghosh, A K Chakraborty “Network Analysis and Synthesis”, McGraw Hill Education (India) Private Limited., 2013, ISBN (13):978-0-07-014478-1.
2. Hayt W. H., Kemmerly J. E. and Durbin S. M., “Engineering Circuit Analysis”, 6th Ed., Tata McGraw-Hill Publishing Company Ltd.,2008

Reference Books

1. Kuo F. F., “Network Analysis and Synthesis”, 2nd Ed., Wiley India. 2008.
2. A Sudhakar and Shyammohan S Palli, “Circuits & Networks: Analysis and Synthesis”, 3rd ed., Tata McGraw-Hill, 2007.
3. Narsingh Deo (2006) Graph Theory, PHI Learning. ISBN: 9788120301450
4. B.R. Gupta & Dana Singhal (2005) Fundamentals of Electrical Networks, S. Chand. ISBN : 978- 8121923187

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Social Internship	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Analog Electronics II Lab	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To help the learners to develop the ability to design the amplifiers circuits.
2. To enable students to design the circuits and use them in real time applications.
3. To give students a perspective to appreciate the importance of transistors (BJT, FET & MOSFET).
4. To enable students acquire knowledge required for develop hardware of real time embedded systems.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the basic circuits for different applications.

CO 2 Analyze the small signal parameters of the electronics circuit.

CO 3 Design the electronics circuits as per prescribed applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	2	1	-	-	-	-	-	-	3	3	3
CO 2	3	3	3	2	1	-	-	-	-	-	-	3	3	3
CO 3	3	3	3	2	1	-	-	-	-	-	-	3	3	3
Average	3	3	3	2	1	-	-	-	-	-	-	3	3	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

List of Experiment

Experiment No. 1

To Study and design constant DC power supply circuit using voltage Regulator ICs.

Experiment No. 2

To study the use of different types Variable Voltage Regulator IC.

Experiment No. 3

To study the input and output characteristics of a transistor in Common Emitter (BJT) configuration and to calculate Hybrid model (h) the parameters.

Experiment No. 4

To study the frequency response and to determine the voltage gain and bandwidth for Common Emitter Amplifier

Experiment No. 5

To study Transfer (Ids, Vgs) and Output Characteristics (Ids, Vds) of Junction Field Effect Transistor (JFET).

Experiment No. 6

To study transfer and output characteristics of an n-channel Metal Oxide Semiconductor field effect Transistor (MOSFET) in Common-source configuration

Experiment No. 7

To study the input and output characteristics of a transistor in Common Source (FET) configuration and to calculate Hybrid model (h) the parameters.

Experiment No. 8

To Design Common Source (FET) Amplifier and to determine its frequency response, voltage gain and bandwidth of the configuration.

Experiment No. 9

To Design RC Coupled amplifier and to determine the frequency response, voltage gain and bandwidth of the cascaded BJT configuration.

Experiment No. 10

To Design RC Coupled amplifier and to determine the frequency response, voltage gain and bandwidth of the cascaded FET configuration.

Textbooks

1. Boylestad, Louis Nashelsky (2009) Electronics Devices & Circuits, Pearson- R.L Boylestad. ISBN: 978-8131727003.

Reference Books

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer (2017) Analysis and Design of Analog Integrated Circuits, Wiley. ISBN:978-1118078891.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Evaluation
Weightage (%)	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Simulation Design I	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

SEMESTER IV

Course Code	Course name	L	T	P	C
	Working with Data	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Exploratory 2	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Electromagnetic Field Theory	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To introduce students with different coordinate systems.
2. To familiarize the students with the different concepts of electrostatic, magneto static and time varying electromagnetic systems.
3. To expose the students to the ideas of electromagnetic waves and structure of transmission line.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Define and recognize different co-ordinate systems to describe the spatial variations of the physical quantities dealt in electromagnetic field theory as they are functions of space and time. Apply different techniques of vector calculus to understand different concepts of Electromagnetic field theory.

CO 2 Explain fundamental laws governing electromagnetic fields and evaluate the physical quantities of electromagnetic fields (Field intensity, Flux density etc.) in different media using the fundamental laws.

CO 3 Determine the electromagnetic force exerted on charged particles, current elements, working principle of various electric and electromagnetic energy conversion devices are based on this force.

CO 4 Design electromagnetic energy storage devices like capacitor, inductor which are frequently used in electrical systems and choose suitable materials required to assemble such electromagnetic energy storage devices

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	-	-	2	-	-	-	-	-	-	-	2	-
CO 2	2	2	-	-	2	-	-	-	-	-	-	-	2	-
CO 3	2	3	-	-	3	-	-	-	-	-	-	-	2	-
CO 4	2	3	-	-	2	-	-	-	-	-	-	-	3	-
Average	2.25	2.5	-	-	2.25	-	-	-	-	-	-	-	2.25	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 12 Lecture Hours

Review of Vector Calculus: Vector algebra -Addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus-differentiation, partial differentiation, integration, vector operator Del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another. Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material, Propagation in good conductors, Skin effect.

Unit II: 12 Lecture Hours

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

Unit III: 8 Lecture Hours

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

Unit IV: 5 Lecture Hours

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

Unit V: 8 Lecture Hours

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

Textbooks

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
5. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
6. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.

7. E. G. Cullwick, “The Fundamentals of Electromagnetism”, Cambridge University Press, 1966.
8. B. D. Popovic, “Introductory Engineering Electromagnetics”, Addison-Wesley Educational Publishers, International Edition, 1971.
9. W. Hayt, “Engineering Electromagnetics”, McGraw Hill Education, 2012.

Reference Books

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

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Digital System Design	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

4. To enable students, understand flipflops and sequential circuits.
5. To enable students, understand and realize state machines.
6. To give the students a perspective to design algorithmic state machine.
7. To enable students, acquire knowledge about logic families.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the fundamentals of sequential circuits, state machines and logic families.

CO 2 Analyze synchronous/asynchronous state machines and ASM chart.

CO 3 Design synchronous/asynchronous state machines and ASM chart

CO 4 Design various logic circuits with the different logic families.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	2	2	-	-	-	-	-	-	3	2	3
CO 2	3	3	3	2	2	-	-	-	-	-	-	3	3	3
CO 3	3	3	3	2	2	-	-	-	-	-	-	3	3	3
CO 4	3	3	3	2	2	-	-	-	-	-	-	3	3	3
Average	3	3	3	2	2	-	-	-	-	-	-	3	3	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 12 Lecture Hours

Sequential Circuits- Difference between Combinational and Sequential circuits, Latch and Flip Flop, Flip Flop types & Timing diagram: S-R Latch, Gated S-R Latch, D Latch, D Flip Flop, J-K Flip-Flop, T Flip-Flip: Edge Triggered S-R, D, J-K and T Flips-Flops, Master - Slave Flip-Flops, race around condition of Master JK Flip Flop, FFs Characteristics equation and excitation tables, Flip Flops Conversions, State assignment, State table, State reduction and analysis, Design by Flip Flops. Counters: types and logic realisation, Registers, Universal Shift register

Unit II: 13 Lecture Hours

State Machines: The Need for State Machines, The State Machine, Basic Concepts in State Machine Analysis. Synchronous State Machine Design, Sequential Counters, State Changes Referenced to Clock, Number of State Flip-Flops, Input Forming Logic, Output Forming Logic, Generation of a State Diagram from a Timing Chart, Redundant States, General State Machine Architecture Asynchronous State Machines: The Fundamental-Mode Model, Problems of Asynchronous Circuits Basic Design Principles, An Asynchronous Design Example.

Unit III: 10 Lecture Hours

Algorithmic state machines: Introduction, data section and control section of a digital systems, state box, decision box, conditional box, ASM block, examples, Realization of ASM chart, traditional synthesis, Multiplexer controller method, Examples.

Unit IV: 10 Lecture Hours

Logic Families: Transistor-Transistor Logic (TTL), Emitter-Coupled Logic (ECL), NMOS, PMOS, CMOS, MOSFET Logic, TTL Gates. Programmable Logic Devices: Introduction to Programmable Logic Devices, Read-Only Memory, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), Combinational PLD-Based State Machines, State Machines on a Chip, FPGAs.

Textbooks

10. Morris M Mano (2001) Digital Design ISBN-13: 978-0130621214.

Reference Books

1. G. K. Kharate (2012) Digital Electronics: Oxford publication, ISBN 13: 780198061830
2. Thomas L. Floyd (2015) Digital Fundamentals, 11th Edition, ISBN-13: 978-0132737968

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	CONTROL SYSTEM ENGINEERING	3	1	0	4
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable student for developing modelling of various physical system.
2. To enable students' transient response analysis of the system behaviour.
3. To enable students' frequency response analysis of the system behaviour.
4. To enable students control system component details and its real time applications.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the essential control system basics, including stability, controllability, and observability.

CO 2 Comprehend the relationship between control system design specifications, such as performance criteria and stability requirements.

CO 3 Analyze the behaviour of closed loop systems using tools such as root locus, Routh Hurwitz, Bode, Nyquist, and Matlab for the stability analyses of the system.

CO 4 Design controllers using classical PID methods, root locus methods, and frequency domain methods and determine the response.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	3	1	1	1	-	-	-	-	-	-	1	2	2
CO 2	3	3	2	1	1	-	-	-	-	-	-	1	2	2
CO 3	3	3	2	1	1	-	-	-	-	-	-	1	2	2
CO 4	3	3	2	2	2	-	-	-	-	-	-	2	2	2
Average	3	3	1.75	1.5	1.5	-	-	-	-	-	-	1.5	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 09 Lecture Hours

Control system modelling - System concept, differential equations and transfer functions. Modeling of electric systems, translational and rotational mechanical systems, and Simple electromechanical systems. Block diagram representation of systems – Block diagram reduction methods – Closed loop transfer function, determination of signal flow graph. Mason's gain formula Examples.

Unit II: 08 Lecture Hours

Time domain analysis - Test signals – time response of first order and second order systems – time domain specifications – types and order of systems – generalized error co-efficient – steady state errors – concepts of stability – Routh-Hurwitz stability – root locus.

Unit III: 10 Lecture Hours

Frequency domain anlysis- Introduction – correlation between time and frequency response – stability analysis using Bode plots, Polar plots, and Nyquist stability criterion – Gain margin – phase margin.

Unit IV: 12 Lecture Hours

Compensators - Realization of basic compensators – cascade compensation in time domain and frequency domain and feedback compensation – design of lag, lead, lag-lead compensator using Bode plot and Root locus. Introduction to P, PI and PID controllers.

Unit V: 06 Lecture Hours

Control system components and application of control systems- Stepper motors – AC servo motor – DC servo motor – Synchros – sensors and encoders – DC tacho generator – AC tacho generator – Hydraulic controller – Pneumatic controller – Typical application of control system in industry

Textbooks

1. M. Gopal (2012), Control Systems: Principles and Design | 4th Edition, McGraw hill, ISBN: 978-0071333269.
2. N.S. Nise (2006), Control Systems Engineering; Wiley publications, ISBN: 10: 0470917695
3. B.C. Kuo (2009),Automatic Control System, PHI, ISBN: 10: 0470048964

Reference Books

4. Ogata (2009), Modern Control Engineering, ISBN: 10: 0136156738
5. D. Johnson (2006) Process control instrumentation technology, PHI, ISBN: 10: 8120330293

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	20	30	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Communication Systems	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To understand the basic building blocks of the analog and digital communication system.
2. To analyze the signal flow/ characteristics of the modulated signals with different types of analog and digital modulation techniques.
3. To analyze error performance of analog and digital communication systems in presence of noise and other interferences.
4. To introduce the concept of information theory, the fundamentals of error control coding techniques, and their applications.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand different analog and digital modulation techniques.

CO 2 Analyse the performance of the analog communication and digital transmission processes and coding techniques.

CO 3 Analyse the performance of a digital pass band modulation schemes.

CO 4 Apply the knowledge of information theory and coding in digital communication systems.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	3	1	-	-	-	-	-	-	3	2	2
CO 2	3	3	2	2	1	-	-	-	-	-	-	3	3	3
CO 3	3	3	2	3	1	-	-	-	-	-	-	3	3	3
CO 4	3	3	2	2	1	-	-	-	-	-	-	3	3	3
Average	3	3	2	2	1	-	-	-	-	-	-	3	3	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

Analog Communication techniques: Basic elements of Communication system, Need for modulation, Baseband and Passband signals, Analog Modulation Techniques, Modulators and demodulators of AM and FM. Angle Modulation: Frequency Modulation (FM) and Phase Modulation (PM), AM Radio Broadcasting, FM Radio Broadcasting, Television Broadcasting.

Unit II: 14 Lecture Hours

Digital Transmission Techniques: Sampling process- Sampling theorem, Spectrum of Sampled Signal, Aliasing, Nyquist Criterion, Signal Reconstruction from Sampled Signal. Pulse Code Modulation (PCM)- Sampler, quantizer, encoder; Noise considerations in PCM, Companding- A-Law and μ -Law; DPCM; Delta modulation, Adaptive Delta modulation; Line codes- RZ, NRZ, Bipolar, Unipolar, Machester coding, AMI and other codes; Typical multiplexed systems-Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM); Inter Symbol Interference (ISI), Eye diagram.

Unit III: 14 Lecture Hours

Digital Modulation Techniques: Baseband Transmission of Digital Data; Digital bandpass modulation techniques- Binary ASK, PSK, and FSK, Differential PSK, QPSK, MSK, M-Ary PSK, M-ary QAM; Signal constellation, Signalling over AWGN Channels; Optimum Filter, Matched Filter Optimum Receivers Using Coherent Detection; Probability of Error; optimal detection and Error Probabilities of Various digital modulation Techniques Equalization principles:

Unit IV: 07 Lecture Hours

Information Theory and coding: Mathematical models for information sources, Source-coding Theorem, Variable-Length Source Coding, The Huffman Coding Algorithm, Block codes, Cyclic codes, Convolutional codes, Viterbi decoding.

Textbooks

1. Taub, Schilling, Guha (2013) “Principle of Communication Systems”, McGraw Hill Publication. ISBN: 9781259029851.

Reference Books

1. Simon Haykin & Michael Moher “Communication Systems”, 4th Edition, Wiley India Publication
2. J. G. Proakis and Masoud Salehi “Fundamentals of Communication Systems”, Prentice Hall, 2008, ISBN: 978-81-317-0573-5
3. B.P. Lathi, Zhi Ding, “Modern Digital and Analog Communication Systems (4/e)”, Oxford university Press, 2010, ISBN: 0195384938, 9780195384932.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Digital System Design Lab	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To help the learners to develop the ability to design the digital logic gates.
2. To enable students to design the combinational digital circuits using Multiplexer, Demultiplexer, decoder and encoder.
3. To give students a perspective to appreciate the importance of sequential circuits such as flip flops, counters and registers.
4. To enable students acquire knowledge required for develop small hardware circuits for some application like decade counter, shift register to scroll the data and basic and universal gates operation using logic families.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the behaviour of a digital logic circuits and their ICs.

CO 2 Analyze the combinational circuits and relate its applications.

CO 3 Design the sequential circuits such as flip slops, registers, counters.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	3	3	1	-	-	-	-	-	-	3	2	2
CO 2	3	2	3	3	1	-	-	-	-	-	-	3	2	2
CO 3	3	2	3	3	1	-	-	-	-	-	-	3	2	2
Average	3	2	3	3	1	-	-	-	-	-	-	3	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

List of Experiment

Experiment No. 1

Implementation of AND, OR, NOT Gate using NAND & NOR (Universal gates).

Experiment No. 2

Implementation of half and full adder digital circuits.

Experiment No. 3

Implementation of half and full subtractor digital circuits.

Experiment No. 4

Study of basic Flip-Flop's (RS and SR) using NAND (7400) and NOR GATES (7402).

Experiment No. 5

Study of basic Flip-Flop's (RS and SR) using NAND (7400) and NOR GATES (7402).

Experiment No. 6

Design Code Convertors- (i) Binary to Gray (ii) Gray to Binary

Experiment No. 7

Design Code Convertors- (i)-BCD to Excess-3 (ii)- Excess-3 to BCD

Experiment No. 8

To Design and Implement Encoder and Decoder using logic gates and study of IC 7445 and IC 74147.

Experiment No. 9

To design and implement 3 bit synchronous up/down counter.

Experiment No. 10

To design and implementation of universal shift register using 74LS194/195 IC

Textbooks

1. Morris M Mano (2001) Digital Design ISBN-13: 978-0130621214

Reference Books

1. G. K. Kharate (2012) Digital Electronics: Oxford publication, ISBN 13: 780198061830.
2. Thomas L. Floyd (2015) Digital Fundamentals, 11th Edition ISBN-13: 978-0132737968.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Evaluation
Weightage (%)	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Control System Lab	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Simulation Design I	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

SEMESTER V

Course Code	Course name	L	T	P	C
	Technolologies of Future/Meta 101	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Leadership and Teamwork	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Formulate and articulate a personal point of view about the meaning of leadership and teamwork, and why they are important.
2. Explore and appreciate the scope of leadership and teamwork in one's day to day life. Understand the concepts of effective leadership and teamwork in organizations.
3. Identify and assess the skills and motivations associated with effective leadership and teamwork.
4. Improve effective communications in groups and manage team conflict to resolve issues. Learn how to perform in teams to achieve results on personal and professional levels.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Employ electronic and electrical components and devices to solve the Engineering problems.

CO 2 Analyze and make simple circuits and systems of Electrical and Electronics Engineering.

CO 3 Design the electrical system with discrete components and to understand the specifications of industrial equipment.

CO 4 Design the electronics system with discrete components and to understand the specifications of industrial equipment.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO 2	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO 3	-	-	-	-	-	-	-	3	3	3	-	3	-	-
CO 4	-	-	-	-	-	-	-	-	-	3	-	3	-	-
Average	-	-	-	-	-	-	-	-	-	3	-	3	-	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**

3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **12 Lecture Hours**

Leadership: Introduction, Self-Awareness & Leadership Examples: Introduction to the Course, Importance and Its Application in Life, Self-Awareness and Leadership Examples from Different Walks of Life, Personality Assessment through (i) BIG 5, (ii) MBTI.

Unit II: **08 Lecture Hours**

Introduction to Machine Learning: Introduction to machine learning. Types of machine learning: unsupervised learning, supervised learning, and reinforcement learning, Gradient descent algorithm. Aspects of developing a learning system: training data, concept representation, function approximation.

Unit III: **08 Lecture Hours**

Supervised Machine Learning: Regression: Linear regression with one variable, model representation, ordinary least square algorithm, definition of cost function, Regularized Linear Regression. Multivariate Regression.

Classification: Logistic regression: classification, hypothesis representation and decision boundary. Regularized Logistic Regression. Support Vector Machines, k-Nearest Neighbour algorithm, Decision Trees and Random Forest algorithm. Naive Bayes Classifier.

Unit IV: **07 Lecture Hours**

Unsupervised Machine Learning: Introduction to unsupervised learning. Random initialization and clustering. K-means clustering algorithm, Hierarchical Clustering, Density based clustering, Case Studies. Principles of self-organization, Principal Component Analysis Algorithm. Data Compression and its reconstruction. Application of Principal Component Analysis.

Unit V: **10 Lecture Hours**

Artificial Neural Networks: Introduction to Neural Network, Model of a neuron and human brain. Network Architecture, Model representation, Perceptron, Single layer Perceptron and Multi-layer perceptron, Backpropagation Algorithm, XOR problem, Radial Basis function neural network.

Textbooks

1. Python: The Complete Reference, Martin C. Brow, TMH.
2. Machine Learning, Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, First Edition, Pearson, 2018.
3. Python Machine Learning Cookbook, Practical Solutions from Preprocessing to Deep Learning, Chris Albon, O'Reilly, 2018.

Reference Books

1. Introduction to Machine Learning, Ethem Alpaydin, Third Edition, MIT Press, 2014.

2. Python Machine Learning, Machine Learning and Deep Learning with Python, scikit-learn and Tensor flow, Sebastian Raschka, Vahid Mirjalili, Second Edition, Packt, 2015.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	20	30	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Exploratory 3	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Electrical Machines	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To give exposure about the magnetic circuits, & electromagnetic energy conversion principles and study details of transformers, DC & AC machines, including their constructional features, principle of operation and performance analysis.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the concepts of magnetic circuits & electromagnetic energy conversion principles and classify electrical machines i.e., static machine (transformer) and all DC & AC rotating machines (Generators and Motors).

CO 2 Analyse the working of DC & AC machines and their no-load/load characteristics along with application areas.

CO 3 Estimate the starting, running and speed-torque characteristic along with application areas and predict the performance by various testing methods.

CO 4 Examine the performance of machine and testing of the transformers and machines.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	2	1	1	1	1	-	-	-	-	-	-	1	1
CO 2	2	2	-	2	-	-	1	-	-	-	1	-	2	2
CO 3	2	-	-	-	-	1	2	-	-	-	2	-	2	2
CO 4	1	-	-	2	1	-	1	-	-	-	1	-	1	1
Average	1.5	2	1	1.66	1	1	1.33	-	-	-	1.33	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **07 Lecture Hours**

Magnetic Circuits and Magnetic Materials: Magnetic circuits –laws governing magnetic circuits - flux linkage, inductance, and energy – statically and dynamically induced emf - torque – properties of magnetic materials, hysteresis, and eddy current losses - ac excitation, introduction to permanent magnets - transformer as a magnetically coupled circuit.

Unit II: 08 Lecture Hours

Energy Conversion and Concepts in Rotating Machines: Energy in magnetic system – field energy and co energy-force and torque equations – singly and multiply excited magnetic field systems-mmf of distributed windings – winding inductances-, magnetic fields in rotating machines – rotating mmf waves – magnetic saturation and leakage fluxes.

Unit III: 10 Lecture Hours

DC Machines: Regression: Construction and components of DC Machine – Principle of operation - Lap and wave windings EMF equations. Types of field excitations - separately excited, shunt and series, circuit model, Armature reaction and Compensations - commutation and inter pole, Voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. DC motor starters speed control of DC shunt, series and compound motors, Losses, efficiency and testing of DC machines - Swinburne's - Hopkinson's - retardation - Field Test etc., Braking.

Unit IV: 10 Lecture Hours

Transformers: Principle, construction and operation of single-phase & three-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses, Open delta or V – V connection, Scott connection or T-T connection, Autotransformers - construction, principle, applications and comparison with two winding transformer, Parallel operation of transformers ,Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers, Cooling of transformers.

Unit V: 10 Lecture Hours

Three Phase Induction Machines: Construction, Types (squirrel cage and slipring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses, and Efficiency, Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency), Starting and speed control (with and without e.m.f. injection in the rotor circuit), deep bar and double cage induction motors, cogging and crawling, braking, generator operation, self-excitation.

Textbooks

1. Electric Machinery by P.S. Bhimbra, Khanna Publications 7th edition.
2. Electric Machines by I.J. Nagrath & D.P. Kothari, Tata Mc Graw - Hill Publishers.
3. Electric Machinery, Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, Sixth edition, Tata McGraw Hill Books Company, 2003.

Reference Books

1. Performance and design of DC Machines, A. E. Clayton and N. N. Hancock, CBS Publishers, 2004.

2. Electrical Machines Theory and Practice, M. N. Bandyopadhyay, PHI Learning Pvt Ltd., New Delhi, 2009.
3. Electrical Technology volume II", Theraja B. L; Theraja A.K., S.Chand , 2006.
4. Theory & Performance of Electric Machines, by J. B. Gupta, S.K. Kataria & Sons.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Microprocessors and Microcontrollers	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To develop understanding of microprocessor and microprocessor-based system.
2. To develop understanding of microcontroller and microcontroller-based system.
3. To give the students an experimental approach to implement the microprocessor/ microcontroller-based systems.
4. Analyze the data transfer information through serial & parallel ports in microprocessor/ microcontrollers.
5. Build a real time embedded system

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the fundamentals of microprocessors and microcontrollers.

CO 2 Build the program for microprocessors and microcontrollers using assembly and embedded C language.

CO 3 Interface different input-output peripherals with microprocessor and microcontroller.

CO 4 Analyse the performance of advanced microcontroller-based system.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	1	3	3	3	-	-	-	-	-	2	3	2	2
CO 2	2	2	3	2	3	-	-	-	-	-	2	3	2	1
CO 3	2	2	3	3	1	-	-	-	-	-	1	3	2	1
CO 4	1	2	3	3	3	-	-	-	-	-	2	3	2	3
Average	2	2	3	3	3	-	-	-	-	-	2	1	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 6 Lecture Hours

Microprocessor Fundamentals: Introduction to Microprocessors, Origins of Microprocessors, Timeline of Microprocessors evolution, classification of microprocessors, types of memory, introduction to interfacing devices, applications of microprocessors, programming languages for microprocessors, Von Neumann and Harvard Architecture, Internal Bus Organization, Control signals.

Unit II: 12 Lecture Hours

8085 and 8086 Microprocessor: Architecture of 8085, Pin Configuration and Function; Internal Register & Flag Register, Generation of Control Signals Bus Timings: Demultiplexing of Address /Data Bus; Fetch Cycle, Execute Cycle, Instruction Cycle, Timing Diagram. Instructions for 8085 microprocessors, Operation: Machine Cycle Concept; Addressing Modes, Memory organization and Mapping, Interrupts in 8085. Architecture and Pin Configuration of 8086, Instruction types, Assembler Directives and Operators.

Unit III: 10 Lecture Hours

8051 Microcontroller: 8051 Microcontrollers and Family, Pin Configuration of 8051, 89C52RD2. Instruction Set of 8051: Assembly Language Programming, Internal Structure of 8051, Power resetting, built up RAM & ROM, I/O Programming and Addressing Modes. Counter and Timer details: Counter and Timer Programming using 8051, Interrupt Programming, Types of interrupts, Embedded 'C' Programming

Unit IV: 10 Lecture Hours

Peripherals & Interfacing: Architecture, Pin Diagram and functioning of 8155/8156 (RAM), 8355/8755 (ROM), 8255 (PPI). Simple Programs like Initialization and I/O Operations of the Ports, Programmable Internal Timer 8253/8254: Block Diagram, Pin Configuration, Modes, Initialization of Keyboard and Display Interface (8279), USART (8251).

Unit V: 7 Lecture Hours

ARM Microcontrollers: Architecture of ARM Cortex-M, Various Units in the architecture, debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence, case study and applications using ARM-32 and ARM-64 bit.

Textbooks

1. Ramesh Gaonkar (1984) "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Penram International Publication (India) Pvt. Ltd. ISBN: 81-87972-15-7
2. Douglas V. Hall (2012) "Microprocessors and Interfacing", Tata McGraw Hill ISBN 13: 9781259006159.
3. Lewis, D. W. (2012). Fundamentals of Embedded Software: With the ARM Cortex-M3. Pearson.
4. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey '8051 Microcontroller & Embedded System', Pearson Education, 2008.

Reference Books

1. Ünsalan, Cem, Hüseyin Deniz Gürhan, and Mehmet Erkin Yücel (2022) "Microcontroller Architecture." Embedded System Design with ARM Cortex-M Microcontrollers. Springer, Cham, 7-25.
2. N Senthil Kumar, M Saravanan, and S Jeevananthan (2012) “Microprocessors and Microcontrollers” Oxford University Press. ISBN-13: 978-0198066477
3. B. Ram (2008), “Fundamentals of Microprocessors and Microcontrollers” Dhanpat Rai Publications.
4. Pyeatt, L., & Ughetta, W. (2019). ARM 64-Bit Assembly Language. Newnes.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	20	30	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	INDUSTRIAL POWER ELECTRONICS	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To understand the power electronics components and learn their characteristics.
2. To understand the operation, losses, and efficiency of the power electronic converters.
3. To learn methods to understand and analyses the power electronics circuits.
4. To understand the operating limitations and issues in practical converters in industrial applications.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understanding of power electronics devices and application.

CO 2 Apply the concepts of power electronics devices in AC/DC conversion.

CO 3 Analyse the operation of power electronics devices in AC/DC conversion.

CO 4 Examine the performance and waveforms of power electronics circuits in industrial applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	-	2	-	3	-	-	-	-	-	-	-	3	3
CO 2	3	-	2	-	3	-	-	-	-	-	-	-	2	2
CO 3	3	-	2	-	3	-	-	-	-	-	-	-	2	2
CO 4	3	-	2	-	3	-	-	-	-	-	-	-	3	3
Average	3	-	2	-	3	-	-	-	-	-	-	-	2.5	2.5

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **09 Lecture Hours**

Power Semiconductor Devices: Introduction to power electronics, uncontrolled switches, semi-controlled switches, fully controlled switches, constructional features, operating principle, characteristics, and specification of power semiconductor devices (SCR, MOSFET, GTO, IGBT, GTO, SIT, SITH & MCT), hard and soft switching of power semiconductors switches.

Practice

1. Simulation of V-I characteristics of power diode & power transistor.
2. Simulation of V-I characteristics of power semiconductor devices.
3. Simulation of V-I characteristics of silicon-controlled rectifier.

Unit II: 10 Lecture Hours

AC to DC Converter: Overview of rectifiers, half wave uncontrolled rectifier with R load and R-L load, use of freewheeling diode, half wave rectifier R-L load with FWD, full wave bridge uncontrolled rectifier, half wave controlled rectifier with R load, R-L load and R-L load with free-wheeling diode, half controlled bridge rectifier, fully controlled bridge rectifier, effect of source inductance on the performance of ac to dc converters, power factor improvement, harmonic reduction, filter design.

Practice

1. Simulation of single-phase half-wave and full-wave diode rectifier using R & L load.
2. Simulation of single phase fully controlled converter using R & L load.
3. Simulation of single-phase semi converter using R-L load.
4. Simulation of 3-phase semi converter with R, R-L and dc motor load with/without freewheeling diode.
5. Simulation of 3-phase bridge converter with R, R-L and dc motor load with/without freewheeling diode.

Unit III: 10 Lecture Hours

DC to DC Converter: Introduction to chopper (Type A, B, C, D, E), switching techniques, step down dc chopper with R, R-L, R-L-E load, step up dc chopper with R, R-L, R-L-E load, buck regulator, boost regulator, Buck-boost regulator, CUK and SEPIC converter, commutation of thyristor based circuits part-I, commutation of thyristor based circuits part-II, introduction to SMPS circuits, fly back type SMPS, forward type SMPS, design of transformer for SMPS circuits.

Practice

1. Simulation of dc-dc converters.
2. Simulation of buck, boost & buck-boost converters.

Unit IV: 10 Lecture Hours

DC to AC Converter: Introduction to inverters, importance and application of inverters, single phase half bridge inverter with R and R-L load, single phase bridge inverter with R and R-L load, three phase inverters, control techniques of inverter, single/multiple pulse width modulation, sinusoidal pulse width modulation and its realization, CSI, load-commutated CSI,

industrial inverter, PWM techniques - single pulse, multiple pulse, selective harmonic elimination, sinusoidal PWM.

Practice

1. Simulation of single-phase inverter & three phase inverter.
2. Simulation of PWM generation and application.

Unit V: 06 Lecture Hours

AC to AC Converter: AC voltage controller - Single phase bi-directional controllers with R and R-L load, effect of load inductance, firing pulse requirement, single phase cyclo-converters - waveforms, control technique, introduction of matrix converter.

Practice

1. Simulation of single-phase AC voltage controller.
2. Simulation of cyclo-converter.

Reference Books

1. Dubey G. K., Doradla S. R., Joshi A. and Sinha R. M. K., “Thyristorised Power Controllers”, New Age International Private Limited.
2. Mohan N., Undeland T. M. and Robbins W. P., “Power Electronics- Converters, Applications and Design”, 3rd Ed., Wiley India.
3. Rashid M. H., “Power Electronics Circuits Devices and Applications”, 3rd Ed., Pearson Education.
4. Lander C. W., “Power Electronics”, 3rd Ed., McGraw-Hill 2007 International Book Company.
5. Ramshaw R.S., “Power Electronics Semiconductor Switches”, Chapman & Hall.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Electrical Machines Lab	0	0	2	1
Total Units to be Covered:	Total Contact Hours:				
Prerequisite(s):		Syllabus version:			

Course Code	Course name		L	T	P	C
	Power Electronics Lab		0	0	2	1
Total Units to be Covered:		Total Contact Hours:				
Prerequisite(s):			Syllabus version:			

Course Code	Course name	L	T	P	C
	Microprocessors and Microcontrollers Lab	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To under the generations and functionality microprocessor.
2. To enable students design intelligent systems.
3. To give the students an experimental approach to implement the microprocessor-based systems.
4. To enable students, acquire knowledge about interfacing of input/output devices with microprocessor.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand an in-depth understanding of the operation of microprocessors and microcontrollers.

CO 2 Interface the memory and input output devices with microprocessors and microcontrollers.

CO 3 Design the microprocessors and microcontrollers based electronic system.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	3	2	-	-	-	-	-	-	3	3	3
CO 2	3	2	2	3	2	-	-	-	-	-	-	3	3	3
CO 3	3	2	2	3	2	-	-	-	-	-	-	3	3	3
Average	3	2	2	3	2	-	-	-	-	-	-	3	3	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

List of Experiment

Experiment No. 1

Program for the :

a) Addition of two eight-bit numbers along with carry (fetch numbers from memory and store result in memory)

b) Subtraction of two eight-bit numbers along with carry (fetch numbers from memory and store result in memory)

c) Multiplication of two eight-bit numbers along with carry (fetch numbers from memory and store result in memory)

d) Division of two eight-bit numbers along with carry (fetch numbers from memory and store result in memory)

Experiment No. 2

Program for arranging n 8-bit numbers stored in memory in ascending order and descending order.

Experiment No. 3

Program for :

a) ASCII to Decimal Conversion

b) BCD to Hex Conversion

c) HEX to Decimal Conversion

d) (HEX to Binary Conversion.

Experiment No. 4

Interfacing of 8085 with 5x4 keypad to display corresponding keys pressed.

Experiment No. 5

Interfacing thumb wheel switch with 8085.

Experiment No. 6

Interfacing 4-digit seven segment with 8085

Experiment No. 7

Interfacing of 8085 Microprocessor with DAC 0800 to generate.

a) Square wave form
b) Triangular wave form
c) Saw-tooth wave form.

Experiment No. 8

Interfacing 8x8 LED matrix with 8085 to display various patterns

Experiment No. 9

Interfacing 16x2 LCD with 8085 to display hello message

Experiment No. 10

Write and execute an 8086-assembly language program (ALP) to add, subtract, and multiply two 16-bit unsigned numbers. Store the result in extra segment.

Experiment No. 11

Stepper motor interfacing with 8085 microprocessors.

Experiment No. 12

Movement of motor clockwise and anticlockwise

Experiment No. 13

To run a stepper motor for required angle within 360ºc which is equivalent to 256 steps

Experiment No. 14

Interfacing traffic light controller with 8085/8086.

Experiment No. 15

Interfacing elevator control with 8085/8086.

Experiment No. 16

Interfacing temperature measurement module with 8085/8086

Experiment No. 17

Interfacing IC tester module with 8085/8086

Textbooks

1. Ramesh Gaonkar (1984) “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Penram International Publication (India) Pvt. Ltd. ISBN: 81-87972-15-7.
2. Douglas V. Hall (2012) “Microprocessors and Interfacing”, Tata McGraw Hill ISBN 13: 9781259006159.

Reference Books

1. N Senthil Kumar, M Saravanan, and S Jeevananthan (2012) “Microprocessors and Microcontrollers” Oxford University Press. ISBN-13: 978-0198066477.
2. B. Ram (2008), “Fundamentals of Microprocessors and Microcontrollers” Dhanpat Rai Publications

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Evaluation
Weightage (%)	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Capstone I				2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

SEMESTER VI

Course Code	Course name	L	T	P	C
	Start your Own Start-up	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Exploratory 4	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Advance Electrical Machines	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To give exposure about the magnetic circuits, & electromagnetic energy conversion principles and study details of advance AC machines and special machines, including their constructional features, principle of operation and performance analysis.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the concepts of pulsating and rotating magnetic field and classify AC rotating machines with their functions and applications.

CO 2 Understand construction and analyse the performance of salient and non – salient type advance machines.

CO 3 Analyse the starting, running and speed-torque characteristic along with application areas and predict the performance by various testing methods.

CO 4 Evaluate the performance of advance and special purpose machines along with its application.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	2	1	1	1	1	-	-	-	-	-	-	1	1
CO 2	2	2	-	2	-	-	1	-	-	-	1	-	2	2
CO 3	2	-	-	-	-	1	2	-	-	-	2	-	2	2
CO 4	1	-	-	2	1	-	1	-	-	-	1	-	1	1
Average	1.5	2	1	1.66	1	1	1.33	-	-	-	1.33	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 07 Lecture Hours

Fundamentals of AC Machine Design: Physical arrangement of windings in stator and cylindrical rotor; full-pitch and short pitch coils, concentrated winding, distributed winding, pulsating magnetic field - alternating current in windings with spatial displacement, windings

spatially shifted by 90 degrees, three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Unit II: 08 Lecture Hours

Synchronous Motor: Principle of operation, starting methods, phasor diagram, torque-angle characteristics, V-curves, hunting and damping, synchronous condenser.

Unit III: 10 Lecture Hours

Synchronous Generator: Constructional features, armature windings, Excitation Systems: Static, brushless excitation, AVR, Winding coefficients, E.M.F. equation., harmonics in the induced E.M.F. armature reaction. O.C and S.C. tests. Voltage regulation-Synchronous impedance method, MMF Method, Potier`s triangle method, Parallel operation, operation on infinite bus; cooling of alternators. Two-reaction theory, power expressions for cylindrical and salient pole machines, performance characteristics.

Unit IV: 10 Lecture Hours

Single-Phase Induction Machines: Constructional features, double revolving field theory, Equivalent circuit of single-phase single winding induction motor, Determination of equivalent circuit parameters, Split phase induction motor, Capacitor motor, Permanent split capacitor motor; Shaded pole motor, Single phase synchronous motor, Universal motor, Stepper motor and applications.

Unit V: 10 Lecture Hours

Permanent Magnet Machines: Principle and construction of permanent magnet brushless dc motor drives (PMBDCM); Operation with sinusoidal, square, and trapezoidal waves; Control strategies; Flux weakening operation; Converter topologies for PMBDCM drive, Principle and construction of synchronous reluctance-based drive, operating condition and power factor of synchronous reluctance motors, constant power operation, PM reluctance motors, Servo motors and applications.

Text Books

1. Electric Machinery by P.S. Bhimbra, Khanna Publications 7th edition.
2. Electric Machines by I.J. Nagrath & D.P. Kothari, Tata Mc Graw - Hill Publishers.
3. Electric Machinery, Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, Sixth edition, Tata McGraw Hill Books Company, 2003.

Reference Books

1. Electric Machinery", A. E. Fitzgerald and C. Kingsley McGraw Hill Education, 2013.
2. "Performance and design of AC machines", M. G. Say, CBS Publishers, 2002.
3. "Alternating current machines", A. S. Langsdorf, McGraw Hill Education, 1984.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Modern Control System	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable student for developing modelling of various physical system.
2. To enable students' transient response analysis of the system behaviour.
3. To enable students' frequency response analysis of the system behaviour.
4. To enable students control system component details and its real time applications.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Apply systems theory to complex real-world problems in order to obtain models that are expressed using differential equations, transfer functions, and state space equations

CO 2 Analyze the system behaviour based on the mathematical model of that system where the model will be expressed in time or frequency domain.

CO 3 Analyze the behaviour of closed loop systems using tools such as root locus, Routh Hurwitz, Bode, Nyquist, and Matlab for the stability analyses of the system.

CO 4 Design controllers using classical PID methods, root locus methods, and frequency domain methods and determine the response of different order systems for various step inputs

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	3	1	1	1	-	-	-	-	-	-	1	2	2
CO 2	3	3	2	1	1	-	-	-	-	-	-	1	2	2
CO 3	3	3	2	1	1	-	-	-	-	-	-	1	2	2
CO 4	3	3	2	2	2	-	-	-	-	-	-	2	2	2
Average	3	3	2	1	1	-	-	-	-	-	-	1	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **04 Lecture Hours**

Introduction: Mathematical background: Matrices: Definition of Matrices; Matrix Algebra; Matrix Multiplication and Inversion; Rank of a Matrix; Differentiation and Integration of Matrices.

Unit II: **10 Lecture Hours**

Controllability and Observalibitly: Concept of Controllability and Observability; Controllability and Observability tests for continuous time system; Controllability and Observability of discrete time system; Controllability and Observability of state model in Jordan canonical form; Loss of Controllability and Observability for sampling

Unit III: **10 Lecture Hours**

State space analysis- The Concept of State and State Models, State Diagram, State Space and State Trajectory, State Space Representation using Phase Variable and Canonical Variables, Solution of State Equation, State Transition Matrix and its Properties, Eigen Values, Eigen Vectors, Model Matrix, Diagolization, Generalized Eigen vectors, Computation of State Transition Matrix using Laplace Transformation, Power Series Method, Cayley-Hamilton Method, Similarity Transformation Method. Controllability and Observability Tests: Kalman's test, Gilbert's Test, Controllability and Observability Canonical Forms.

Unit IV: **12 Lecture Hours**

Digital control system - Introduction to Discrete Time Systems, Necessary for Digital Control System, Spectrum Analysis of Sampling Process, Signal Reconstruction, Difference Equations, Z transforms, and the Inverse Z transform, Pulse Transfer Function, Time Response of Sampled Data Systems, Stability using Jury Criterion, Bilinear Transformation.

Unit V: **09 Lecture Hours**

Nonlinear systems :Introduction, common physical nonlinearities-saturation, dead-zone, relay, relay with dead zone, hysteresis, backlash, etc, jump resonance, limit cycle. Phase-plane analysis-phase plane and phase trajectory, singular points, construction of phase trajectory, evaluation of time, stability analysis.

Text Books

1. M. Gopal (2012), Digital control and state variable method; Tata McGraw Hill.
2. M. Gopal (2013), Modern control system; Tata McGraw Hill.
3. N.S. Nise (2006), Control Systems Engineering; Wiley publications, ISBN: 10: 0470917695.
4. B.C. Kuo (2009), Automatic Control System, PHI, ISBN: 10: 0470048964.

Reference Books

1. Ogata (2009), Modern Control Engineering, ISBN: 10: 0136156738.
2. D. Johnson (2006) Process control instrumentation technology, PHI, ISBN: 10: 8120330293.ernating current machines", A. S. Langsdorf, McGraw Hill Education, 1984.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Embedded Systems and IoT	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Build an understanding of the fundamental concepts of embedded systems and IoT.
2. Familiarize the student with the basic terminology of the embedded systems and IoT.
3. Introduce students to the general principles of embedded design and it's in-depth analysis.
4. Allow the student to gain expertise in specific areas of such as the design and maintenance of individual systems.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand components, applications, future trends, communication protocols of IoT and RTOS for embedded systems.

CO 2 Design the electronics system based on microcontrollers and conduct experiments as well as to analyze and interpret data focusing on field of fundamental embedded systems design paradigms.

CO 3 Implement the assembly and embedded 'C' code for industrial embedded systems and intelligent embedded system development

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	3	2	3	-	-	-	-	-	-	3	2	3
CO 2	3	2	3	2	3	-	-	-	-	-	-	3	2	3
CO 3	3	2	3	2	3	-	-	-	-	-	-	3	2	3
Average	3	2	3	2	3	-	-	-	-	-	-	3	2	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 05 Lecture Hours

Introduction: Embedded Systems overview, Design challenge- optimizing design metrics, time to market, NRE cost, Embedded Systems definition, types of embedded systems, characteristics and design parameters of embedded systems, embedded systems life cycle, hardware software co-design.

Unit II: 10 Lecture Hours

Introduction to AVR Microcontroller, Architecture, Pin configuration, Memory organization, Assembly Language /C Programming of AVR Microcontroller, GPIO, Interrupt, Counter and Timers, Serial communication. Introduction to AVR studio4, Proteus, Simulation Software, Write/Burn a program to ATMEGA Microcontroller.

Unit III: 12 Lecture Hours

ATMEGA Interfacing: LED, Seven Segment Display, LCD, DC and Stepper Motors, Switches and Relays, Interfacing with analog and digital sensors, analog to digital converter (ADC) and digital to analog converter (DAC), Multiple Devices, ATMEGA Communication Modes: USART/UART, DTMF, SPI, 12C/TWI, MATLAB GUI and its Interfacing with ATMEGA.

Unit IV: 10 Lecture Hours

Internet of Things (IoT) - Inception and background, Definitions and fundamental requirements, Architecture of IoT, Components of IoT, IoT middleware, IoT Applications, Open research challenges and future trends in IoT. Introduction to cloud services: open source and licensed (ex: AWS, Microsoft azure, etc), Communication protocols for IoT: Wireless HART, Z Wave, Bluetooth Low Energy, Zigbee.

Unit V: 08 Lecture Hours

RTOS: Introduction, structure of OS, System calls, Tasks, inter task communication, task scheduling, pre-emptive and non-pre-emptive scheduling, priorities, inversion, Semaphore, events, messages, queues.

Textbooks

1. Andrew N. Sloss, Dominic Symes, Chris Wright ARM Systems Developer's Guides-Designing & Optimizing System Software – 2008, Elsevier ISBN 1-55860-874-5.
2. Steve Furber, 'ARM system on chip architecture', Addision Wesley ISBN-13: 9780201403527.
3. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The EvolvingWorld of M2M.
4. Communications", ISBN: 978-1-118-47347-4, Willy Publications ,2016
5. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things",ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016.

6. Sudip Misra, Subhadeep Sarkar, Subarna Chatterjee: Sensors, Cloud, and Fog The Enabling Technologies for the Internet of Things, ISBN 9780367196127, CRC Press, 2019.

Reference Books

1. Trevor Martin, 'The Insider's Guide to The Philips ARM7-Based Microcontrollers, An Engineer's Introduction to The LPC2100 Series' Hitex (UK) Ltd.,
2. Dananjay V. Gadre 'Programming and Customizing the AVR microcontroller', McGraw Hill 2001

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Advance Electrical Machines Lab	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Embedded Systems and IoT Lab	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name		L	T	P	C
	Specialization Course II		3	0	0	3
Total Units to be Covered:		Total Contact Hours:				
Prerequisite(s):			Syllabus version:			

Course Code	Course name	L	T	P	C
	Capstone II				2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

SEMESTER VII

Course Code	Course name	L	T	P	C
	Exploratory 5	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Industrial Communication and Networking	2	0	0	2
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	E-Vehicle	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To impart basic knowledge of Battery Electric Vehicles (BEV) & Hybrid Electric Vehicles (HEV), including regenerative braking, transmission, hybrid architectures, automotive powertrains, operating mode and cost estimates.
2. To give students an understanding of Electric Motor Drives used in BEV and HEVs and their configurations, optimization, control and applications.
3. To enable students to acquire basic knowledge about Energy Storage Systems used in BEV and HEV, and Battery Management Systems.
4. To give students an insight into the role of Energy Management System, and support systems (Electrical overlay harness & communications, steering & braking systems)

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand different drive train topologies for Battery Electric Vehicles (BEV) & Hybrid Electric Vehicles (HEV), Drive Cycle implications & Fuel Efficiency estimations.

CO 2 Analyse the performance of different Electric Motor Drives used in BEV / HEVs and their configurations, optimization, control and applications.

CO 3 Evaluate energy storage technologies used in BEV / HEVs and their characteristics (Batteries, Super capacitors, Flywheels, Fuel cells).

CO 4 Design a power train of an electric vehicle including inverter, battery sizing and motor rating.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	2	2	2	-	-	-	-	-	-	1	-	-	-
CO 2	-	-		2	-	2	-	-	2	-	-	-	-
CO 3	-	2	-	-	3	-	1	-	-	-	1	2	-
CO 4	2	2	-	-									
Average	2	2	2	2	3	2	1	-	2	1	1	2	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 14 Lecture Hours

History of Battery Electric vehicles (BEV), Hybrid Electric vehicles (HEV) and Fuel Cell vehicles (FCV). Impact of different transportation technologies on environment and energy supply. The dynamics of vehicle motion. Vehicle power plant, transmission characteristics and vehicle performance. Different electric and hybrid drive train topologies - Parallel, Series parallel and Complex drive trains. Basic concept of electric traction and architecture. Drive cycle implications.

Unit II: 14 Lecture Hours

Electric drives used in BEV and HEVs - their classifications and general characteristics. DC Motor drives and their principle of operation and performance. Motor Drives for BEV and HEV - Induction motor drives, Permanent Magnet motor drives, Switch Reluctance motor drives - their configurations, optimization, control and applications. Losses in traction motors, inverters and efficiency maps.

Unit III: 10 Lecture Hours

Energy Storage for BEV and HEVs: Battery based energy storage, Battery Terminologies. Fuel cells and their characteristics, Super capacitor-based energy storage. Hybridization of various energy storage devices - advantages and challenges. Selecting the energy storage technology.

Unit IV: 07 Lecture Hours

Case study of design of a BEV - Battery Electric Vehicle, Case study of design of a HEV - Hybrid Electric Vehicle.

Textbooks

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	E-Vehicle Lab	0	0	2	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name		L	T	P	C
	POWER SYSTEM		3	0	0	3
Total Units to be Covered:		Total Contact Hours:				
Prerequisite(s):			Syllabus version:			

Course Objectives

1. To learn the fundamentals of power system for designing a system that meets specific need.
2. Calculate the line parameters and analyse the necessity of line loading.
3. To examine the need of various analysis like fault analysis, short circuit analysis stability analysis, steady state, and transient analysis.
4. Understand concepts of different types of HVDC links.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the various power system components and their applications.

CO 2 Comprehend the generation of over-voltages and insulation coordination.

CO 3 Evaluate fault currents for different types of faults and install protection schemes.

CO 4 Analyze the voltage profile and grid operation using power flow study.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	-	3	-	-	3	-	-	-	-	3	3
CO 2	3	3	3	-	3	-	-	3	-	-	-	-	3	3
CO 3	3	-	3	-	3	-	-	3	-	-	-	-	3	3
CO 4	3	3	3	-	3	-	-	3	-	-	-	-	3	3
Average	3	2.66	2.75	-	3	-	-	3	-	-	-	-	3	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **06 Lecture Hours**

Basic Concepts: Structure of a power system. Generation: Conventional and Renewable Energy Sources. Analysis of three-phase circuits. Complex Power. Per-unit System and per-unit calculations.

Unit II: 08 Lecture Hours

Line Constant Calculations: Inductance of three phase unsymmetrically spaced transmission line, Transposition of power lines, Inductance of composite conductors, Inductance of double circuit three phase line, Bundled conductors, Proximity, and skin effect. Short transmission line, medium transmission line and Ferranti effect.

Unit III: 06 Lecture Hours

Corona and Overhead line Insulators: Critical Disruptive voltage, Corona Loss, Disadvantages of corona, Radio interference and inductive interference. Types of insulators, Potential Distribution over a string of suspension Insulators and Methods of equalizing the Potential.

Unit IV: 10 Lecture Hours

Symmetrical Components and Fault Analysis: Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding.Case study of design of a BEV - Battery Electric Vehicle, Case study of design of a HEV - Hybrid Electric Vehicle.

Unit V: 08 Lecture Hours

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

Unit VI: 07 Lecture Hours

HVDC: Necessity of HVDC systems, Equipment's of HVDC transmission systems, Types of HVDC Links, Comparison of AC and DC Transmission, Application of DC Transmission System, Planning and Modern trends in D.C. Transmission.

Textbooks / Reference Books

1. C.L. Wadhwa," Electrical Power Systems", New Age International Publishers,2016.
2. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
3. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
4. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
5. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
6. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.
7. R. Padiyarï, "HVDC Power Transmission Systems: Technology and system Interactions", New Age International (P) Limited, and Publishers, 1990.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name		L	T	P	C
	Specialization Course II		3	0	0	3
Total Units to be Covered:		Total Contact Hours:				
Prerequisite(s):			Syllabus version:			

Course Code	Course name		L	T	P	C
	Specialization Course III		3	0	0	3
Total Units to be Covered:		Total Contact Hours:				
Prerequisite(s):			Syllabus version:			

Course Code	Course name		L	T	P	C
	Major Project 1		0	0	0	2
Total Units to be Covered:		Total Contact Hours:				
Prerequisite(s):			Syllabus version:			

Course Objectives

1. This assignment aims for developing the solving ability in students. The objectives of the project are to explore, formularize, conceptualization of idea floated by him and / or faculty and finally do the results analysis with conclusion and future scope. The project should be carried out at university. In case the project requires outside support/dwelling in any R&D Organization / Industry, a prior permission regarding the same must be obtained from the concern authority of the university. The project is divided into both the semesters and termed as Project I and Project II.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Explain the proposed topic and idea.

CO 2 Explain the objectives of the projects.

CO 3 Demonstrate methodology to achieve the objectives.

CO 4 Apply the professional ethics involved in projects.

CO 5 Illustrate presentation skills and report.

CO 6 Demonstrate ability to work effectively in a team and leadership skills.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	2	1	-	-	1	1	-	1	1	3	2	-	1
CO 2	2	3	1	1	1	-	-	-	-	1	1	1	-	-
CO 3	1	2	-	2	1	-	-	-	-	1	1	1	1	1
CO 4	-	-	-	-	1	1	1	3	1	3	1	-	-	-
CO 5	-	-	-	-	-	-	-	-	1	3	2	-	-	-
CO 6	-	-	-	-	-	-	-	-	3	2	3	-	-	-
Average	1.3	2.3	1	1.5	1	1	1	3	1.5	1.8	1.8	1.3	1	1

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Catalog Description

Project 1: In this part, the student should develop the project by defining the objectives, literature review and making detailed methodology. At the end of the semester, the student is expected to submit a report containing objectives literature status, and proposed solution.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Total
Weightage (%)	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Industrial Internship	0	0	0	1
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

SEMESTER VIII

Course Code	Course name	L	T	P	C
	Exploratory 6	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Specialization Course IV	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	Specialization Course V	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Code	Course name	L	T	P	C
	SWITCHGEAR AND PROTECTION	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Comprehensive exposure to philosophy and technology of protection.
2. Understanding of evolution process of different generation of protection system.
3. Introduction to switchgear.
4. The arcing phenomenon in circuit breaker.
5. The design techniques for different types of circuit breakers

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understanding the concept of relays in the protection systems

CO 2 Understand types of the protection systems for a generation, Transmission & Distribution

CO 3 Applying the knowledge of the protection system & calculate the setting of the relays.

CO 4 Analysing the basics terminologies of switchgear system

CO 5 Implementing the basic knowledge of switchgear for distribution system

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	3	-	-	-	-	-	-	-	-	-	-	3	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO 3	3		-	-	3	-	-	-	-	-	-	-	3	2
CO 4		3	-	-	3	-	-	-	-	-	-	-	3	2
CO 5	3	3	-	-		-	-	-	-	-	-	-	3	2
Average	2.7	3	-	-	3	-	-	-	-	-	-	-	3	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 04 Lecture Hours

Importance of protective relaying in power systems; Fundamental requirements of a good protection scheme; Zones of protection, Primary and Back–up Relaying.

Unit II: 10 Lecture Hours

Terms used in protective relaying; Classifications of Relays - Constructional / Functional; Electromagnetic Relays – attracted armature, induction disc, induction cup types relays; Over current and Earth fault relays, Directional, Differential, Distance Relays; Principles & Characteristics of relays; Operation, setting, testing and applications, maintenance requirements of relays; Negative Sequence relays; Universal Relay Torque Equation; Electronic relays; Static relays; Digital relays; Microprocessor and PC based relaying; Current & Future trends.

Unit III: 08 Lecture Hours

Schemes for protection of transmission line; Mertz-Price circulating current scheme, Percentage differential relay, Restricted earth fault protection, Negative Sequence protection, Carrier relaying scheme, Pilot relaying scheme, Static and other relays used in transmission line protection.

Unit IV: 08 Lecture Hours

Generator Protection; Transformer Protection, Motor Protection: Faults and Protection systems; Busbar Protection; Feeder Protection: Outline of protection systems – Pilot wire, carrier current, distance protection, PLCC.

Unit V: 10 Lecture Hours

Physics of arcing phenomenon and arc interruption — DC and AC circuit breaking — re-striking voltage and recovery voltage — rate of rise of recovery voltage — resistance switching — current chopping — interruption of capacitive current — Types of circuit breakers — air blast, oil, SF6 and vacuum circuit breakers — comparison of different circuit breakers — Rating and selection of Circuit breakers.

Unit VI: 05 Lecture Hours

Numerical relaying, Block diagram, Sampling, Anti-aliasing, Phasor estimation techniques, Frequency estimation.

Textbooks

1. Sunil S. Rao Switchgear & Protection - 2nd Edition Dhanpat Rai & Co.
2. M.L. Soni, Gupta, Bhatnagar “A course in Electrical Power system”, Dhanpat Rai & Co, 2001.
3. Ravindranath & Chandar Switchgear & Protection PhI Publication.

Reference Books

1. Badri Ram & D N Vishwakarma“Power System Protection & Switchgear” Tata McGraw-Hill, 2005

2. Chunikhin, A. and Zhavoronkov, M., “High Voltage Switchgear Analysis and Design”, Mir Publishers, Moscow, 1989.
3. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India Pvt. Ltd, 2005
4. Flursscheim, C.H. (Editor), “Power Circuit Breaker-Theory and Design”, IEE Monograph Series 17, Peter Peregrinus Ltd., Southgate House, Stevenage, Herts, SC1 1HQ, England, 1977.
5. Ananthakrishnan S and Guruprasad K.P., “Transient Recovery Voltage and Circuit Breakers”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1999.
6. Funio Nakanishi, “Switching Phenomena in High Voltage Circuit Breakers”, Marcel Dekker Inc., New York, 1991.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Major Project 2	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

2. This assignment aims for developing the solving ability in students. The objectives of the project are to explore, formularize, conceptualization of idea floated by him and / or faculty and finally do the results analysis with conclusion and future scope. The project should be carried out at university. In case the project requires outside support/dwelling in any R&D Organization / Industry, a prior permission regarding the same must be obtained from the concern authority of the university. The project is divided into both the semesters and termed as Project I and Project II.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Explain the proposed topic and idea.

CO 2 Explain the objectives of the projects.

CO 3 Demonstrate methodology to achieve the objectives.

CO 4 Apply the professional ethics involved in projects.

CO 5 Illustrate presentation skills and report.

CO 6 Demonstrate ability to work effectively in a team and leadership skills.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	2	1	-	-	1	1	-	1	1	3	2	-	1
CO 2	2	3	1	1	1	-	-	-	-	1	1	1	-	-
CO 3	1	2	-	2	1	-	-	-	-	1	1	1	1	1
CO 4	-	-	-	-	1	1	1	3	1	3	1	-	-	-
CO 5	-	-	-	-	-	-	-	-	1	3	2	-	-	-
CO 6	-	-	-	-	-	-	-	-	3	2	3	-	-	-
Average	1.3	2.3	1	1.5	1	1	1	3	1.5	1.8	1.8	1.3	1	1

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Catalog Description

Project 2: This will normally be in continuation of Project I. The student is expected to work on the objective in depth and come out with specific conclusions. The Final Report will be evaluated as per the rubrics.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Total
Weightage (%)	100

Detailed breakup of Internal Assessment

Specialization in Wearable Devices

Course Code	Course name	L	T	P	C
	Advanced Microcontrollers	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To understand advanced architectures.
2. To develop Programs both in C and assembly for advanced architectures.
3. To understand the advanced features like memory management unit, exception handling.
4. To build real-time system using advanced Microcontrollers.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the concepts of advanced microcontrollers like AVR, ARM, TI.

CO 2 Program the Advanced microcontrollers to build an intelligent system for specific embedded applications.

CO 3 Interface the different interfacing ICs and peripherals to microcontrollers.

CO 4 Configure an embedded system for real time embedded communication and IoT applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	1	1	1	-	-	-	-	-	-	1	2	2
CO 2	1	2	1	-	2	-	-	-	-	-	-	1	1	3
CO 3	1	2	1	1	2	-	-	-	-	-	-	1	1	3
CO 4	2	1	2	-	-	-	-	-	-	-	-	1	2	3
Average	1	2	1	1	2	-	-	-	-	-	-	1	2	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

AVR Architecture and Programming: AVR Register File, Special Addressing registers, Addressing modes, Stack pointer, Program status register, Pipelines, Clock, Arithmetic and

logical Instructions, Jump and branch Instructions, Move, Load store Instructions, Load and store Program memory, Push and pop Instruction, Bit Instructions, I/O Port. AVR C Programming, Data types, Time delays, I/O Programming, Logic Operations, Data Conversion, Data Serialization, Memory allocation.

Unit II: 06 Lecture Hours

AVR Interfacing: AVR Peripherals, Timers, Interrupts, Serial Port Module:4 Communication with real world (C programming): 8 hours SPI, I2C, ADC & DAC, PWM, Relay, stepper motor, LCD, keyboard.

Unit III: 09 Lecture Hours

Texas Instruments Microcontrollers: The MSP430 Architecture, CPU Registers, Instruction Set, addressing modes, the MSP430family viz. MSP430x2x, MSP430x4x, MSP430x5x. Energia IDE, Low power aspects of MSP430: low power modes, active Vs standby current consumption, FRAM Vs Flash for low power and reliability.

Unit IV: 10 Lecture Hours

ARM-Processor: Architecture of ARM Cortex-M, Various Units in the architecture, debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence, Case study and applications using ARM-32.

Unit V: 10 Lecture Hours

Interfacing with ARM processor: Peripheral interfacing to ARM, LED, LCD, Seven Segment, Keyboard, Buzzer, Stepper motor, DC motor, BLDC, Timer, USART, Push Button, Case study on different applications.

Textbooks

1. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, “AVR Microcontroller and Embedded Systems Using Assembly and C”, Pearson, 2013
2. John H. Davies, “MSP 430 Micro controller basics”, Elsevier, 2008.
3. Andrew NSLOSS, ARM System Developers guide, Dominic SYMES, Chris WRIGHT, Elsevier, 2012.
4. Steve Furber, “ARM System –On –Chip architecture”, Addision Wesley, 2000.
5. Ünsalan, Cem, Hüseyin Deniz Gürhan, and Mehmet Erkin Yücel (2022)"Microcontroller Architecture." Embedded System Design with ARM Cortex-M Microcontrollers. Springer, Cham, pp.7-25.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Sensor and Interfacing	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Introducing fundamentals of sensing and exploration of various sensors widely used for real life application.
2. To provide the basic understanding of Transducers and sensors systems
3. To provide insight on the resistive sensors and its applications in real life
4. To have an insight on the interfacing of sensors

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand fundamental concepts of sensors and their applications.

CO 2 Realize signal conditioning and data acquisition for different applications of sensors.

CO 3 Interpret the acquired data from sensors.

CO 4 Create analytical design and development solutions for sensors and actuators.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	1	1	1	-	-	-	-	-	-	1	1	1
CO 2	1	2	2	1	1	-	-	-	-	-	-	2	2	2
CO 3	1	2	1	2	1	-	-	-	-	-	-	2	2	3
CO 4	2	1	2	1	2	-	-	-	-	-	-	1	1	2
Average	1	2	1	1	1	-	-	-	-	-	-	1	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

Transducers and sensors: Principles of sensors and transducers, Parameters, Characteristics, Classification, Characterization of sensors. Types of sensors: Capacitive

Sensors, Electrostatic Transducer, Force/Stress Sensors using Quartz Resonators, Ultrasonic Sensors. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges. Inductive Sensors-Sensitivity and Linearity of the Sensor. Sensor selection and its calibration techniques.

Unit II: 10 Lecture Hours

Sensors and Applications: Thermal Sensor, types, principle of operation, Applications. Radiation sensors–X-ray and Nuclear Radiation Sensors. Fibre Optic Sensors. Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface. Integrated and Smart sensors, Overview of various smart sensors: Digital temperature sensor, Humidity sensor, IR sensor, Gas sensor, Pressure sensors, Accelerometers, Structural health monitoring sensors, Introduction to MEMS and Flexible sensors.

Unit III: 05 Lecture Hours

Self generating sensors: Thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, temperature sensitive fabric, electrochemical sensors.

Unit IV: 10 Lecture Hours

Actuators and Interfacing: Actuators Pneumatic and Hydraulic Actuation Systems-Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves, Cylinders, Servo and proportional control valves, Process control valves, Rotary actuators, Mechanical Actuation Systems Types of motion, Kinematic chains, Cams, Gears, Ratchet and pawl, Belt and chain drives, Bearings, Mechanical aspects of motor selection, Electrical Actuation Systems, Electrical systems, Mechanical switches, Solid-state switches, Solenoids, DC Motors, AC Motors, Stepper motors, interfacing to microcontrollers.

Unit V: 10 Lecture Hours

Signal conditioning: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers, Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers. Data Acquisition Systems.

Textbooks

1. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications.
2. B.C. Nakra, K.K. Choudhury, “Instrumentation, Measurement and Analysis”-3rd Edition, Tata McGraw, 2009.
3. D. Patranabis, “Sensors and Transducers”, PHI Learning Private Limited.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Ubiquitous Computing	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To understand the characteristics of ubiquitous computing applications.
2. To understand the basic computing application problems.
3. To apply the concepts for improving quality of services for ubiquitous computing.
4. To Develop major system components and architectures of the systems.
5. To Explore the key technologies involved in the development of Ubiquitous systems.
6. To Highlight the trends and problems of current pervasive computing systems using examples.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the characteristics of Ubiquitous computing applications and technologies involved in the ubiquitous systems.

CO 2 Recognize the different ways that humans will interact with systems in a ubiquitous environment.

CO 3 Analyse the security and privacy issues of Ubiquitous/pervasive computing. Design smart devices using wearable technology.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	1	1	2	-	-	-	-	-	-	2	1	1
CO 2	1	2	2	1	2	-	-	-	-	-	-	1	2	3
CO 3	2	1	2	1	1	-	-	-	-	-	-	1	1	2
CO 4	1	2	2	1	2	-	-	-	-	-	-	1	2	3
Average	1	2	1	1	2	-	-	-	-	-	-	1	2	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **10 Lecture Hours**

Introduction to Ubiquitous Computing: Overview, challenges, NFC, wireless LAN, Personal assistants, location aware computing, location tracking, location-based service and applications, LBSN Concept of Distributed Computing, Mobile Computing, Pervasive Computing, Wearable Computing, Modeling the Key Ubiquitous Computing Properties, Mobile Adaptive Computing, Mobility Management and Caching.

Unit II: **09 Lecture Hours**

Pervasive Computing Devices and security: Smart Environment: CPI and CCI Smart Devices: Application and Requirements, Device Technology and Connectivity, Human Computer Interaction. Security and Privacy in Pervasive Networks

Unit III: **08 Lecture Hours**

Human Computer Interaction: Explicit HCI, Implicit HCI, User Interface and Interaction for hand-held widely used devices, Hidden UI via basic smart devices, Hidden UI via wearable and Implanted devices, Human centered design, user models.

Unit IV: **08 Lecture Hours**

Wearable computing: basics of wearable computing, Glass and augmented Reality, Eye Tracking, Digital Pen and Paper, Mobile social networking and crowd sensing, Event based social Network.

Unit V: **10 Lecture Hours**

Smart devices and interaction: Overview of challenges, smart devices, Smart Interaction, Smart physical environment device interaction, Smart human-device interaction, Human Intelligence versus machine intelligence, social issues.

Textbooks

1. Ubiquitous Computing - Smart Devices, Environments and Interactions by S Poslad.
2. Ubiquitous Computing Fundamentals" by John Krumm.
3. "Handbook on Mobile and Ubiquitous Computing: Status and Perspective" by Laurence T Yang and Evi Syukur.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Real Time Operating System	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To understand the behavior of real time operating system
2. To apply communication protocols for designing embedded and real time systems
3. To be able to write coding related to software pertaining to UNIX and other development tools
4. To understand different RTOS based applications and design.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand and classify embedded and real-time systems.

CO 2 Analyze communication bus protocols used for embedded and real-time systems.

CO 3 Apply different scheduling technique and OS for programming and development of specific RTOS application.

CO 4 Design an Interrupt driven RTOS based applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	1	1	1	-	-	-	-	-	-	1	-	1
CO 2	1	2	1	1	2	-	-	-	-	-	-	1	-	2
CO 3	2	1	2	1	1	-	-	-	-	-	-	1	-	3
CO 4	2	1	2	1	2	-	-	-	-	-	-	1	1	3
Average	1	2	1	1	2	-	-	-	-	-	-	1	1	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **10 Lecture Hours**

RTOS Fundamentals: Introduction to RTOS, structure of RTOS, Issues of RTOS, RTOS vs OS, Structure of OS, System calls, Tasks and Task states, foreground and background systems, Context switches, inter task communication, task assignment and task scheduling, Preemptive and Non preemptive scheduling, Task assignment, task priorities, priority inversion, timing specifications, kernel, scheduler, process, inter process communication, Classical uniprocessor scheduling algorithms, Uniprocessor scheduling of IRI Stacks, Mode changes and Fault Tolerant Scheduling, Multitasking and run time support.

Unit II: 06 Lecture Hours

Real Time Scheduling: Smart Environment: Clock driven scheduling-notations and assumptions, static, time driven scheduler, general structure of cyclic schedulers, average response time, scheduling example, practical considerations, algorithm, priority driven scheduling.

Unit III: 09 Lecture Hours

Interrupts: Interrupts, ISR, interrupt handling, interrupt latency, interrupt response, interrupt recovery, clock ticks, Deadlock, Semaphores, types of semaphore, semaphore management, creating, deleting, waiting and signaling of semaphore, Shared data problem, Message queues, Mailboxes and pipes, Memory management, Interrupt routines, Encapsulating semaphore and queues, Petri nets. Event and Flag management.

Unit IV: 10 Lecture Hours

RTOS System programming: Real Time operating systems, POSIX compliant OS, LINUX for Operating systems, MUCOS (muC/OS-II), introduction to unix based RTOS, RTOS Vxworks-Basic features, Task management, creating and activating a task, VXworks system functions and system tasks, Signals and Interrupt handling functions, Inter process communication functions, Creating a binary semaphore, creating a counting semaphore, message queue, POSIX queues.

Unit V: 10 Lecture Hours

Real Time Communication: Model of real time communication, priority-based service disciplines for switched networks, weighted round robin service disciplines, medium access control protocols of broadcast networks, internet and resource reservation protocols, real time protocol, Communication and multicomputer system.

Textbooks

1. Hermann Kopetz, Real–Time systems, Design Principles for distributed Embedded Applications", Second Edition, Springer 2011.
2. Jean J Labrosse, Micro C/OS II, The Real Time Kernel II Edition, CMP books USA.
3. C.M. Krishna, Kang G. Shin, "Real – Time Systems", McGraw – Hill International Editions.
4. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011
5. Embedded Systems- Architecture, Programming and Design by Raj kamal, 2007, TMH.
6. Advanced UNIX Programming, Richard Stevens
7. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Wearable Technology	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To be acquainted with the working principle of special purpose sensors and the need for developing smart sensors.
2. To understand the design constraints and the measurement techniques for physical and biological signals.
3. To understand and design the wearable computing systems.
4. To evaluate the wearable technology's impact on healthcare system.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the working principle of special purpose sensors, smart sensors and wearable computing.

CO 2 Evaluate the design constraints of wearable devices for measuring physical and biological signals.

CO 3 Analyze the signal processing in different Wearable electronics devices.

CO 4 Apply wearable technology in healthcare applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	1	1	2	-	-	-	-	-	-	2	1	1
CO 2	1	2	2	1	2	-	-	-	-	-	-	1	2	3
CO 3	2	1	2	1	1	-	-	-	-	-	-	1	1	2
CO 4	1	2	2	1	2	-	-	-	-	-	-	1	2	3
Average	1	2	1	1	2	-	-	-	-	-	-	1	2	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **10 Lecture Hours**

Wearable Technology: Evolution of wearable technology, Wearable IoT use cases- Smart watches, Android wear, Smart glasses, fitness trackers, health care devices, cameras, smart clothing etc, Need for wearable systems, Sensors for wearable systems. Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, The first devices, Wearable Computers, The Thorp–Shannon roulette predictor, Mann's Wear cam, Wearable Electronics: Wearable Electronic Devices, Design, Target Groups. Wearable ground reaction for sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS -Based Biosensors, E-Textiles, Bio compatibility.

Unit II: 09 Lecture Hours

Components and Systems: Wearable Devices, Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety. Sensor Patches and Bands, Sensors for Wearable Systems: Biomechanical Sensors, Physiological Sensors, Energy Harvesting for Self-Powered Wearable Devices: Principles of Energy Harvesting by using human body heat, Characteristics of Wearable TEGs, Human Body as a Heat Source for a Wearable Thermoelectric Power Supply, TEGs.

Unit III: 08 Lecture Hours

Wearable Computing: Body Area Networks, Communication Technologies: System- Level Considerations, Wireless Standards Comparison, Lower-Level Tradeoffs: Wireless Technology Categories, Signal Throughput, Resource Allocations, Power Optimization, System Architecture Requirements: Sensors, Signal Acquisition, Processing Module and Data Storage, Wireless Interface, Energy Management.

Unit IV: 08 Lecture Hours

Signal Processing in Wearable Technology: Signal Processing Flow, System Architecture and Coverage and Node Placement, Preprocessing and Feature Extraction: Time-Frequency Analysis, Multiscale Analysis, Principal Component Analysis, Laplacian, Eigenmaps, Classification: K-Means Clustering, Support Vector Machine, SWAB, SAX, Hidden Markov Event Model, Viterbi Algorithm, Parametrization and Feature Selection.

Unit V: 10 Lecture Hours

Wearable Devices for Healthcare: Electrode – design, geometry, material; Fabrication of interdigitated (IDE) electrodes, choice of substrate, sensing film; Wearable Bioelectric impedance devices for Galvanic skin response; Wearable ECG devices: Basics of ECG and its design, Electrodes and the Electrode–Skin Interface; Wearable EEG devices: Principle and origin of EEG, Basic Measurement set-up, ECE(BSW) Page 36 electrodes and instrumentation; Wearable EMG devices: EMG/ SEMG Signals, EMG Measurement – wearable surface electrodes, SEMG Signal Conditioning, Applications. Smart textile for neurological rehabilitation system (NRS), Study of flexible and wearable EMG sensors. Epidermal electronics system (EES), Study of Multiparametric (ECG, EEG, EMG) Epidermal Electronics Systems.

Textbooks

1. Annalisa Bonfiglio, Danilo De Rossi "Wearable Monitoring Systems", Springer, 2011

2. J. McCann, D. Bryson, "Smart clothes and wearable technology" Woodhead Publishing, Elsevier, 2009.
3. Annalisa Bonfiglio, Danilo De Rossi, “Wearable Monitoring Systems”, Springer, 2011.
4. Sandeep K. S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security, and Sustainability,” Cambridge University Press, 2013.
5. Mehmet R. Yuce, Jamil Y. Khan, “Wireless Body Area Networks Technology, Implementation and Applications”, Pan Stanford Publishing Pvt. Ltd, Singapore, 2012.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Specialization in Microelectronics

Course Code	Course name	L	T	P	C
	VLSI Technologies	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To Familiar with the different fabrication techniques for integrated circuits
2. To learn the design aspects of the different MOSFET ICs and their fabrication processes.
3. To analyse the different low-power MOSFET circuits under low power circuit level and logic level design techniques
4. To test different VLSI design and circuits.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the different fabrication techniques for Integrated Circuits.

CO 2 Apply the fabrication methods for BJT and MOSFET integrated circuits.

CO 3 Analyze the different circuits with low-power models.

CO 4 Perform VLSI Testing and Fault Modeling for Design and Testability.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	-	-	-	-	-	-	-	-	3	1	2
CO 2	3	1	-	1	-	-	-	-	-	-	-	2	1	3
CO 3	2	3	2	-	-	-	-	-	-	-	-	3	1	2
CO 4	1	2	1	1	-	-	-	-	-	-	-	2	1	2
Average	3	2	2	1	1	-	-	-	-	-	-	2	1	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **10 Lecture Hours**

Introduction to Integrated Circuits & ITRS Road Map: The scale of Integration: SSI, MSI, LSI, VLSI, ULSI, GSI, Moore's Law, VLSI Design flow, Y-Chart, Design hierarchy concept of regularity, Modularity Semiconductor technology, Scaling Trends and Scaling Methodologies,

Scaling Challenges, ITRS Roadmap; Starting material, silicon structure and properties, Czochralski and Float Zone crystal growth, GaAs growth; Silicon oxidation methods and properties, Deal Grove Model, Photolithography – masks, pattern transfer techniques, minimum resolvable feature sizes, UV sources, photoresists.

Unit II: **08 Lecture Hours**

Fabrication Techniques: Diffusion and ion implantation, Types of diffusion, Ficks laws, junction depth, Stopping mechanisms, Gaussian implantation profile, variations to predicted distribution, implantation damage and annealing; Deposition requirements and techniques, Physical and Chemical Vapor deposition, Epitaxial growth techniques; Wet and dry etching techniques, Chemical Mechanical Polishing.

Unit III: **09 Lecture Hours**

Lithography and Other Methods: Lithography: Photolithography, E-beam lithography, and newer lithography techniques for VLSI/ULSI, mask generation. CVD techniques for deposition of polysilicon, silinitridexide, silicon nitrite and metal films, epitaxial growth of silicon. Nanolithography techniques, PECVD, Photoresist, metallization, and packaging. Metal film deposition: Evaporation and sputtering techniques, failure mechanisms in metal interconnect multilevel metallization schemes, plasma etching and RIE techniques, RTP techniques for annealing, growth and deposition of various films for use in ULSI.

Unit IV: **08 Lecture Hours**

BJT and MOSFET Fabrication: PNP and PNP BJT Fabrication, NMOS fabrication, PMOS Fabrication CMOS Fabrication, N-well, P-well, and Twin tub process, SOI Process, MOSFET Scaling, BiCMOS, Latch-up problem in CMOS, MOSFET scaling.

Unit V: **10 Lecture Hours**

Low Power VLSI, Physical Design and Testing: Introduction to low power VLSI Design, Basic, Principles of low power design, probabilistic power analysis, Need of low power, CMOS leakage current, static current, random signal probability and frequency signal entropy, circuit level and logic level design techniques, Circuit partitioning, Top-down and bottom-up approach, Hyper graphs, Ratio cut, Floor planning, Placement, Top-down approach routing: Global routing, randomized routing, Power models estimation, Physical design, VLSI Testing And Fault Modeling, Design For Testability, Self Test and Test Algorithms, Fault Diagnosis Logic, BIST.

Textbooks

1. Gary. S. May and S. M. Sze, “Fundamentals of semiconductor fabrication”, John Wiley, First Edition, 2003.
2. Marc J. Madou, “Fundamentals of Microfabrication and Nanotechnology – Volume II”, CRC Press, Third Edition, 2011.
3. James D. Plummer, Michael D. Deal, Peter B. Griffin, “Silicon VLSI Technology: Fundamentals, Practice and Modeling”, Prentice Hall India Private Limited, 2000.
4. James D. Plummer, Michael D. Deal, “Silicon VLSI Technology” Pearson Education
5. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House.

Reference Books

1. Pal, A. (2014). Low-power VLSI circuits and systems. Springer.
2. Pucknell, D. A., & Eshraghian, K. (1994). Basic VLSI design. Prentice-Hall, Inc.
3. Sarkar, A., De, S., Chanda, M., & Sarkar, C. K. (2016). Low power VLSI design: fundamentals. Walter de Gruyter GmbH & Co KG.
4. Bhargava, C., & Khanal, G. M. (2022). Basic VLSI Design Technology: Technical Questions and Solutions. CRC Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	FPGA-Based System Design	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To provide an understanding of the HDL design for different combinational and sequential circuits.
2. To Simulate and verify the logic on different series and company FPGA boards.
3. To perform system portioning for network on chip system-on-chip design
4. To Familiar with ASIC and FPGA at system level integration.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the HDL design and simulation for different digital circuits.

CO 2 Simulate and synthesize the NoC and SOC on FPGA.

CO 3 Apply the Design under test for optimizing the FPGA parameters.

CO 4 Design the SoC for processors and microcontrollers.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	3	1	-	-	-	-	-	-	-	-	3	3	2
CO 2	3	2	1	-	-	-	-	-	-	-	-	3	3	2
CO 3	2	2	1	-	-	-	-	-	-	-	-	3	3	2
CO 4	3	2	1	-	-	-	-	-	-	-	-	3	1	3
Average	2	2	1	-	-	-	-	-	-	-	-	3	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

HDL Design: Design of combinational and sequential circuits using VHDL, Verilog HDL, System 'C', Finite state machine design, Modeling in HDL, Simulation, and Synthesis, Adders,

Multiplier design, multiplexer, demultiplexer, encoder, decoder, Flip-flops, Shift registers, Counters, design in HDL.

Unit II: **09 Lecture Hours**

Processor and Controller Chip Design: ALU design, Comparator, shifter design Chip design of 32/64 bit microprocessor, Chip design of microcontroller, RAM Design, ROM Design, Multiport memory design, Control unit Design, CPU Design, FSM Control, Linked state machines, encoded state machines, one hot encoding.

Unit III: **09 Lecture Hours**

CPLD and FPGA: Programmable Logic Devices (PLDs), Digital Design Using ROMs, PALs and PLAs, Realization State Machine using PLD, CPLD, CPLD Architecture, FPGA Technology, Types, FPGA Design Flow, Xilinx Series of FPGA, Virtex -5, Virtex -7, Spartan 6 FPGA, Xilinx Zed -Board, FPGA, Altera FPGA, ASIC design Flow, Xilinx Vivado, Quaturs-3 Software Simulation.

Unit IV: **09 Lecture Hours**

Logic Synthesis: Test bench design and Synthesis on FPGA, Logic implementation, floor planning, Placement, routing, and logic verification on FPGA Board, Synthesis on Xilinx series FPGA, Altera support FPGAs, or Intel FPGAs, ASIC Design.

Unit V: **08 Lecture Hours**

DUT and Analysis: Pre and Post synthesis, Design under test, Loop Up Table, System partitioning, MPSOC, NoC, SOC, FPGA to FPGA Communication, Power model estimation on FPGA, Delay model estimation, Static Timing analysis on FPGA, Logic optimization on FPGA, Case studies and synthesis on FPGA.

Textbooks

1. M.J.S. SMITH, “Application Specific Integrated Circuits”, Addison Wesley Longman Inc., 1997.
2. Ricardo Reis, “Design of System on a Chip: Devices and Components”, 1st Edition, 2004, Springer.
3. Wolf Wayne, “FPGA Based System Design”, Pearson Education India, 2004.
4. Chakravarthi Veena S “A Practical Approach to VLSI System on Chip (SoC) Design”, Springer International Publisher, 2020.
5. Perry L Douglas (2013) “VHDL Design by Example” TMH Publication, ISBN: 978-0071400701.
6. Hübner, M., & Becker, J. (Eds.). (2010). Multiprocessor system-on-chip: hardware design and tool integration. Springer Science & Business Media.

Reference Books

1. Mohammed Ismail and Terri Fiez, “Analog VLSI Signal and Information Processing”, McGraw Hill, 1994.
2. Design manuals of Altera, Xilinx and Actel. (From the web).

3. P. Marwedel, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, Third Edition, Springer, 2018.

4. Jr. Roth, Charles H., Lizy Kurian John, Digital Systems Design Using VHDL (January 2017), 3rd Edition.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	IC Fabrication and Packaging	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To familiar with the different fabrication techniques for integrated circuits
2. To give a widespread introduction to the different electronics packaging
3. To give the knowledge of power, thermal, speed, signal and integrity issues in ICs.
4. To introduce about CAD used in designing wiring boards and PCB.
5. To understand the testing and verification of IC Packaging.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the different fabrication techniques for Integrated Circuits.

CO 2 Assemble the different electrical and electronics components for IC assembly and microchip packaging.

CO 3 Develop the high-speed board and PCB for the design requirements.

CO 4 Simulate the CAD Models for different aspects of packing and electronics components.

CO 5 Evaluate the performance and reliability of the electronics system.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	1	3	2	3	-	-	-	-	-	-	2	2	2
CO 2	2	1	1	2	3	-	-	-	-	-	-	3	2	2
CO 3	2	1	1	2	3	-	-	-	-	-	-	2	1	1
CO 4	2	1	3	2	3	-	-	-	-	-	-	1	3	3
CO 5	2	1	1	2	3	-	-	-	-	-	-	2	1	1
Average	2	1	3	2	3	-	-	-	-	-	-	1	3	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **10 Lecture Hours**

Fabrication Techniques: Crystal growth, Oxidation, Diffusion, ion-implantation, Lithography: Photolithography, metallization, Etching, and packaging, CVD techniques for deposition of polysilicon, silicon nitrite and metal films, epitaxial growth of silicon. Nanolithography techniques, PECVD.

Unit II: **09 Lecture Hours**

Electronic Systems and Microchip Packaging: IC Evolution: Current and Future, System-on-Chip: Status and Challenges, Electronic Packaging and Evolution of IC Packaging- Cost, size, performance, reliability, Package Electrical Design - Signal distribution, power distribution, delta-I noise, mixed-signal design, Package Thermomechanical Design- Stress development, modeling, reliability, Electrical Test, - Testing and test methods at IC packaging level, board level, and system level, Microsystems Packaging.

Unit III: **09 Lecture Hours**

Electrical RF Issues: Electrical Issues in Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines, Clock Distribution, Noise Sources, Digital and RF Issues. Design Process Electrical Design; Packaging roadmaps - Electrical Design considerations in systems packaging- Resistive, Capacitive and Inductive parasitic, interconnections.

Unit IV: **09 Lecture Hours**

Chip Packages and PCB: Different chip packages, flip-chip, single chip packaging, multi-chip packaging, types, functions, processes, properties and materials CAD tools for PCB design, printed wiring board technologies, surface mount technology, thermal management, embedded capacitors, Processes for embedded, capacitors.

Unit V: **08 Lecture Hours**

Testing and Verification: Case study on Reliability, Basic concepts, Environmental interactions. Thermal mismatch and fatigue, failures, thermo mechanically induced, Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability.

Textbooks

1. Tummala & Swaminathan, System on Package (SOP): Miniaturization of the Entire System (1st edition), McGraw Hill, 2008. ISBN 9780071459068
2. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2001. 2. William D. Brown, Advanced Electronic Packaging, IEEE Press, 1999.
3. Fjelstad, Joseph, Reza Ghaffarian, and Young-Gon Kim. Chip scale packaging for modern electronics. Electrochemical Publications, 2003.
4. Gary. S. May and S. M. Sze, “Fundamentals of semiconductor fabrication”, John Wiley, First Edition, 2003.

Reference Books

1. William D. Brown, Advanced Electronic Packaging, IEEE Press, 1999.
2. Blackwell, Glenn R., ed. The electronic packaging CRC Press, 2017.

3. Lau, John, Chengkuo Lee, C. Premachandran, and Yu Aibin. Advanced MEMS packaging. McGraw-Hill Education, 2010.
4. Bhargava, C., & Khanal, G. M. (2022). Basic VLSI Design Technology: Technical Questions and Solutions. CRC Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Nano Electronics Devices	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Understand the underlying operating principles of nano semiconductor devices.
2. Demonstrate specialized practical and theoretical knowledge of the steps involved in fabrication.
3. Understand the interrelation between different technologies in the design of integrated devices operational principles of MOSFET.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand certain nano electronic systems and building blocks for future trends.

CO 2 Analyse the impact of nanoelectronics and related devices onto communication system, sensors and energy harvesting devices.

CO 3 Design integrated circuits (micro-chip) using state-of-the-art CMOS technology.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	1	1	-	-	-	-	-	-	3	1	2
CO 2	3	1	1	1	1	-	-	-	-	-	-	2	1	3
CO 3	2	3	2	1	1	-	-	-	-	-	-	3	1	2
Average	3	2	2	1	1	-	-	-	-	-	-	2	1	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

Introduction to Nanotechnology: Background to nanotechnology: Types of nanotechnology and nanomachines – periodic table – atomic structure – molecules and phases – energy – molecular and atomic size – surface and dimensional space – top down and bottom up; Molecular Nanotechnology: Electron microscope – scanning electron microscope – atomic force microscope – scanning tunnelling microscope – nanomanipulator – nanotweezers –

atom manipulation – nanodots – self-assembly – dip pen nanolithography. Nanomaterials: preparation – plasma arcing – chemical vapor deposition – sol-gels – electrodeposition – ball milling – applications of nanomaterials.

Unit II: **09 Lecture Hours**

Fundamentals of Nanoelectronics: IC Evolution: Fundamentals of logic devices:- Requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices:- classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons – performance estimation for the human brain. Ultimate computation: - power dissipation limit – dissipation in reversible computation – the ultimate computer.

Unit III: **08 Lecture Hours**

Silicon MOSFET& Quantum Transport Devices: Silicon MOSFETs - Novel materials and alternate concepts: - fundamentals of MOSFET Devices- scaling rules – silicon-dioxide-based gate dielectrics – metal gates – junctions & contacts – advanced MOSFET concepts. Quantum transport devices based on resonant tunneling: - Electron tunneling – resonant tunneling diodes – resonant tunneling devices; Single electron devices for logic applications: - Single electron devices – applications of single electron devices to logic circuits.

Unit IV: **08 Lecture Hours**

Carbon Nanotubes: Carbon Nanotube: Fullerenes - types of nanotubes – formation of nanotubes – assemblies – purification of carbon nanotubes – electronic properties – synthesis of carbon nanotubes – carbon nanotube interconnects – carbon nanotube FETs – Nanotube for memory applications – prospects of all carbon nanotube nano-electronics.

Unit V: **10 Lecture Hours**

Molecular Electronics: Electrodes & contacts – functions – molecular electronic devices – first test systems – simulation and circuit design – fabrication; Future applications: MEMS – robots – random access memory – mass storage devices.

Textbooks

1. Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall / CRC, 2002.
2. T. Pradeep, NANO: The Essentials – Understanding Nanoscience and Nanotechnology, TMH, 2007.
3. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2003.

Reference Books

1. Concepts in Spintronics – Sadamichi Maekawa 2. Spin Electronics – David Awschalom.
2. Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices: Karl Goser, Jan Dienstuhl and others.
3. Nano Electronics and Information Technology: Rainer Waser.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	System on Chip Design	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To provide an understanding of the HDL design and synthesis process for the digital design
2. To understand the design aspects of the IC at different levels of chip modelling.
3. To explore the concept of network-on-chip design using different strikers and topologies
4. To perform system portioning and system-on-chip design
5. To get Familiar with ASIC and FPGA at system level integration

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the HDL design and simulation.

CO 2 Simulate and synthesize the NoC and SOC on ASIC and FPGA.

CO 3 Design the SoC for processors and microcontrollers.

CO 4 Design the Network on Chip and System on Chip architecture.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	3	1	1	-	-	-	-	-	-	-	-	3	2
CO 2	3	2	1	1	-	-	-	-	-	-	-	-	3	2
CO 3	2	2	1	1	-	-	-	-	-	-	-	-	3	2
CO 4	3	2	1	1	-	-	-	-	-	-	-	-	1	3
Average	2	2	1	1	-	-	-	-	-	-	-	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

HDL Design: Design of combinational and sequential circuits using VHDL, Verilog HDL, System 'C', Finite state machine design, Simulation, and Synthesis.

Unit II: **08 Lecture Hours**

Processor and Controller Chip Design: ALU design, Chip design of 32/4 bit microprocessor, Chip design of microcontroller, RAM Design, ROM Design, Multiport memory design, Control unit Design, CPU Design, FSM Control. IC Evolution: Fundamentals of logic devices:- Requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices:- classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons – performance estimation for the human brain. Ultimate computation: - power dissipation limit – dissipation in reversible computation – the ultimate computer.

Unit III: **09 Lecture Hours**

FPGA and ASIC: FPGA Technology, Types, FPGA Design Flow, Xilinx Series of FPGA, Virtex -5, Virtex -7, Spartan 6 FPGA, Xilinx Zed -Board, FPGA, Altera FPGA, Intel FPGA ASIC design Flow, Xilinx Vivado, Quaturs-3 Software Simulation.

Unit IV: **08 Lecture Hours**

Network on Chip: Bus based Approach, NoC approach, NoC types, Comparison and Performance of NoC topological networks, reconfigurable structures, Packet switched network for on-chip communication – energy reliability tradeoff for NoC's – clocking strategies – parallel computer as NoC's region.

Unit V: **10 Lecture Hours**

SOC Design: Introduction to SoC Design, MPSoC, Designing of Energy Aware MPSoCs, Performance modeling of MPSoC, ASIC to System and NoC, Network topology, Concept of heterogeneous real time system, design optimization, multi-cluster system, multicluster optimization, mapping and partitioning, frame packing, System partition, FPGA partitioning, Partitioning methods, Floor planning, Placement, Physical Design Flow, Global routing, Detailed routing, Special routing, Circuit extraction, DRC, AMBA Bus, PCI Bus, CAN Controller.

Textbooks

1. Ricardo Reis, "Design of System on a Chip: Devices and Components", 1st Edition, 2004, Springer.
2. Wolf Wayne, "FPGA Based System Design", Pearson Education India, 2004.
3. Chakravarthi Veena S "A Practical Approach to VLSI System on Chip (SoC) Design", Springer International Publisher, 2020.
4. Perry L Douglas (2013) "VHDL Design by Example" TMH Publication, ISBN: 978-0071400701.terials and Novel Devices, Wiley-VCH, 2003.

Reference Books

1. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", McGraw Hill, 1994.
2. Design manuals of Altera, Xilinx and Actel. (From the web).

3. P. Marwedel, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, Third Edition, Springer, 2018.
4. Jr. Roth, Charles H., Lizy Kurian John, Digital Systems Design Using VHDL (January 2017), 3rd Edition.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Specialization in 5G & 6G Technology

Course Code	Course name	L	T	P	C
	Electromagnetic Waves and Antennas	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Principle of Electromagnetic field theory.
2. Principle of radiation & Evaluation of fields and power radiated by an antenna.
3. Various parameters for the characterization of antennas.
4. Antenna array concept.
5. Different practical antennas used for airborne applications.
6. EM wave propagation in free space as sky wave and space wave propagation under Line-of-sight communication.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand various antenna parameters.

CO 2 Understand Sky Wave and space wave propagation in free space and LOS propagation and draw the radiation pattern of any type of antenna by determining the radiated fields.

CO 3 Analyse the fields and wave radiated by an antenna.

CO 4 Analyse and design antenna array with uniform and non-uniform excitations.

CO 5 Design and analyse of practical antennas and calculate its parameters (Gain, HPBW, Bandwidth etc).

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	1	-	-	-	-	-	-	-	-	-	-	1
CO 2	1	1	1	-	-	-	-	-	-	-	-	-	-	1
CO 3	2	2	1	-	2	-	-	-	-	-	-	-	-	2
CO 4	2	2	3	-	2	-	-	-	-	-	-	-	-	2
Average	1.5	1.5	1.5	-	2	-	-	-	-	-	-	-	-	1.5

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 10 Lecture Hours

Fundamentals of EM waves: Maxwell's Equations in Different Final Forms and Word Statements, Continuity equation, Wave Equations for Conducting and Perfect Dielectric Media, Uniform Plane Waves, Wave Propagation in Lossless and Conducting Media, Wave Propagation in Good Conductors and Good Dielectrics, Polarization, Poynting Vector and Poynting Theorem Reflection and Refraction of Plane Waves – Normal and Oblique Incidences, for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total Internal Reflection, Surface Impedance.

Unit II: 10 Lecture Hours

Fundamentals of Radiation: Introduction of antennas, Radiation from oscillating dipole antenna parameters – Gain, Directivity, Effective aperture, Radiation Resistance, bandwidth, beamwidth, input impedance, polarization mismatch, Antenna noise temperature. Half wave dipole, Folded dipole, Yagi-Uda array, Matching Networks, Baluns.

Unit III: 05 Lecture Hours

Antenna Array: Two-element arrays, Pattern Multiplication, N-element Uniform Linear Arrays – Broadside and End-fire Arrays, Concept of Scanning Arrays. Non-Uniform array: Binomial Arrays and Chebyshev array design. Planar array.

Unit IV: 10 Lecture Hours

Practical Antennas: Uniform Rectangular apertures, Tapered aperture, Horn antenna, Slot Antenna

Reflector antenna, Aperture blockage feeding structures microstrip antennas, Frequency Independent Antennas, Spiral Antenna, Helical Antenna, Log Periodic Antenna, Reconfigurable Antenna, Active Antenna, Dielectric Antennas Antenna measurement: test ranges, measurement of gain, radiation pattern, polarization, and VSWR.

Unit V: 10 Lecture Hours

Propagation of Radio Waves: Concepts of Propagation – frequency ranges. Ground Wave Propagation, Sky Wave Propagation – Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance. Optimum Working Frequency, Virtual Height, Ionospheric Abnormalities. Fundamental Equation for Free-Space Propagation, Space Wave Propagation Tropospheric Wave Propagation – LOS and NLOS propagation, Radius of Curvature of path, M-curves and Duct Propagation.

Textbooks

1. J. D. Kraus, A. S. Khan and R. J. Marhefka, "Antennas& wave propagation", TMH 5thed, 2016.
2. E.C. Jordan and K.G. Balmain, Electromagnetic Waves and Radiating Systems, PHI, 2ndEdition, 2000.
3. Mathew N.O Sadikku, Elements of Electromagnetics, Oxford Press,3rd End

Reference Books

1. RE Collin, "Antennas and Radio Wave Propagation "McGraw Hill 1985.

2. Constantine. A. Balanis, “Antenna Theory Analysis and Design”, Wiley student Edition. 2006.
3. S. Drabowitch, “Modern Antennas” Second Edition Publications, 2007.
4. Robert S. Elliott, “Antenna Theory and Design” Wiley student Edition, 2006.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Cellular and Mobile Communication	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To introduce the concept of cellular and the example of cellular communication systems.
2. To learn the concept of frequency reuse and how to design the cellular systems in different environments.
3. To introduce the concept of call processing mechanism.
4. To introduce the concept of multiple access

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the technologies used in cellular communication systems.

CO 2 Compute the concept of frequency reuse and design the cellular systems.

CO 3 Analyze different generation of mobile technology.

CO 4 Interpret and apply the concept of multiple access.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	2	-	-	-	-	-	-	-	-	2	2
CO 2	2	2	1	2	-	-	-	-	-	-	-	-	2	2
CO 3	2	2	1	2	-	-	-	-	-	-	-	-	2	2
CO 4	2	1	1	2	-	-	-	-	-	-	-	-	2	2
Average	2	2	2	2	-	-	-	-	-	-	-	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 08 Lecture Hours

Introduction to Cellular Communication Systems: Evolution of mobile radio communications, examples of wireless comm. systems, paging systems, Cordless telephone systems, comparison of various wireless systems.

Fundamental of Cellular Mobile Systems: Spectrum Allocation, basic Cellular Systems, performance Criteria, Operation of cellular systems, analog cellular systems, digital Cellular Systems.

Unit II: 08 Lecture Hours

Design of Cellular System Mobile Systems: Frequency Reuse, channel assignment strategies, handoff Strategies, Interference and system capacity, tracking and grade off service, improving coverage and capacity.

Unit III: 08 Lecture Hours

Multiple Access Techniques for Wireless Communication: Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access, packet ratio, capacity of a cellular systems.

Unit IV: 18 Lecture Hours

Generation of Cellular Communication Systems: First Generation cellular networks, Second generation cellular networks; MS, NTSC, BSC, Channel, Framing, efficiency. Third generation wireless networks; CDMA, HSPA, HSPA+, AMPS system. Fourth generation cellular networks: LTE, LTE-A, Architecture, Call connection and data flow. Fifth generation cellular networks: NR, Architecture, efficiency.

Textbooks

1. K. Feher, Wireless Digital Communication, Prentice Hall of India, New Delhi, 1995, ISBN: 0130986178, 9780130986177.

Reference Books

1. T.S. Rappaport, Wireless Communication; Principles and Practice, Prentice Hall, NJ, 2009, ISBN: 978-81-317-2882-6.
2. W.C.Y. Lee, Mobile Communication Engineering; Theory and Application, Second Edition, McGraw-Hill International, 1998, ISBN: 0070371032, 9780070371033

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Next Generation Communication Technology	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Describe the evolution of mobile communication leading to the introduction of 5G.
2. Discuss key issues and challenges in 5G deployment.
3. Providing a basic knowledge on the key technologies and enablers of 5G and beyond communication systems.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand different cellular mobile communication standard from 1G to 5G.

CO 2 Identify the spectrum requirements and key challenges for 5G systems.

CO 3 Interpret knowledge on various radio access technologies used 5G networks.

CO 4 Identify key technologies and enablers of 5G communication systems.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	1	2	-	-	-	-	-	-	2	2	2
CO 2	2	1	2	1	2	-	-	-	-	-	-	2	1	2
CO 3	2	1	2	2	2	-	-	-	-	-	-	2	1	2
CO 4	2	2	2	1	2	-	-	-	-	-	-	2	1	2
Average	2	2	2	1	1	-	-	-	-	-	-	2	1	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **08 Lecture Hours**

DRIVERS FOR 5G: Introduction – Historical trend of cellular mobile communication – evolution of mobile cellular communication: 1G- AMPS, 2G- GSM. 2.5G- GPRS, 3G- WCDMA LTE and LTE-A, 5G features and challenges, 5G vision, 5G Road map, Pillars of 5G, 5G service requirements, 5G use cases: Internet of Things (IoT) and ultra-reliable low latency communication (URLLC), VR, Industrial automation, 5G Radio Network specifications.

Unit II: **12 Lecture Hours**

5G Spectrum: Introduction – 5G spectrum landscape and requirements: Spectrum for 5G – Spectrum Challenges in 5G, 5G-New Radio (NR); Spectrum Access Modes and Sharing Scenarios; Spectrum access modes and sharing scenarios. 5G spectrum technologies – value of spectrum for 5G: a techno – economic perspectives.

Unit III: **12 Lecture Hours**

5G Radio Access Methodologies: 5G waveform techniques: OFDM, filtered bank multicarrier (FBMC), GFDM, Universal Filtered Multicarrier (UFMC), OTFS. Access Design Principles for Multi-user Communications – Multi-carrier with Filtering – Nonorthogonal Schemes for Efficient Multiple Access- NOMA – Radio Access for Dense Deployments – Radio Access for V2X Communication – Radio Access for Massive Machine-type Communication.

Unit IV: **12 Lecture Hours**

5G Key Technologies: Channels, Networking, Small cells, massive MIMO, mm Wave; Small Cells – Capacity limits and Achievable gains with densification – Mobile data demand – Demand vs Capacity – small cell challenges. Small cells: Past, present, and future trends of cellular networks coverage and capacity of small cell networks Interference management, D2D architecture Towards IoT Spectrum sharing.

Textbooks

Reference Books

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Satellite System Engineering	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To introduce the concept of satellite functioning with example of Indian contest.
2. To learn the concept of orbital mechanism and subsystem of satellite.
3. To analyse the link established between earth and satellite.
4. To introduce the concept of navigational satellite system.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the working of a communication satellite link.

CO 2 Compute and analyse the orbital concept employed in communication satellite system.

CO 3 Interpret the concept of transmission of carrier signal using different access methods employed in satellite message delivery.

CO 4 Design the basic link equation of satellite transmission.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	2	2	-	-	-	-	-	-	-	2	2
CO 2	2	2	1	2	2	-	-	-	-	-	-	-	2	2
CO 3	2	2	1	2	1	-	-	-	-	-	-	-	2	2
CO 4	2	2	1	2	2	-	-	-	-	-	-	-	2	1
Average	2	2	1	2	2	-	-	-	-	-	-	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 08 Lecture Hours

INTRODUCTION: Origin of Satellite Communications, Historical Background, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future

Trends of Satellite Communications. Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.

Unit II: 08 Lecture Hours

SATELLITE SUBSYSTEMS: Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment reliability and Space qualification. Earth station: Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods.

Unit III: 10 Lecture Hours

SATELLITE LINK DESIGN: Basic transmission theory, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example.

Unit IV: 08 Lecture Hours

MULTIPLE ACCESS: Frequency division multiple access (FDMA) Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA), Spread spectrum transmission and reception.

Unit V: 08 Lecture Hours

SATELLITE NAVIGATION & THE GLOBAL POSITIONING SYSTEM: Radio and Satellite Navigation, GPS Position Location principles, GPS Receivers and codes, Satellite signal acquisition, GPS Navigation Message, GPS signal levels, GPS receiver operation, GPS C/A code accuracy, Differential GPS.

Textbooks

1. Digital Satellite Communication – T. T. Ha, 3rd ed, McGraw Hill.

Reference Books

1. T. Pratt, Ch. Bostain, J. Allnutt, Satellite Communications, 2nd edition, John Wiley & Sons, 1986
2. Dennis Roddy, Satellite Communications, 3rd ed., McGraw-Hill, 2001.
3. Elbert, Introduction to Satellite Communications, 2nd ed., Artech House, 1999.
4. G. Maral, M. Bousquet, Satellite Communications systems, 2nd edition, John Wiley & Sons, 2002.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Vehicular Communication	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To introduce students with the emerging technologies, standards, and applications in vehicular communication systems and networks.
2. To make the students appreciate the challenges and design considerations of vehicle-to anything (V2X) communications at various networking layers.
3. To teach how to simulate various aspects of a vehicular communication network and investigate and compare the performances of various solutions.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand and describe the basic theories, principles, technologies, standards, and system architecture of vehicular networks.

CO 2 Analyze, design, and evaluate vehicular communication technologies for various kinds of safety and infotainment applications.

CO 3 Evaluate and compare vehicular routing and information dissemination protocols.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	3	2	2	-	-	-	-	-	-	2	2	3
CO 2	3	2	3	2	2	-	-	-	-	-	-	2	1	3
CO 3	2	2	3	2	2	-	-	-	-	-	-	2	1	3
Average	2	2	3	2	2	-	-	-	-	-	-	2	1	3

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 08 Lecture Hours

Applications of V2X: Safety vs. non-safety; Use cases: Traffic information systems, Safety critical applications; Mapping service requirements to communication technologies.

Unit II: **08 Lecture Hours**

Layering and Standards: Fundamental principles of layering, DSRC/WAVE, ETSI ITS-G5 and ARIB architectures; DSRC standard: Channelization, SAE J2735 message set dictionary, Basic Safety Message, IEEE 1609 WAVE multi-channel operation, IEEE 802.11p MAC and PHY.

Unit III: **13 Lecture Hours**

Vehicular channel characteristics: Pathloss, Shadowing and Small-scale fading, Delay spread. and Doppler spread, Coherence bandwidth and coherence time, Impact of channel impairments on system design; Techniques for combating channel impairments; Digital modulation schemes in 802.11p; Design of OFDM parameters in 802.11p (symbol time, subcarrier spacing, pilot spacing); Transmit power control and transmit masks.

Unit IV: **12 Lecture Hours**

Routing in VANETs: Flooding and the 'Broadcast Storm Problem'; Traditional MANET routing: Topology based / table-driven routing protocols, Proactive (DSDV) vs. Reactive / On-demand (DSR, AODV, DYMO) routing protocols; Geographic routing protocols; Beaconing; DTN and peer-to-peer ideas for VANET routing; Vehicular network simulations using VEINS: Mobility models, Traffic flow models.

Textbooks/ Reference Books

1. Christophe Sommer and Falko Dressler, Vehicular Networking, Cambridge University Press, 2014.
2. Hannes Hartenstein and Kenneth Laberteaux (eds.), VANET Vehicular Applications and Inter-networking Technologies, John Wiley & Sons, 2009.
3. Claudia Campolo, Antonella Molinaro and Riccardo Scopigno, Vehicular ad hoc Networks: Standards, Solutions, and Research, Springer, 2015.
4. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Specialization in Industrial Drive

Course Code	Course name	L	T	P	C
	Advanced Microcontroller & Interfacing	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To familiar with the basic concepts and architecture of 16-bit and 32-bit microcontrollers.
2. Program the different hardware with Embedded 'C'.
3. Interface the different peripherals through serial & parallel ports in 16/32bit microcontrollers.
4. Build the real time embedded system and test the performance.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the operation of microprocessors and microcontrollers.

CO 2 Apply the assembly and Embedded 'C' for industrial applications and systems to develop intelligent electronics systems.

CO 3 Analyse the interfacing and interpret data focusing on applications of microcontrollers.

CO 4 Assemble I/Os devices and peripherals.

CO 5 Configure the microprocessor/microcontroller-based system for the real world.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	1	-	3	3	-	-	-	3	-	2	1	2	2
CO 2	2	2	-	2	3	-	-	-	2	-	2	1	2	1
CO 3	2	2	-	3	1	-	-	-	2	-	1	1	2	1
CO 4	1	2	-	3	3	-	-	-	3	-	2	1	2	3
CO 5	1	2	-	3	3	-	-	-	3	-	2	1	2	3
Average	2	2	-	3	3	-	-	-	3	-	2	1	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **07 Lecture Hours**

Advanced Microcontroller Fundamentals: RISC, CISC, instruction set, programming techniques, Pipelined Concept, Parallel computing, Assembly language & C programming-Development, Tools, Cross Compilers, Hardware Design Issues.

Unit II: **09 Lecture Hours**

MSP430 Architecture: The MSP430 Architecture, CPU Registers, Instruction Set, addressing modes, the MSP430 family viz. MSP430x2x, MSP430x4x, MSP430x5x. Low power aspects of MSP430: low power modes, active Vs standby current consumption, FRAM Vs Flash for low power and reliability.

Unit III: **10 Lecture Hours**

Microcontroller Peripherals and Interfacing: LEDs, LCD, Memory, EEPROM, I/O Ports, Timers, Keyboard, DC Motor, Stepper motor, Servo motor, RTC, BLDC motor, UART, Interrupt Structure, Serial Communication with PC, ADC/DAC Types Interfacing, Data Acquisition system, Watchdog Timer.

Unit IV: **10 Lecture Hours**

ARM ARCHITECTURE AND ORGANISATION: Arcon RISC Machine, Architectural Inheritance, Core & Architectures - Registers, ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families, ARM organization.

Unit V: **10 Lecture Hours**

ARM PROGRAMMING AND APPLICATIONS: Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions., Thumb instruction set, The ARM Programmer's mode, ARM Development tools, Instruction cycle timings, ARM Assembly Language Programming and 'C Compiler programming. MMU, Page Tables, Translation, Access Permissions, Context Switch, IDE Development, Applications of ARM in Wireless sensor networks, Robotics.

Textbooks

1. John H. Davies Paper back: MSP430 Microcontroller Basics, 2008
2. ARM Systems Developer's Guides- Designing & Optimizing System Software – Andrew N. Sloss, Dominic Symes, Chris Wright, 2008, Elsevier.
3. Steve Furber, 'ARM system on chip architecture', Addision Wesley.
4. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield 'ARM System Developer's Guide Designing and Optimizing System Software', Elsevier 2007.
5. K. Uma Rao, Andhe Pallav, The 8051 and MSP430 Microcontrollers: Architecture, Programming and Applications, Wiley
6. Ünsalan, Cem, Hüseyin Deniz Gürhan, and Mehmet Erkin Yücel (2022) "Microcontroller Architecture." Embedded System Design with ARM Cortex-M Microcontrollers. Springer, Cham, 7-25.

Reference Books

1. Trevor Martin, 'The Insider's Guide To The Philips ARM7-Based Microcontrollers, An Engineer's Introduction To The LPC2100 Series' Hitex (UK) Ltd.
2. Dananjay V. Gadre 'Programming and Customizing the AVR microcontroller', McGraw Hill 2001.
3. MSP430™ MCUs Development Guide Book, Texas Instruments, 2020.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Advanced Electrical Drives	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To provide state-of-the-art speed control techniques used in modern ac drives, fed from LCI/VSI/CSI, for superior high-performance requirements.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the concepts of electrical converters for various machine drives.

CO 2 Understand working of different DC & AC asynchronous machine drives and analyse their performance in modern applications.

CO 3 Analyse the performance of various magnet and magnet less drives.

CO 4 Familiarize soft switching in inverters and converters utilizing resonant circuits and to understand modern and evolutionary techniques such as fuzzy and ANN control.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	2	1	1	1	1	-	-	-	-	-	-	1	1
CO 2	2	2	-	2	-	-	1	-	-	-	1	-	2	2
CO 3	2	-	-	-	-	1	2	-	-	-	2	-	2	2
CO 4	1	-	-	2	1	-	1	-	-	-	1	-	1	1
Average	1.5	2	1	1.66	1	1	1.33	-	-	-	1.33	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 05 Lecture Hours

Review of Power Converters: Power electronic converters for ac drive control, voltage source and current source inverters.

Unit II: 12 Lecture Hours

LCI and FOC of IM Drive: Drive configuration, commutation at different speeds, mathematical modeling, control structure, resonance problem and performance, direct and indirect FOC, influence of parameters, VSI and CSI fed schemes, adaptive drive control.

Unit III: 12 Lecture Hours

Brushless DC and Permanent Magnet SM Drives: Self-control, CSI with load commutation, low speed commutation, inverter control strategies and performance, Principle of operation for SM Drives, converter configuration, synchronization, trapezoidal and sinusoidal drive control structures, and performance.

Unit IV: 06 Lecture Hours

Switched Reluctance Motor Drives: Principle of operation, converter circuits, sensors, speed control and performance.

Unit V: 10 Lecture Hours

Resonant-Link Converters and Advanced Control Techniques: Principle of soft switching in inverters and converters utilizing resonant circuits, modulation strategies and application in IM drives, Application of modern and evolutionary techniques in drives such as fuzzy and ANN control.

Textbooks

1. Dubey G. K., "Power Semiconductor Controlled Drives", Prentice-Hall International Editions.
2. Bose B. K., "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.
3. Krishnan R., “Electric Motor Drives – Modeling, Analysis and Control”, Prentice Hall of India Private Limited.

Reference Books

1. Murphy J. M. D. and Turnbull F. G., “Power Electronics Control of AC Motors”, Peragmon Press.
2. Bose B. K., “Modern Power Electronics and AC Drives”, Pearson Education.
3. Leonard W., “Control of Electric Drives”, Springer Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Industrial Converters	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To provide state-of-the-art topologies of industry power converters for high power applications

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the concepts of different power converters.

CO 2 Apply the concepts of power converters for different applications.

CO 3 Analyse the performance of various power converters.

CO 4 Implement the different topologies of power converters.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	2	1	1	1	1	-	-	-	-	-	-	1	1
CO 2	2	2	-	2	-	-	1	-	-	-	1	-	2	2
CO 3	2	-	-	-	-	1	2	-	-	-	2	-	2	2
CO 4	1	-	-	2	1	-	1	-	-	-	1	-	1	1
Average	1.5	2	1	1.66	1	1	1.33	-	-	-	1.33	-	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 07 Lecture Hours

Review: Brief Introduction to Components in Power Electronics, Calculation of Losses and Cooling, Uncontrolled and Phase controlled rectifiers.

Unit II: 15 Lecture Hours

DC to DC Converter: Modelling and operating principles of Non-isolated DC-DC converter topologies, Isolated DC-DC converter topologies, Small signal modelling, Control of DC-DC converter, Soft-switching converters and Applications.

Unit III: **15 Lecture Hours**

DC to AC Converter: Modelling and operating principles of two-level voltage source inverter (VSI), multilevel VSI and Selective Harmonic Elimination, current source inverter (CSI). PWM techniques for the inverters and applications.

Unit IV: **08 Lecture Hours**

AC to AC Converter: Operating principles of AC voltage controllers, Cyclo-converter, Matrix Converter and Applications.

Textbooks

1. Dubey G. K., "Power Semiconductor Controlled Drives", Prentice-Hall International Editions.
2. Bose B. K., "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.
3. Krishnan R., “Electric Motor Drives – Modeling, Analysis and Control”, Prentice Hall of India Private Limited.

Reference Books

1. Murphy J. M. D. and Turnbull F. G., “Power Electronics Control of AC Motors”, Peragmon Press.
2. Bose B. K., “Modern Power Electronics and AC Drives”, Pearson Education.
3. Leonard W., “Control of Electric Drives”, Springer Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Nonlinear Control System	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To introduce the need and concept of nonlinear system.
2. To enable students for developing a variety of methods for analyzing the structure and behavior of nonlinear feedback systems.
3. To enable students basic design techniques including feedback linearization, feedback passivation, Lyapunov design, backstepping.
4. To familiarize with the design of different types of nonlinear controllers.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand tools for stability analysis and response evaluation of control problems with significant nonlinearities.

CO 2 Compute the performance and stability of the system.

CO 3 Identify the design problem and distinguish between the controls strategies.

CO 4 Correlate between design parameters and the system performance.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	3	1	1	1	-	-	-	-	-	-	1	2	2
CO 2	3	3	2	1	1	-	-	-	-	-	-	1	2	2
CO 3	3	3	2	1	1	-	-	-	-	-	-	1	2	2
CO 4	3	3	2	2	2	-	-	-	-	-	-	2	2	2
Average	3	3	2	1	1	-	-	-	-	-	-	1	2	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **09 Lecture Hours**

UNIT I: Linear versus nonlinear systems - Describing function analysis: Fundamentals, common nonlinearities (saturation, dead - zone, on - off non - linearity, backlash, hysteresis) and their describing functions.

Unit II: **09 Lecture Hours**

Describing function analysis of nonlinear systems. Reliability of describing method analysis. Compensation and design of nonlinear system using describing function method. Phase plane analysis: Phase portraits, Singular points characterization. Analysis of non - linear systems using phase plane technique. Existence of limit cycles. Linearization: Exact linearization, input - state linearization, input - output linearization.

Unit III: **09 Lecture Hours**

Concept of stability, Zero - input and BIBO stability, stability in the sense of Lyapunov and absolute stability, Stability in the small and stability in the large, Lyapunov stability definitions, First method of Lyapunov, Second (or direct) method of Lyapunov stability theory for continuous and discrete time systems, Aids to generate Lyapunov function – Krasovskii's theorem, Variable gradient method.

Unit IV: **09 Lecture Hours**

Aizerman's and Kalman's conjecture. Construction of Lyapunov function - Methods of Aizerman, Zubov, Variable gradient method. Lure problem. Popov's stability criterion, generalized circle criterion, Kalman - Yakubovich - Popov Lemma. Popov's hyperstability theorem.

Unit V: **09 Lecture Hours**

Concept of variable - structure controller and sliding control, reaching condition and reaching mode, implementation of switching control laws. Reduction of chattering in sliding and steady state mode. Some design examples of nonlinear systems such as the ball and beam, flight control, magnetic levitation and robotic manipulator etc.

Textbooks

1. J. E. Slotine and Weiping LI, Applied Nonlinear Control, Prentice Hall,
2. Hassan K. Khalil, Nonlinear Systems, Prentice Hall, 1996.

Reference Books

1. Sankar Sastry, Nonlinear Systems Analysis, Stability and Control.
2. M. Vidyasagar, Nonlinear Systems Analysis, Prentice - Hall International editions,1993.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C

	Hybrid Electric Vehicle	3	0	0	3
Total Units to be Covered:	**Total Contact Hours:**				
Prerequisite(s):		**Syllabus version:**			

Course Objectives

1. To impart a basic knowledge of Battery Electric Vehicles (BEV) & Hybrid Electric Vehicles (HEV).
2. To give students an understanding of Electric Motor Drives used in BEV and HEVs and their configurations, optimization, control and applications.
3. To enable students to acquire basic knowledge about Energy Storage Systems used in BEV and HEV, and Battery Management Systems.
4. To give students an insight into the role of Energy Management System, and support systems (Electrical overlay harness & communications, steering & braking systems)

Course Outcomes

On completion of this course, the students will be able to

CO 1 Select appropriate cycle. source of energy for the hybrid electric vehicle based on driving cycle.

CO 2 Analyze the power and energy need of the various hybrid electric vehicle.

CO 3 Measure and estimate the energy consumption of the Hybrid Vehicles.

CO 4 Evaluate energy efficiency of the vehicle for its drive trains.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	-	-	-	-	-	-	1	-	-	1	-
CO 2	-	-		2	-	2	-	-	2	-	-	-	1	-
CO 3	-	2	-	-	3	-	1	-	-	-	1	2	1	-
Average	2	1	2	2	3	2	1	-	2	1	1	2	1	-

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **14 Lecture Hours**

INTRODUCTION: ELECTRIC VEHICLE: History, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, Comparison with Internal

combustion Engine: Benefits and Challenges, EV classification and their electrification levels. EV Terminology.

Unit II: **14 Lecture Hours**

TRACTIVE EFFORT AND EV ARCHITECTURE: Calculating the Rolling Resistance, calculating the grade resistance, Calculating The Acceleration Force, Finding The Total Tractive Effort, Torque Required On The Drive Wheel. Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV, Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles.

Unit III: **10 Lecture Hours**

ELECTRIC DRIVE AND CONTROLLER: Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor, Electrical connection of motor.

Unit IV: **07 Lecture Hours**

ENERGY STORAGE SOLUTIONS: Cell Types (Lead Acid/Li/NiMH), Battery charging and discharging calculation, Cell Selection and sizing, Battery lay outing design, Battery Pack Configuration, Battery Pack Construction, Battery selection criteria, Need of BMS, Rule based control and optimization-based control, Software-based high level supervisory control, Mode of power, Behavior of motor, Advance Features.

Textbooks

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
4. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Specialization in AI & ML Applications

Course Code	Course name	L	T	P	C
	Statistics & Data Science	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand and use linear and non-linear regression models and classification techniques for data analysis.

CO 2 Implement scientific and technical computing using the SciPy package and its sub-packages such as Integrate, Optimize, Statistics, IO, and Weave.

CO 3 Analyze the concepts recommendation engine, time series modeling, gain practical mastery over principles, algorithms, and applications of Machine Learning.

CO 4 Analyze data using Tableau and become proficient in building interactive dashboards.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	1	2	-	-	1	-	-	-	-	-	-	-	1
CO 2	2	2	1	-	-	-	-	-	-	-	-	-	-	1
CO 3	1	2	2	-	-	-	-	--	-	-	-	-	-	1
CO 4	2	1	1	-	-	-	-	-	1	-	-	-	-	1
Average	1.75	1.5	1.5	-	-	1	-	-	1		-	-	-	1

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 08 Lecture Hours

Introduction-Sample or Population Data?-The Fundamentals of Descriptive Statistics-Measures of Central Tendency, Asymmetry, and Variability-Practical Example: Descriptive Statistics-Distributions-Estimators and Estimates-Confidence Intervals: Advanced Topics-Practical Example: Inferential Statistics-Hypothesis Testing: Introduction-Hypothesis Testing: Let's Start Testing!-Practical Example: Hypothesis Testing-The Fundamentals of Regression

Analysis-Subtleties of Regression Analysis-Assumptions for Linear Regression Analysis-Dealing with Categorical Data- Practical Example: Regression Analysis

Unit II: 04 Lecture Hours

Python for Data Science: Python Basics- Python Data Structures-Python Programming Fundamentals- Working with Data in Python- Working with NumPy Arrays.

Unit III: 08 Lecture Hours

Applied Data Science with Python: Data Science Overview- Data Analytics Overview-Statistical Analysis and Business Applications-Python Environment Setup and Essentials-Mathematical Computing with Python (NumPy)-Scientific Computing with Python (SciPy)-Data Manipulation with Pandas-Data Visualization in Python using Matplotlib.

Unit IV: 10 Lecture Hours

Machine Learning: Introduction to Artificial Intelligence and Machine Learning-Data Preprocessing- Supervised Learning-Feature Engineering- Supervised Learning-Classification-Unsupervised Learning-Time Series Modelling-Ensemble Learning-Recommender Systems.

Unit V: 08 Lecture Hours

Tableau: Getting Started with Tableau- Core Tableau in Topics- Creating Charts in Tableau-Working with Metadata- Filters in Tableau- Applying Analytics to the worksheet - Dashboard in Tableau- Modifications to Data Connections- Introduction to Level of Details in Tableau (LODS).

Unit VI: 07 Lecture Hours

Data Science Capstone Project: Data Processing - Apply various data processing techniques to make raw data meaningful.

Model Building - Leveraging techniques such as regression and decision trees to build Machine Learning models that enable accurate and intelligent predictions. One may explore Python, R, or SAS to develop one's model. One will follow the complete model-building exercise from data split to test and validate data using the k-fold cross- validation process.

Model Fine-tuning - Apply various techniques to improve the accuracy of your model and select the champion model that provides the best accuracy.

Dash-Boarding and Representing Results - As the final step, one will be required to export one's results into a dashboard with meaningful insights using Tableau.

Textbooks/ Reference Books

1. Practical Statistics for Data Scientists by Peter Bruce (Author), Andrew Bruce (Author)O′Reilly Publication, 2017.
2. Data Science from Scratch: First Principles with Python, Second Edition Paperback – 5 May 2019 by Joel Grus (Author), O′Reilly Publication.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Soft Computing Techniques	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable students, understand basics of soft computing techniques.
2. To enable students, understand fuzzy logic and fuzzy system.
3. To make students learn and implement metaheuristic algorithms
4. To make students understand artificial neural networks.

Course Outcomes

On completion of this course, the students will be able to

CO 1	Understand soft computing techniques and their roles in building intelligent machines.
CO 2	Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
CO 3	Analyze metaheuristic algorithms to solve combinatorial optimization problems.
CO 4	Implement regression and classification problems using artificial neural network.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	3	2	-	-	-	-	-	-	3	-	2
CO 2	3	3	3	3	2	-	-	-	-	-	-	3	-	2
CO 3	3	3	3	3	2	-	-	-	-	-	-	3	-	2
CO 4	3	3	3	3	2	-	-	-	-	-	-	3	-	2
Average	3	3	3	3	2	-	-	-	-	-	-	3	-	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 06 Lecture Hours

Introduction to Soft Computing: Concept of computing systems, "Soft" computing versus "Hard" computing, Characteristics of Soft computing, Applications of Soft computing techniques.

Unit II: **10 Lecture Hours**

Fuzzy logic: Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic.

Unit III: **12 Lecture Hours**

Metaheuristic Techniques: Introduction to metaheuristic algorithms, key principles, types and applications of metaheuristic algorithms. No Free Lunch theorem. Foraging, trail laying/following mechanisms. Genetic Algorithms (GA) and Particle swarm optimization (PSO). Recently developed algorithms: Grey Wolf Optimization (GWO) and Whale Optimization Algorithm (WOA). Case studies using Python/MATLAB programming language.

Unit IV: **07 Lecture Hours**

Multi-objective Optimization Problem Solving: Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Some applications with MOEAs.

Unit V: **10 Lecture Hours**

Artificial Neural Networks: Introduction to neural network, artificial neuron model, types of activation function, neural network architectures, feed forward neural networks: single layer perceptron and multi-layer perceptron neural network. Learning processes: error correction learning, memory-based learning, Hebbian learning, competitive learning. Adaptive filtering algorithm, method of steepest descent, Newton's method, Gauss Newton's method, Linear least square algorithm. Perceptron, learning rate, epochs. Neural network training using gradient descent and the back propagation algorithm. Neural network as function approximator.

Textbooks/ Reference Books

1. Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms, Samir Roy, Udit Chakraborty, Pearson, 2013.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
3. Practical genetic algorithms, R. L. Haupt & S. E. Haupt, Second Edition, Wiley.
4. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Artificial Intelligence	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable students to understand the basics of artificial intelligence.
2. To enable students learn heuristic and game playing techniques.
3. To make students understand supervised and unsupervised machine learning algorithms.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the basics of artificial intelligence.

CO 2 Analyse heuristic search and game playing algorithms.

CO 3 Identify different ways of real-world knowledge representation.

CO 4 Implement different types of machine learning algorithms.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	3	3	3	3	2	-	-	-	-	3	-	2
CO 2	3	2	3	3	3	2	2	-	-	-	-	3	-	2
CO 3	3	2	3	3	3	2	2	-	-	-	-	3	-	2
CO 4	3	2	3	3	3	3	2	-	-	-	-	3	-	2
Average	3	2	3	3	3	3	2	-	-	-	-	3	-	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **08 Lecture Hours**

Overview of Artificial Intelligence: Definition and brief history of artificial intelligence, emulation of human cognitive process, foundation, sub-areas and applications of artificial intelligence. Production system, state space representation, nature of environment, structure of agents, Introduction to artificial intelligence programming language: LISP, Prolog and Python.

Unit II: **10 Lecture Hours**

Heuristic Search and Game Playing Techniques: Heuristic Search techniques: General and Test, Hill climbing, Depth first search, Breadth first search, Best first search, A*, AND/OR Graphs; Problem Reduction and AO* algorithm, constraints satisfaction and mean-end analysis algorithm. Game Playing: Minmax search procedure; Alpha-Beta pruning algorithm.

Unit III: 09 Lecture Hours

Knowledge Representation: Knowledge representation and mapping, approaches to knowledge representation, issues in knowledge representation, and categories of knowledge representation: structure based, logic based, procedural based and graph-based knowledge representation. Frames, conceptual dependency, scripts, semantic network, propositional logic, first order predicate logic, quantifiers and resolution.

Unit IV: 10 Lecture Hours

Supervised Machine Learning Algorithms: Introduction and brief history of machine learning, Types of machine learning: supervised learning and unsupervised learning. Linear regression with one variable, model representation, definition of cost function. Gradient descent algorithm for linear regression with one variable and multiple variables. Features and Polynomial Regression. Logistic regression: classification, hypothesis representation and decision boundary. Multiclass classification. Regularized Linear Regression and Regularized Logistic Regression. Supervised classification algorithms: k nearest neighborhood algorithm (kNN), support vector machines, Decision Trees, Random Forest, Bayes Optimal Classifier. Case studies in python programming language.

Unit V: 08 Lecture Hours

Unsupervised Machine Learning Algorithms: Dimensionality reduction: Principal Component Analysis. Data Compression and its reconstruction. Application of Principal Component Analysis algorithm. Unsupervised machine learning algorithm. Clustering: k-means, spectral clustering, and hierarchical clustering and density-based clustering algorithm. Case studies in python programming language.

Textbooks

1. Artificial Intelligence, Elaine Rich, Kevin Knight, Shivashankar N Nair, Third Edition, TMH.
2. Artificial Intelligence, Saroj Kaushik, CENGAGE Learning.
3. Machine Learning, Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, 1st Edition, Pearson.

Reference Books

1. Artificial Intelligence and Intelligent systems, N. P. Padhy, OXFORD University Press.
2. Introduction to Machine Learning, Ethem Alpaydin, Third Edition, MIT Press, 2014.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Deep Learning	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. To enable students to understand the mathematical, statistical and computational challenges of building neural networks.
2. To enable students to understand the concept of deep networks and dimensionality reduction technique.
3. To develop students' skills in convolutional and recurrent neural networks.
4. To enable students to solve engineering problems using deep learning algorithms.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the basics of dimensionality reduction technique and deep neural networks.

CO 2 Analyse different types of deep networks, viz. convolutional and recurrent neural network.

CO 3 Implement deep neural network for real time engineering applications.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	3	2	2	-	-	-	-	-	-	3	-	2
CO 2	3	2	2	2	2	-	-	-	-	-	-	3	-	2
CO 3	3	2	3	2	3	-	-	-	-	-	-	3	-	2
Average	3	2	3	2	2	-	-	-	-	-	-	3	-	2

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**
3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: 08 Lecture Hours

Introduction of Artificial Neural Network: Introduction to neural network, artificial neuron model, types of activation function, neural network architectures, feed forward neural networks: single layer perceptron and multi-layer perceptron neural network. Neural network training using

gradient descent and the back propagation algorithm. Neural network as function approximator.

Unit II: 07 Lecture Hours

Deep Neural Networks and Dimensionality Reduction: History of Deep Learning, A Probabilistic Theory of Deep Learning, Backpropagation and regularization, batch normalization, VC Dimension and Neural Nets-Deep Vs Shallow Networks, Principal component analysis, auto encoders and dimensionality reduction in networks, data compression and its reconstruction. Application of Principal component analysis.

Unit III: 10 Lecture Hours

Convolutional Neural Network: Convolutional Neural Networks: Architectures, Convolution and pooling operation, Padding and Stride, ConvNet Architectures: Discussions on famous convnet architectures –LeNet, AlexNet, VGG, Network in Network, GoogLeNet, ResNet, DenseNet, Training a Convnet: weights initialization, batch normalization, hyperparameter optimization.

Unit IV: 10 Lecture Hours

Recurrent Neural Network: Recurrent Neural Networks (RNNs), Language Model and Sequence Generation, Sampling Novel Sequences, Vanishing Gradient with RNN, Long-Short Term Memory (LSTM) architectures, Gated Recurrent Unit, Encoder Decoder architectures, Recurrent Neural Network Language Models, Word-Level RNNs & Deep Reinforcement Learning.

Unit V: 10 Lecture Hours

Deep Learning Applications: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models, Attention models for computer vision tasks. Audio detection, Natural Language Processing, Word2Vec, Joint Detection, Bioinformatics, Face Recognition.

Textbooks

1. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
2. Neural Networks and Deep Learning, Michael Nielsen, Determination Press, 2015.
3. Deep learning from Scratch, Seth Weidman, Oreilly.

Reference Books

1. Deep Learning with Python, Francois Chollet, Manning.
2. Neural networks and learning machines, Simon Haykins, Third Edition, PHI.
3. Python Deep Learning, Ivan Vasilev, Daniel Slater, Gianmario Spacagna, Peter Roelants Valentino Zocca, Second Edition, Packt Publishing Limited.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Course Code	Course name	L	T	P	C
	Neural Language Processing	3	0	0	3
Total Units to be Covered:		Total Contact Hours:			
Prerequisite(s):		Syllabus version:			

Course Objectives

1. Develop a comprehensive understanding of the fundamental concepts and techniques of natural language processing (NLP), including language modeling, parsing, and text classification.
2. Learn to apply NLP techniques to real-world problems, such as sentiment analysis, machine translation, and text summarization.
3. Understand the limitations and challenges of NLP, including issues of data quality, interpretability, and ethical considerations.
4. Develop the ability to critically evaluate and design NLP systems, and to communicate research findings and results effectively.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand and apply fundamental concepts of natural language processing, such as language structure, syntax, semantics, and pragmatics.

CO 2 Design and implement natural language processing algorithms and models, including machine learning techniques for text classification, sentiment analysis, and named entity recognition.

CO 3 Evaluate and compare the performance of different natural language processing techniques and understand their limitations and strengths.

CO 4 Apply natural language processing techniques to real-world problems and applications, such as natural language generation, dialogue systems, and information retrieval.

CO-PO Mapping

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	1	1	2	-	-	-	-	-	-	3	-	1
CO 2	2	2	2	1	2	-	-	-	-	-	-	3	-	1
CO 3	2	2	1	1	2	-	-	-	-	-	-	3	-	1
CO 4	2	2	1	1	1	-	-	-	-	-	-	3	-	1
Average	2	2	1	1	2	-	-	-	-	-	-	3	-	1

1 – Weakly Mapped (Low) **2 – Moderately Mapped (Medium)**

3 – Strongly Mapped (High) **"_" means there is no correlation**

Syllabus

Unit I: **06 Lecture Hours**

Introduction to Natural Language Processing: Overview of NLP and its applications; History and development of NLP; Key concepts and terminologies in NLP; Text representation and pre-processing techniques.

Unit II: **10 Lecture Hours**

Syntax and Parsing: Sentence structure and grammar; Parsing algorithms and techniques; Dependency parsing and constituency parsing; Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs. Neural shift-reduce dependency parsing, Applications of parsing in NLP.

Unit III: **10 Lecture Hours**

Semantics and Pragmatics: Understanding the meaning of text; Semantic representation and reasoning; Pragmatics and context in NLP; Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labelling and Semantic Parsing. Applications of semantics and pragmatics in NLP.

Unit IV: **09 Lecture Hours**

Machine Learning in NLP: Overview of machine learning and its applications in NLP; Supervised and unsupervised learning techniques; Feature extraction and representation; Applications of machine learning in NLP tasks such as sentiment analysis and named entity recognition.

Unit V: **10 Lecture Hours**

Advanced NLP Topics: Text summarization and generation, Dialogue systems and conversational agents, Machine translation and multilingual NLP, Applications of NLP in emerging areas such as virtual assistants and chatbots.

Textbooks

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing.
2. T Ganegedara "Natural Language Processing with TensorFlow".

Reference Books

1. Richard Sproat, Natural Language Processing and Computational Linguistics".
2. Christopher Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing".

Online simulators and resources

Coursera (https://www.coursera.org/)

NLTK (Natural Language Toolkit) (https://www.nltk.org/)

spaCy (https://spacy.io/)

TensorFlow (https://www.tensorflow.org/)

Kaggle (https://www.kaggle.com/)

OpenAI's GPT-3 (https://openai.com/)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Detailed breakup of Internal Assessment

Version Control

Details		Name	Date
Created by	**Cluster Head/ Programme head**		
Checked by	**IQAC**		
Approved by	**Dean**		

CCC/ DCC meeting date	
Board of Studies Approval Date	
AC subcommittee approval date	
Academic Council approval Date	

Version: **Approval Date:**