KPR Institute of Engineering and Technology

Learn Beyond (Autonomous, NAAC "A")

Avinashi Road, Arasur, Coimbatore.

Great Place To Work. Certified MAR 2022 - MAR 2023 INDIA

B.E. – Electronics and Communication Engineering

Curriculum and Syllabi

Regulations – 2021 (Revised)

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I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

Mission

- Commitment to offer value-based education and enhancement of practical skills.
- Continuous assessment of teaching and learning processes through scholarly activities.
- Enriching research and innovation activities in collaboration with industry and institutes of repute
- Ensuring the academic processes to uphold culture, ethics and social responsibilities.

II. Vision and Mission of the Department

Vision

To be a centre of excellence for education, research and development in the field of Electronics and Communication Engineering to meet the growing needs of the society

Mission

The Mission of the Department is to

- Develop competencies in emerging technologies through skill based education collaborating with industries of repute
- Provide conducive environment for research and innovation to cater to the needs of the society
- Inculcate professionalism, ethical values and lifelong learning

III. Program Educational Objectives (PEOs)

PEO1: Apply principles of Electronics and Communication Engineering to provide solutions to the emerging problems in the society

PEO2: Embrace technological challenges through skill upgradation or higher education or research

PEO3: Exhibit leadership qualities with professional and ethical values

IV. Program Outcomes (POs)

Graduates of Electronics and Communication Engineering will be able to

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

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex electronics and communication engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/ development of solutions: Design solutions for complex electronics and communication 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.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex electronics and communication engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

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

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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

V. Program Specific Outcomes (PSOs)

Graduates of Electronics and Communication Engineering will be able to

PSO 1: Design and develop intelligent systems using embedded controllers, Internet of Things and network security protocols.

PSO 2: Design, fabricate and test modern antennas for communication systems.

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VII. Mapping of Course Outcomes with Program Outcomes

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM I	Heritage of Tamils	-	-	-	-	-	-	✓	✓	-	✓	-	✓	-	-
	Introduction to Electrical and Electronics Engineering	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-
	Calculus and Differential Equations	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-	-
	English for Technologist	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Engineering Physics	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-
	Engineering Chemistry	✓	✓	✓	✓	-	-	✓	-	✓	-	-	✓	-	-
	Problem Solving and C Programming	✓	✓	✓	✓	-	-	-	-	✓	✓	✓	✓	-	-
	Engineering Studio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-
SEM II	Tamils and Technology	-	-	-	-	-	-	✓	✓	-	✓	-	✓	-	-
	Circuit Analysis	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-
	Materials Science	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
	Personality Enhancement	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Linear Algebra and Complex Variables	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	-	-
	Python Programming	✓	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	-	-
	Electronic Devices and Circuits	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	Engineering Graphics	✓	✓	✓	✓	✓	-	-	✓	-	-	-	✓	-	-
SEM III	Probability and Random Processes	✓	✓	✓	✓	✓	✓	-	-	-	-	-	✓	-	-
	Signals and Systems	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Analog Electronics	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-

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SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM III	Analog Communication	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Data Structures	✓	✓	✓	✓	-	-	-	-	✓	✓	-	✓	-	-
	Linear Integrated Circuits	✓	✓	✓	✓	-	-	-	-	✓	✓	-	✓	✓	-
	Digital Electronics	✓	✓	✓	✓	-	-	-	-	✓	✓	-	✓	✓	-
	Analog Electronics Laboratory	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-
	Design Studio I	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓	✓	✓
SEM IV	Electromagnetic Fields and Waveguides	✓	✓	✓	-	-	-	✓	-	-	-	-	✓	-	✓
	Digital Signal Processing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Digital Communication	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Java Programming	✓	✓	✓	✓	-	-	-	-	✓	✓	-	✓	-	-
	Microprocessors and Microcontrollers	✓	✓	✓	✓	-	-	-	-	✓	✓	-	✓	✓	-
	Soft Skills – I	-	-	-	-	-	-	-	-	✓	✓	-	✓	-	-
	Analog and Digital Communication Laboratory	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
	Digital Signal Processing Laboratory	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-
	Design Studio II	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	✓	✓
SEM V	Transmission Lines and Antennas	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Control System Theory	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	-
	Computer Communication Networks	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	Soft Skills - II	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-
	RF and Antenna Design Laboratory	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	✓
	Proto Studio I	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓	✓	✓

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SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM VI	Embedded Systems and IoT	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	-
	VLSI Design	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	-
	Artificial Intelligence and Machine Learning	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	Soft Skills - III	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Embedded Systems and IoT Laboratory	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-
	Proto Studio II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SEM VII	Wireless Communication	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	✓
	Optical and Microwave Engineering	✓	✓	✓	✓	-	-	-	-	✓	✓	-	✓	-	✓
	Project work Phase - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SEM VIII	Project work Phase - II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VERTICAL 1: IC Design and Testing	Verilog Programming	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	-
	System Design using FPGA	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	-
	CMOS Analog Circuit Design	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	-
	Physical Design Automation	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	-
	Design for Testability	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	VLSI Verification Methodologies	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	-
	System on Chip	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	CMOS Memory Design	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
VERTICAL 2: Signal Processing	Statistical Signal Processing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Speech Processing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Medical Signal Processing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Medical Electronics	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Radar signal Processing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	VLSI Signal Processing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Digital Imaging	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	DSP Processor Architecture	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	DSP Integrated Circuits	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
VERTICAL 3: IoT for Smart Systems	Sensors and Transducers for IoT	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Embedded Programming for IoT	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	IoT Architecture and Protocols	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Advanced Controllers for IIoT	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	IoT Cloud Computing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	IoT Security and Privacy	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Industry 4.0 and Industrial IoT	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	IoT Based Smart Systems	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-

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SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
VERTICAL 4: Advanced Communication Technologies	Adhoc and Wireless Sensors Networks	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	Network Security for Communication	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-
	5G Wireless Standard Design	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	✓
	Vehicular Communication	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	✓
	Body Area Networks and Sensors	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	✓
	Electromagnetic Interference and Compatibility	✓	✓	✓	✓	✓	-	-	-	✓	✓	-	✓	-	✓
	Software Defined Networks	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Optical Networks	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Satellite Communication	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Advanced Communication System	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Cognitive Radio	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

REGULATIONS – 2021

For the students admitted in the year 2022 onwards

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I - VIII SEMESTERS



SEMESTER I

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21GEG01	Heritage of Tamils	HSMC	1	0	0	0	1
2	U21EC101	Introduction to Electrical and Electronics Engineering	BSC	2	0	0	0	2
3	U21MA101	Calculus and Differential Equations	BSC	3	1	0	0	4
	THEORY COURSE WITH LABORATORY COMPONENT							
4	U21EN101	English for Technologists	HSMC	1	0	2	0	2
5	U21PH101	Engineering Physics	BSC	2	0	2	0	3
6	U21CY101	Engineering Chemistry	BSC	2	0	2	0	3
7	U21CSG01	Problem Solving and C Programming	ESC	2	0	2	0	3
	LABORATORY COURSES							
8	U21ECG03	Engineering Studio	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC01	Induction program	MNC	Three Weeks				
			TOTAL	**13**	**1**	**12**	**0**	**20**

SEMESTER II

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21GEG02	Tamils and Technology	HSMC	1	0	0	0	1
2	U21EC201	Circuit Analysis	ESC	3	0	0	0	3
3	U21PH201	Materials Science	ESC	2	0	0	0	2
	THEORY COURSE WITH LABORATORY COMPONENT							
4	U21EN201	Personality Enhancement	HSMC	1	0	2	0	2
5	U21MA206	Linear Algebra and Complex Variables	BSC	3	0	2	0	4
6	U21CSG02	Python Programming	ESC	2	0	2	0	3
7	U21EC202	Electronic Devices and Circuits	PCC	2	0	2	0	3
	LABORATORY COURSES							
8	U21MEG01	Engineering Graphics	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC02	Environmental Science	MNC	1	0	0	0	0
			TOTAL	**15**	**0**	**12**	**0**	**20**

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SEMESTER III

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA304	Probability and Random Processes	BSC	3	0	0	0	3
2	U21EC301	Signals and Systems	PCC	3	1	0	0	4
3	U21EC302	Analog Electronics	PCC	3	0	0	0	3
4	U21EC303	Analog Communication	PCC	2	0	0	0	2
	THEORY COURSE WITH LABORATORY COMPONENT							
5	U21CSG03	Data Structures	ESC	2	0	2	0	3
6	U21EC304	Linear Integrated Circuits	PCC	2	0	2	0	3
7	U21ECG01	Digital Electronics	PCC	2	0	2	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
8	U21EC305	Analog Electronics Laboratory	PCC	0	0	2	2	2
9	U21EC306	Design Studio I	EEC	0	0	0	2	1
	MANDATORY NON CREDIT COURSES							
10	U21MYC03	Essence of Indian Traditional Knowledge	MNC	1	0	0	0	0
			TOTAL	18	1	8	4	24

SEMESTER IV

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EC401	Electromagnetic Fields and Waveguides	PCC	3	0	0	0	3
2	U21EC402	Digital Signal Processing	PCC	3	0	0	0	3
3	U21EC403	Digital Communication	PCC	2	0	0	0	2
4		Open Elective – I	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
5	U21CSG04	Java Programming	ESC	2	0	2	0	3
6	U21EC404	Microprocessors and Microcontrollers	PCC	3	0	2	0	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG01	Soft Skills – I	HSMC	0	0	2	0	1
8	U21EC405	Analog and Digital Communication Laboratory	PCC	0	0	4	0	2
9	U21EC406	Digital Signal Processing Laboratory	PCC	0	0	2	2	2
10	U21EC407	Design Studio II	EEC	0	0	0	2	1
	MANDATORY NON CREDIT COURSES							
11	U21MYC04	Indian Constitution	MNC	1	0	0	0	0
			TOTAL	17	0	12	4	24

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SEMESTER V

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EC501	Transmission Lines and Antennas	PCC	3	1	0	0	4
2	U21EC502	Control System Theory	PCC	3	1	0	0	4
3		Professional Elective - I	PEC	3	0	0	0	3
4		Professional Elective - II	PEC	3	0	0	0	3
5		Open Elective - II	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
6	U21EC503	Computer Communication Networks	PCC	3	0	2	0	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG02	Soft Skills - II	HSMC	0	0	2	0	1
8	U21EC504	RF and Antenna Design Laboratory	PCC	0	0	2	2	2
9	U21EC506	Proto Studio I	EEC	0	0	0	2	1
	MANDATORY NON CREDIT COURSES							
10	U21MYC05	Cyber Security Essentials	MNC	1	0	0	0	0
	OPTIONAL COURSE							
11	U21EC507	(Live-in-Labs – I)	(HSMC)	3	0	0	0	3
			TOTAL	19	2	6	4	25

SEMESTER VI

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21ECG05	Embedded Systems and IoT	PCC	3	0	0	0	3
2		Professional Elective - III	PEC	3	0	0	0	3
3		Professional Elective - IV	PEC	3	0	0	0	3
4		Open Elective - III	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
5	U21EC601	VLSI Design	PCC	2	0	2	0	3
6	U21AMG01	Artificial Intelligence and Machine Learning	ESC	3	0	2	0	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG03	Soft Skills - III	HSMC	0	0	2	0	1
8	U21ECG06	Embedded Systems and IoT Laboratory	EEC	0	0	2	2	2
9	U21EC602	Proto Studio II	EEC	0	0	0	2	1
	MANDATORY NON CREDIT COURSES							
10	U21MYC06	Introduction to UN SDGs: An Integrative Approach	MNC	1	0	0	0	0
	OPTIONAL COURSE							
11	U21EC603	(Live-in-Labs – II)	(HSMC)	3	0	0	0	3
			TOTAL	18	0	8	4	23

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SEMESTER VII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1		Professional Elective – V	PEC	3	0	0	0	3
2		Professional Elective – VI	PEC	3	0	0	0	3
3		Open Elective – IV	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
4	U21EC701	Wireless Communication	PCC	3	0	2	0	4
5	U21EC702	Optical and Microwave Engineering	PCC	3	0	2	0	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
6	U21EC704	Project work Phase - I	EEC	0	0	0	4	2
			TOTAL	**15**	**0**	**4**	**4**	**19**

SEMESTER VIII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EC802	Project work Phase - II	EEC	0	0	0	16	8
			TOTAL	**0**	**0**	**0**	**16**	**8**

INDUSTRIAL TRAINING / INTERNSHIP

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECI01	Industrial Training / Internship *	EEC	0	0	0	0	2
			TOTAL	**0**	**0**	**0**	**0**	**2**

*Four Weeks during any semester vacation from III to VI Semester

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NCC CREDIT COURSES:

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21NCC01	National Cadet Corps - I	-	1	0	2	0	2
2	U21NCC02	National Cadet Corps - II	-	1	0	2	0	2
3	U21NCC03	National Cadet Corps - III	-	1	0	2	0	2
4	U21NCC04	National Cadet Corps - IV	-	2	0	2	0	3
5	U21NCC05	National Cadet Corps - V	-	1	0	2	0	2
6	U21NCC06	National Cadet Corps - VI	-	2	0	2	0	3
				8	-	12	-	14

NCC Credit Course (Level 1 – Level 6) are offered for NCC students only. The grades earned by the students will be recorded in the mark sheet, however the same shall not be considered for the computation of CGPA.

TOTAL CREDITS: 165

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PROFESSIONAL ELECTIVES COURSES: VERTICALS

Vertical I (IC Design and Testing)	Vertical II (Signal Processing)	Vertical III (IoT for Smart Systems)	Vertical IV (Advanced Communication Technologies)
Verilog Programming	Statistical signal Processing	Sensors and Transducers for IoT	Adhoc and Wireless Sensors Networks
System Design using FPGA	Speech Processing	Embedded Programming for IoT	Network Security for Communication
CMOS Analog Circuit Design	Medical Signal Processing	IoT Architecture and Protocols	5G Wireless Standard Design
Physical Design Automation	Medical Electronics	Advanced Controllers for IIoT	Vehicular Communication
Design for Testability	Radar signal Processing	IoT Cloud Computing	Body Area Networks and Sensors
VLSI Verification Methodologies	VLSI Signal Processing	IoT Security and Privacy	Electromagnetic Interference and Compatibility
System On Chip	Digital Imaging	Industry 4.0 and Industrial IoT	Software Defined Networks
CMOS Memory Design	DSP Processor Architecture	IoT Based Smart Systems	Optical Networks
	DSP Integrated Circuits		Satellite Communication
			Advanced Communication System
			Cognitive Radio

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V to VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VII.

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1: IC Design and Testing

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECP01	Verilog Programming	PEC	2	0	2	0	3
2	U21ECP06	System Design using FPGA	PEC	2	0	2	0	3
3	U21ECP04	CMOS Analog Circuit Design	PEC	2	0	2	0	3
4	U21ECP03	Physical Design Automation	PEC	2	0	2	0	3
5	U21ECP07	Design for Testability	PEC	3	0	0	0	3
6	U21ECP02	VLSI Verification Methodologies	PEC	2	0	2	0	3
7	U21ECP05	System on Chip	PEC	3	0	0	0	3
8	U21ECP08	CMOS Memory Design	PEC	3	0	0	0	3

VERTICAL 2: Signal Processing

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECP10	Statistical Signal Processing	PEC	3	0	0	0	3
2	U21ECP11	Speech Processing	PEC	3	0	0	0	3
3	U21ECP12	Medical Signal Processing	PEC	3	0	0	0	3
4	U21ECP45	Medical Electronics	PEC	3	0	0	0	3
5	U21ECP14	Radar signal Processing	PEC	3	0	0	0	3
6	U21ECP15	VLSI Signal Processing	PEC	3	0	0	0	3
7	U21ECP16	Digital Imaging	PEC	3	0	0	0	3
8	U21ECP09	DSP Processor Architecture	PEC	3	0	0	0	3
9	U21ECP13	DSP Integrated Circuits	PEC	3	0	0	0	3

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VERTICAL 3: IoT for Smart Systems

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECP17	Sensors and Transducers for IoT	PEC	3	0	0	0	3
2	U21ECP20	Embedded Programming for IoT	PEC	2	0	2	0	3
3	U21ECP19	IoT Architecture and Protocols	PEC	3	0	0	0	3
4	U21ECP23	Advanced Controllers for IIoT	PEC	2	0	2	0	3
5	U21ECP18	IoT Cloud Computing	PEC	3	0	0	0	3
6	U21ECP21	IoT Security and Privacy	PEC	3	0	0	0	3
7	U21ECP24	Industry 4.0 and Industrial IoT	PEC	2	0	2	0	3
8	U21ECP22	IoT Based Smart Systems	PEC	3	0	0	0	3

VERTICAL 4: Advanced Communication Technologies

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECP25	Adhoc and Wireless Sensors Networks	PEC	2	0	2	0	3
2	U21ECP29	Network Security for Communication	PEC	2	0	2	0	3
3	U21ECP27	5G Wireless Standard Design	PEC	2	0	2	0	3
4	U21ECP31	Vehicular Communication	PEC	2	0	2	0	3
5	U21ECP32	Body Area Networks and Sensors	PEC	2	0	2	0	3
6	U21ECP34	Electromagnetic Interference and Compatibility	PEC	2	0	2	0	3
7	U21ECP30	Software Defined Networks	PEC	3	0	0	0	3
8	U21ECP28	Optical Networks	PEC	3	0	0	0	3
9	U21ECP35	Satellite Communication	PEC	3	0	0	0	3
10	U21ECP26	Advanced Communication System	PEC	3	0	0	0	3
11	U21ECP39	Cognitive Radio	PEC	3	0	0	0	3

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OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I (SEMESTER: IV)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECX01	Consumer Electronics	OEC	3	0	0	0	3
2	U21ECX02	Basics of Communication Technologies	OEC	3	0	0	0	3

OPEN ELECTIVES – II (SEMESTER: V)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECX03	Arduino Programming	OEC	3	0	0	0	3
2	U21ECX04	Electronic Waste Management and Sustainable Practices	OEC	3	0	0	0	3

OPEN ELECTIVES – III (SEMESTER: VI)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECX05	Sensors for Engineering Applications	OEC	3	0	0	0	3
2	U21ECX08	Fundamentals of VLSI Technology	OEC	3	0	0	0	3

OPEN ELECTIVES – IV (SEMESTER: VII)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECX06	Basics of Internet of Things	OEC	3	0	0	0	3
2	U21ECX07	Basics of Image Processing	OEC	3	0	0	0	3

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Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester								Credits
		I	II	III	IV	V	VI	VII	VIII	
1.	Humanities and Social Sciences including Management (HSMC)	3	3	-	1	1	1	-	-	9
2.	Basic Science Courses (BSC)	12	4	3	-	-	-	-	-	19
3.	Engineering Science Courses (ESC)	5	10	3	3	-	4	-	-	25
4.	Professional Core Courses (PCC)	-	3	17	16	14	6	8	-	64
5.	Professional Elective Courses (PEC)	-	-	-	-	6	6	6	-	18
6.	Open Elective Courses (OE)	-	-	-	3	3	3	3	-	12
7.	Employability Enhancement Courses (EEC)	-	-	1	1	1	3	2	8	16
8.	Industrial Training/ Internship	-	-	-	-	-	-	-	2	2
9.	Mandatory Non-Credit Course (MNC)	-	-	-	-	-	-	-	-	-
Total		**20**	**20**	**24**	**24**	**25**	**23**	**19**	**10**	**165**

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

KPRIET

SEMESTER I

		Category: HSMC				
U21GEG01	HERITAGE OF TAMILS (Common to all Programmes)	L	T	P	J	C
		1	0	0	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

Upon completion of the course, the student will be able to

- To learn the extensive literature of classical Tamil
- To review the fine arts heritage of Tamil culture
- To realize the contribution of Tamil in Indian freedom struggle

COURSE OUTCOMES:

CO1: Understand the extensive literature of Tamil and its classical nature (Understand)

CO2: Understand the heritage of sculpture, painting and musical instruments of ancient people (Understand)

CO3: Review on folk and martial arts of Tamil people (Understand)

CO4: Realization of thinai concepts, trade and victory of Chozha dynasty (Understand)

CO5: Understand the contribution of Tamil in Indian freedom struggle, Self-esteem movement and siddha medicine (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO2	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO3	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO4	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO5	-	-	-	-	-	-	3	3	-	2	-	3	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India – Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature – Management Principles in Thirukural – Tamil Epics and Impact of Buddhism & Jainism in Tamil Land – Bakthi Literature Azhwars and Nayanmars – Forms of minor Poetry – Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidhasan

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UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture – Bronze icons – Tribes and their handicrafts – Art of temple car making – Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments – Mridhangam, Parai, Veenai, Yazh and Nadhaswaram – Role of Temples in Social and Economic Life of Tamils

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu – Karagattam – Villu Pattu – Kaniyan Koothu – Oyillattam – Leatherpuppetry – Silambattam – Valari – Tiger dance – Sports and Games of Tamils

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils – Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram Concept of Tamils – Education and Literacy during Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age – Overseas Conquest of Cholas

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle – The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement – Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions and Manuscripts – Print History of Tamil Books

Contact Periods:

Lecture: 15 Periods Tutorial: - Periods Practical: – Periods Project: – Periods

Total: 15 Periods

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian , Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

EVALUATION PATTERN:

Continuous Internal Assessment	Total
	100

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SEMESTER I

		Category: HSMC				
U21GEG01	தமிழர் மரபு (அனைத்து துறைகளுக்கும் பொதுவானது)	L	T	P	J	C
		1	0	0	0	1

முன்கூட்டிய துறைசார் அறிவு: தேவையில்லை

பாடத்தின் நோக்கங்கள்:

- தமிழ் மொழியின் இலக்கியச் செறிவைக் கற்றுணர்தல்
- தமிழர் பண்பாட்டின் தூண்கலைகள் பற்றிய ஒரு மீள்பார்வை
- இந்திய தேசிய இயக்கத்தில் தமிழர்களின் பங்கினை அறிதல்

பாடம் கற்றதின் விளைவுகள்:

CO1: தமிழ் மொழியின் செந்தன்மை மற்றும் இலக்கியங்கள் குறித்த தெரிதல் (புரிதல்)

CO2: தமிழர்களின் சிற்பக்கலை, ஓவியக்கலை மற்றும் இசைக்கருவிகள் குறித்த தெளிவு (புரிதல்)

CO3: தமிழர்களின் நாட்டுப்புறக் கலைகள் மற்றும் வீரவிளையாட்டுகள் குறித்த அறிமுகம் (புரிதல்)

CO4: தமிழர்களின் திணைக் கோட்பாடுகள், சங்ககால வணிகம் மற்றும் சோழர்களின் வெற்றிகள் குறித்த தகவல்கள் (புரிதல்)

CO5: இந்திய தேசிய இயக்கம், சுயமரியாதை இயக்கம் மற்றும் சித்த மருத்துவம் பற்றிய புரிதல் (புரிதல்)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO2	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO3	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO4	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO5	-	-	-	-	-	-	3	3	-	2	-	3	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

பாடத்திட்டங்கள்:

அலகு I மொழி மற்றும் இலக்கியம் 3

இந்திய மொழிக்குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள் – தமிழகத்தில் சமண, பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம் – ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு

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அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக்கலை 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப்பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரி முனையில் திருவள்ளுவர் சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக, பொருளாதார வாழ்வில் கோவில்களின் பங்கு

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள் 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்க காலத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும், துறைமுகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிற பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 15 Periods

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

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11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

மதிப்பீட்டு முறை:

தொடர்ச்சியான உள் மதிப்பீடு	மொத்தம்
	100

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Academic Courses

SEMESTER I

		Category: BSC				
		L	T	P	J	C
U21EC101	INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING (Common to ECE and MI : For ECE, It is offered during I Semester and For MI, It is offered during II Semester)	2	0	0	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the basic concepts of electric circuits
- To acquire the knowledge on constructional details of DC and AC machines
- To understand the working of measuring instruments and consumer electronic gadgets

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Outline the fundamental concepts of electric circuits (Understand)

CO2: Identify the suitable DC machines for real time applications (Apply)

CO3: Explain the construction and operation of AC machines (Understand)

CO4: Select the appropriate instruments to measure electrical parameters (Apply)

CO5: Illustrate working principles of consumer electronic gadgets (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I FUNDAMENTALS OF ELECTRIC CIRCUITS 6

Basic terminology – Voltage, current, power, electromotive force, resistor and its types, capacitors and inductors – Types, V-I relations and energy stored – AC fundamentals – Three phase power supply – Line and phase voltages – Star connection – Delta connection

UNIT II DC MACHINES 6

Construction – Operating principle – Types – Applications of DC generator and motor

UNIT III AC MACHINES 6

Construction – Principle of operation – Types – Applications of transformers – Single and three phase induction motor – Stepper motor – Servo motor

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UNIT IV MEASURING INSTRUMENTS 6

Voltmeter – Ammeter – Digital multimeter – Megger – CRO – Storage oscilloscope – Energy meter – Spectrum Analyzer

UNIT V CONSUMER ELECTRONICS 6

Microphone – Loud speaker – Display devices – Digital cameras – Smart TV – Washing machine – Microwave oven – Mobile phones

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. S.Salivahnan, R.Rengaraj, G R Venkatakrishnan., "Basic Electrical, Electronics and Measurement Engineering", 1st edition, Tata McGraw Hill Publishing Company Ltd, 2018
2. A.K.Sawhney, "A course in Electrical and Electronic Measurements and Instrumentation"' 2nd edition, Dhanpat Rai & Sons, 2005

REFERENCES:

1. Bhattacharya S.K., "Electrical Machines", 4th edition, McGraw-Hill Education, New Delhi, 2017
2. Mitchel E Schultz, "Basic Electronics", 10th edition, McGraw Hill Publishers, 2017
3. Bali S P, "Consumer Electronics", 1st edition, Pearson Education Asia Pvt. Ltd., 2008

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21MA101	CALCULUS AND DIFFERENTIAL EQUATIONS (Common to AD, BM, CE, CH, CS, CS(AIML), EC, IT, ME and MI)	Category: BSC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of matrices and calculus which will enable them to model and analyze physical phenomena involving continuous change
- To understand the methodologies involved in solving problems related to fundamental principles of calculus
- To develop confidence to model mathematical pattern and give appropriate solutions

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply eigenvalue concepts and diagonalization techniques to solve matrix problems in various engineering disciplines (Apply)

CO2: Apply multivariable calculus techniques (partial derivatives, Jacobians, optimization) to analyze functions of several variables in engineering applications (Apply)

CO3: Compute areas and volumes using double and triple integrals for engineering geometry problems (Apply)

CO4: Apply vector calculus theorems (Green's, Gauss's, Stokes') to evaluate line, surface, and volume integrals in engineering field problems (Apply)

CO5: Solve second and higher-order linear differential equations using appropriate methods for modelling engineering systems (Understand)

CO-PO MAPPING:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	1	-	-	-	-	-	-	-	1	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I MATRICES **9+3**

Eigenvalues and eigenvectors – Properties (without proof) – Cayley Hamilton theorem (without proof) – Diagonalization using orthogonal transformation – Applications

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UNIT II FUNCTIONS OF SEVERAL VARIABLES **9+3**

Partial derivatives – Total derivative – Jacobians – Taylor's series expansion – Extreme values of functions of two variables – Lagrange multipliers method

UNIT III MULTIPLE INTEGRALS **9+3**

Double integrals – Change of order of integration – Triple integrals – Applications in area and volume

UNIT IV LINE AND SURFACE INTEGRALS **9+3**

Line integrals – Surface integrals – Green's theorem in a plane – Gauss divergence theorem – Stokes' theorem (excluding proofs)

UNIT V ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Second and higher order linear differential equations with constant coefficients – Variable coefficients – Euler Cauchy equation – Legendre's equation – Method of variation of parameters – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: - Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley India Pvt Ltd, New Delhi, 2018
2. Grewal B S, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, New Delhi, 2017

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications, 2016
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th edition, Pearson Education India, 2018
3. Maurice D Weir, Joel Hass and Christopher Heil, "Thomas Calculus", 14th edition, Pearson Education, India, 2018
4. James Stewart, "Calculus: Early Transcendental", 7th edition, Cengage Learning, New Delhi, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21EN101	ENGLISH FOR TECHNOLOGISTS (Common to AD, BM, CH, CE, CS, CS(AIML), EE, EC, ME, MI and IT)	Category: HSMC				
		L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To Infer and Interpret the meaning of Technical, Business, Social and Academic contexts
- To enhance the listening skills and facilitate effective pronunciation
- To make effective presentation and conversation in technical and professional environment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Use correct language mechanics to communicate clearly and accurately in spoken and written contexts (Understand)

CO2: Improve speaking skills in academic and social contexts (Apply)

CO3: Enhance both reading and writing skills to excel in professional career (Analyze)

CO4: Evaluate different perspectives on a topic (Analyze)

CO5: Comprehend global business communication through advanced listening and personality development (Understand)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	2	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO5	-	-	-	-	-	-	-	2	-	3	-	1	-	-
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I SUBJECTIVE INTROSPECTION 3

Module:1 Vocabulary Building

Activity: Word Puzzles, Snappy words, Word Sleuthing

Module:2 Introducing and Sharing Information

Activity: Get to know oneself, Introducing Peer Members

Module:3 Opinion Paragraph

Activity: Note making, analyzing and writing a review

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UNIT II CAREER ENHANCEMENT 3

Module:4 Reading Comprehension
Activity: Reading Newspaper articles/Blogs, Sentence completion

Module:5 E-mail Communication
Activity: Drafting personal and professional emails

Module:6 Career Profiling
Activity: Resume Writing & Digital Profiling

UNIT III LANGUAGE ADEPTNESS 3

Module:7 Rewriting passages
Activity: Conversion of voices & Rephrasing Articles

Module:8 Enhancing Pronunciation skills
Activity: Listening to short technical Reels and reproducing it

Module:9 Making Conversations
Activity: Role play & Narrating Incidents

UNIT IV TECHNICAL WRITING 3

Module:10 Spotting Errors
Activity: Proof reading, Rewriting sentences

Module:11 Data interpretation
Activity: Interpretation of Graphics/Charts/Graphs

Module:12 Expository Writing
Activity: Picture inference, Captions for Posters& Products

UNIT V LANGUAGE UPSKILLING 3

Module:13 Listening for Specific Information
Activity: TED talks/Announcement/Documentaries

Module:14 Presentation
Activity: Extempore & Persuasive Speech

Module:15 Team Communication
Activity: Team building activities, Group Discussion

LIST OF EXERCISES

1. Introducing oneself
2. Role play
3. Listening to short technical Reels
4. Listening to TED Talks/ Announcements/ Documentaries
5. Presentation
6. Group Discussion

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 45 Periods

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TEXT BOOKS:

1. Ashraf Rizvi, "Effective Technical Communication", 2nd edition, Mc Graw – Hill. India 2017
2. Rod Ellis, "English for Engineers & Technologists", Vol. II: (English for Engineers and Technologist: A Skills Approach). 2nd edition, Orient Black Swan, 1990

REFERENCES:

1. Raymond Murphy, "Intermediate English Grammar", 2nd edition, Cambridge University Press, 2009
2. Thomas L Means, "English and Communication for Colleges", 4th edition, Cengage 2017
3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st edition, Orient Black Swan, 2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2">End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21PH101	ENGINEERING PHYSICS (Common to all Programmes)	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamental principles of laser and fibre optics with their applications
- To acquire the knowledge of ultrasonic waves, thermal conductivity and properties of liquids
- To understand the concepts of crystals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the types of laser for various industrial and medical applications (Understand)

CO2: Apply the principles of fibre optics in sensors, communication and medical applications (Apply)

CO3: Identify the properties and production methods of ultrasonic waves for engineering and medical applications (Apply)

CO4: Utilise the concepts of thermal conductivity and viscosity of liquids for various engineering applications (Apply)

CO5: Apply the concepts of various crystals for the design of ingots and Silicon wafers (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	-	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	-	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I LASER 6

Laser characteristics – Spontaneous and stimulated emission – Pumping methods – CO_2 laser – Semiconductor laser – Material Processing – Selective laser Sintering – Hologram – Medical applications (Opthalmology)

UNIT II FIBER OPTICS 6

Total internal reflection – Numerical aperture and acceptance angle – Classification of optical fibers (Materials, modes and refractive index profile) – Fiber optical communication system – Displacement and temperature sensor – Medical Endoscopy

UNIT III ULTRASONICS 6

Properties of ultrasonic waves – Piezoelectric generator – Acoustic grating – Applications of ultrasonics in industry– SONAR – NDT – Ultrasonic scanning methods – Fetal heart movement

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UNIT IV THERMAL PHYSICS AND PROPERTIES OF LIQUIDS 6

Modes of heat transfer – Thermal conductivity – Lee's disc method – Solar thermal power generation – Hybrid vehicles – Microwave oven – Surface tension and coefficient of viscosity – Poiseuille's flow experiment

UNIT V CRYSTAL PHYSICS 6

Unit cell – Bravais lattices – SC, BCC, FCC structures – Miller indices – d spacing in cubic lattice – Crystal growth from melt: Bridgeman Technique – Silicon ingots from Czochralski method – Silicon wafers from ingots and its applications

LIST OF EXPERIMENTS (INDICATIVE)

1. Determination of the wavelength of a given laser source
2. Determination of acceptance angle and numerical aperture of an optical fibre
3. Determination of velocity of sound and compressibility of a liquid using Ultrasonic interferometer
4. Determination of thermal conductivity of a bad conductor using Lee's disc method
5. Determination of viscosity of the given liquid using Poiseuille's flow method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. Bhattacharya D K and Poonam Tandon, "Engineering Physics", 2nd edition, Oxford University Press, Chennai, 2017
2. Marikani A, "Engineering Physics", 3rd edition, PHI publishers, Chennai, 2021

REFERENCES:

1. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", 2nd edition, Pearson India Education Services Private Limited, Chennai, 2018
2. Avadhanulu M N, Kshirsagar P G and Arun Murthy TVS, "A Text book of Engineering Physics", 2nd Edition, S Chand Publishing, New delhi, 2018
3. Thyagaran K, Ajoy Ghatak, "Lasers – Fundamantals and Applications", 2nd edition, Laxmi Publications Pvt Limited, New delhi, 2019
4. https://nptel.ac.in/downloads/104104085/
5. https://nptel.ac.in/courses/122107035/8/

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

		Category: BSC				
U21CY101	ENGINEERING CHEMISTRY (Common to all Programmes)	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate the fundamentals of water technology and electrochemistry
- To gain basic knowledge of corrosion of metals and alloys
- To acquire knowledge about the properties of fuels and applications of polymers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply water technology principles for the treatment and quality assessment of industrial and domestic water systems (Apply)

CO2: Illustrate the principles and applications of electrochemical cells, fuel cells, and solar cells (Understand)

CO3: Discuss various corrosion processes and the industrial methods used for corrosion prevention (Understand)

CO4: Describe fuel analysis, synthesis, related problems, and pollution prevention techniques (Understand)

CO5: Explain polymer basics, types, processing techniques, and engineering applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	1	-	1	-	-	1	-	-
CO2	2	1	-	-	-	-	1	-	1	-	-	1	-	-
CO3	2	1	-	-	-	-	1	-	1	-	-	1	-	-
CO4	2	1	-	-	-	-	1	-	1	-	-	1	-	-
CO5	2	1	-	-	-	-	1	-	1	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I CHARACTERISTICS OF WATER AND ITS TREATMENT 6

Characteristics of water – Hardness – Types, Dissolved oxygen, Total dissolved solids, Disadvantages due to hard water in industries – (Scale, Sludge, Priming, Foaming and Caustic embrittlement), Water softening methods – Lime-soda, Zeolite, Ion exchange processes and reverse Osmosis and their applications. Specifications of domestic water (ICMR and WHO)

Water treatment for municipal supply – Sedimentation with coagulant – Sand Filtration – Chlorination, Disinfection methods – UV treatment, Ozonolysis, Electro dialysis

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UNIT II ELECTROCHEMISTRY AND ENERGY STORAGE SYSTEMS 6

Introduction, Electrodes – (Calomel electrode), Electrochemical series and its applications, Brief introduction to conventional primary and secondary batteries – (Pb acid, Lithium)

Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells – Working principles, advantages, applications. Solar cells – Dye sensitized solar cells – Working principles, characteristics and applications

UNIT III CORROSION AND ITS CONTROL 6

Types – Dry – Chemical corrosion and Wet – Galvanic and differential aeration (Pitting, Crevice, pipeline) – Factors influencing rate of corrosion – Corrosion control methods – Sacrificial anode and impressed current method – Protective coating – Electroplating – Ni plating

Alloys – Ferrous (stainless steel), Heat treatment – Non-ferrous alloys (Brass -Dutch metal, German Silver) – Composition, properties and uses

UNIT IV FUELS AND COMBUSTION 6

Fuels- Solid fuel: Coal - Analysis of coal (Proximate analysis only) – Liquid fuel – Manufacture of synthetic petrol (Bergius process) – Octane number, cetane number, Knocking in engines- Anti-knocking agents, Gasoline additives, Gaseous fuel: Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – Composition only

Calorific value – Higher and lower calorific values – Flue gas analysis (ORSAT method). Measurement of calorific value using bomb calorimeter, Three-way catalytic converter – Selective catalytic reduction of NOx

UNIT V POLYMERS 6

Introduction – Monomer, dimers, functionality, degree of polymerisation, transition glass temperature Classification of polymers, Difference between thermoplastics and thermosetting plastics, Engineering application of plastics - ABS, PVC, PTFE and Bakelite

Types of compounding of plastics – Moulding, Injection moulding, Extrusion moulding, Compression moulding

Conducting polymers – Polypyrrole, Polyacetylene, Polyaniline – Structure and applications, Composites – FRP – Properties and applications

LIST OF EXPERIMENTS (INDICATIVE)

1. Determination of total, permanent and temporary hardness of a given sample water by EDTA method
2. Estimation of ferrous ion by potentiometric titration
3. Estimation of Copper in Brass by EDTA method
4. Determination of percentage of moisture, volatile, ash and carbon content in a given sample of coal.
5. Determination of molecular weight and degree of polymerization of an oil sample by viscosity measurement (Ostwald's viscometer).
6. Determination of chloride content in the water sample
7. Determination of strength of HCl by pH metric method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods Total: 60 Periods

TEXT BOOKS:

1. Jain P C and Monika Jain, "Engineering Chemistry", 16th edition, Dhanpat Rai Publishing Company, Pvt. Ltd., New Delhi, 2015
2. Vairam S, Kalyani P and Suba Ramesh, "Engineering Chemistry", 2nd edition, Wiley India Pvt. Ltd, New Delhi, 2014

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REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", 2nd edition, Scientific International Pvt. Ltd, New Delhi, 2014
2. Prasanta Rath, "Engineering Chemistry", 1st edition, Cengage Learning India, Pvt. Ltd, Delhi, 2015
3. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications", 1st edition, Cambridge University Press, 2015
4. https://nptel.ac.in/courses/113/104/113104008/

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21CSG01	PROBLEM SOLVING AND C PROGRAMMING (Common to all Programmes)	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To provide exposure to problem-solving through programming
- To develop computational thinking perspective of one's own discipline
- To write, compile and debug programs using C language

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Formulate the algorithmic solutions for a given computational problem (Understand)
CO2: Describe modularization, structures and pointers in C language (Understand)
CO3: Design and implement algorithms for a given problem using C control structures (Apply)
CO4: Apply the C programming constructs for searching and sorting techniques (Apply)
CO5: Solve real time problems using suitable non-primitive data structures in C (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	1	1	-	-	-	-
CO2	2	1	-	-	-	-	-	-	1	1	-	-	-	-
CO3	3	2	1	1	-	-	-	-	1	1	-	-	-	-
CO4	3	2	1	1	-	-	-	-	1	1	-	1	-	-
CO5	3	2	1	1	-	-	-	-	1	1	1	1	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I COMPUTATIONAL THINKING 6

Computational Thinking – Modern Computer – Information based Problem solving – Real world information and Computable Data – Data types and data encoding – Number Systems – Introduction to programming languages – Basics of C programming – variables– Data types – keywords – C program structure – Simple programs in C

UNIT II ALGORITHMIC APPROACH 6

Logic – Boolean Logic – Applications of Propositional logic – Problem Definition – Logical Reasoning and Algorithmic thinking – Pseudo code and Flow chart – Constituents of algorithms – Sequence, Selection and Repetition – Problem understanding and analysis – Control structures in C – Algorithm design and implementation using control structures

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UNIT III SEARCHING, SORTING AND MODULARIZATION 6

Data Organization – Arrays – Introduction to Searching and Sorting – Linear Search, Binary Search – Basic sorting techniques – Two-dimensional arrays – Matrix manipulation – Modularization – Functions – Function prototype – Function definition – Function call – Built-in functions (string functions and math functions) – Recursion

UNIT IV STRUCTURES AND POINTERS 6

Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Example Program – Sorting of names – Parameter passing – Pass by value – Pass by reference – Structure – Nested structures – Pointer and Structures – Array of structures – Example Program using structures and pointers – Unions

UNIT V FILES 6

Files – Types of file processing – Sequential access – Random access – Sequential access file – Example Program – Finding average of numbers stored in sequential access file – Random access file – Example Program – Transaction processing using random access files – Command line arguments

LIST OF EXPERIMENT

A. Lab Programs

1. Using IO Statements, get higher secondary marks of a student. Calculate and display the medical and engineering cut-off marks. [Assume the calculation formula]
2. Develop a C program to emulate the operations of an ATM using control structures. Authentication, Deposit, Withdrawal, and Balance check and pin change operations are to be supported
3. Develop a calculator to perform the operations including addition, subtraction, multiplication, division and square of a number
4. Given different prices of a vegetable which is varying through the day (from morning to evening), find out the best buy price and sell price for the maximum profit. Eg. For the prices [33, 35, 28, 36, 39, 25, 22, 31], best buy is at 28 and best sell is at 39
5. Collect height and weight of 4 of your friends and calculate their body mass index. Use 2 dimensional array to store the values
6. Weights of 10 students of your class who are standing in a line is given in a random order. Find out if there is a heavy person whose weight is the sum of previous two persons
7. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions
8. From a given paragraph perform the following using built-in functions:
    a) Find the total number of words
    b) Capitalize the first word of each sentence
9. Solve Towers of Hanoi using recursion
10. Develop an expense manager which reads date, product, price and product category. The program should display the total expense amount based on product category or date as per user's selection. Use structures
11. Develop a banking application to store details of accounts in a file. Count the number of account holders based on a search condition such as - whose balance is less than the minimum balance

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B. Mini project (SAMPLE)

Create a Railway Reservation system with the following modules of Booking,

- Availability checking
- Cancellation
- Prepare chart

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. David D. Railey and Kenny A.Hunt , "Computational Thinking for Modern problem Solver", 1st Edition, CRC Press, 2014
2. Brian W. Kernighan and Dennis Ritchie, " The C Programming Language" , 2nd Edition, Pearson, 2015

REFERENCES:

1. Paolo Ferragina and Fabrizio Luccio, "Computational Thinking First Algorithms", Then Code" ,1st Edition,Springer International Publishing, 2018
2. Reema Thareja, "Programming in C", 2nd Edition, Oxford University Press, 2016
3. Paul Deitel and Harvey Deitel, "C How to Program", 7th Edition, Pearson Publication
4. Juneja, B. L and Anita Seth, "Programming in C",1st Edition, Cengage Learning India Pvt. Ltd., 2011
5. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", 1st Edition, Oxford University Press, 2009

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21ECG03	ENGINEERING STUDIO (Common to all Programmes)	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To enable the students understand the functioning of simple to complex devices and systems
- To help the students design and build simple applications on their own
- To create an immersive environment in the engineering lab

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Build basic electronics circuits (Apply)

CO2: Select suitable sensors for simple applications (Apply)

CO3: Develop prototype for real time applications (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	-	2	1	-	1	1	-
CO2	3	2	1	1	1	-	-	-	2	1	-	1	1	-
CO3	3	3	2	2	2	2	2	2	2	1	-	2	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

Basics of Electronics

1. Breadboard Basics – LED glowing, Ohm's Law
   Series and Parallel Circuits
2. Controlling the circuit response using Potentiometer
   Capacitor Charging and Discharging
3. Water level Indicator using transistor
   Touch sensor using transistor
4. Automatic night light- (LDR –transistor) circuit
   Fire alarm Circuit
5. IR Sensor-Obstacle detecting circuit
   Doorbell using 555 Timer circuit
6. LED Chaser circuit using Counter IC
   Shadow detector using IC741
7. Regulated output using Regulator IC
   Logic gate Realization

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Basics of IoT (With Arduino)

1. Basics of ARDUINO and IoT
   Working with LEDs
2. Working with digital switch
   Adjusting voltage using potentiometer
3. Measuring the presence / absence of light using LDR
   Finding the distance of an object using ultrasonic sensor
4. Finding the Temperature and Humidity in the surroundings
   Detecting the motion of human using PIR
5. Working with Servo motor
   Establish communication using Bluetooth

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments
Evaluation of course workbook, Tasks **(Rubrics based)**
100

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SEMESTER II

		Category: HSMC				
U21GEG02	TAMILS AND TECHNOLOGY (Common to all programs)	L	T	P	J	C
		1	0	0	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

Upon completion of the course, the student will be able to

- To learn weaving, ceramic and construction technology of Tamils
- To understand the agriculture, irrigation and manufacturing technology of Tamils
- To realize the development of scientific Tamil and Tamil computing

COURSE OUTCOMES:

CO1: Understand the weaving and ceramic technology of ancient Tamil people nature (Understand)

CO2: Understand the construction technology, building materials in sangam period and case studies (Understand)

CO3: Infer the metal process, coin and beads manufacturing with relevant archaeological evidence (Understand)

CO4: Realize the agriculture methods, irrigation technology and pearl diving (Understand)

CO5: Apply the knowledge of scientific Tamil and Tamil computing (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO2	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO3	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO4	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO5	-	-	-	-	-	-	3	3	-	2	-	3	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple) – Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period

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UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting,steel –Copper and gold– Coins as source of history – Minting of Coins – Beads making-industries Stone beads – Glass beads – Terracotta beads – Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project

Contact Periods:

Lecture: 15 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 15 Periods

TEXT - CUM - REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

EVALUATION PATTERN:

	Total
Continuous Internal Assessment	100

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SEMESTER II

		Category: HSMC				
U21GEG02	தமிழரும் தொழில்நுட்பமும் (அனைத்து துறைகளுக்கும் பொதுவானது)	L	T	P	J	C
		1	0	0	0	1

முன்கூட்டிய துறைசார் அறிவு: தேவையில்லை

பாடத்தின் நோக்கங்கள்:

- தமிழர்களின் சங்ககால நெசவு, பானை வனைதல் மற்றும் கட்டட தொழில்நுட்பம் குறித்து அறிதல்
- தமிழர்களின் சங்ககால வேளாண்மை, நீர்ப்பாசனம் மற்றும் உற்பத்தி முறைகள் குறித்த கற்றல்
- நவீன அறிவியல் தமிழ் மற்றும் கணித்தமிழ் குறித்த புரிதல்

பாடம் கற்றதின் விளைவுகள்:

CO1: சங்ககாலத் தமிழர்களின் நெசவு மற்றும் பானை வனைதல் தொழில்நுட்பம் குறித்த கற்றுணர்தல் (புரிதல்)

CO2: சங்ககாலத் தமிழர்களின் கட்டட தொழில்நுட்பம், கட்டுமானப் பொருட்கள் மற்றும் அவற்றை விளக்கும் தளங்கள் குறித்த அறிவு (புரிதல்)

CO3: சங்ககாலத் தமிழர்களின் உலோகத்தொழில், நாணயங்கள் மற்றும் மணிகள் சார்ந்த தொல்லியல் சான்றுகள் பற்றிய அறிவு (புரிதல்)

CO4: சங்ககாலத் தமிழர்களின் வேளாண்மை, நீர்ப்பாசன முறைகள் மற்றும் முத்து குளித்தல் குறித்த தெளிவு (புரிதல்)

CO5: நவீன அறிவியல் தமிழ் மற்றும் கணித்தமிழ் குறித்த புரிந்துகொள்ளலும் மற்றும் பயன்படுத்துதலும் (கற்றலை பயன்படுத்துதல்)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO2	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO3	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO4	-	-	-	-	-	-	3	3	-	2	-	3	-	-
CO5	-	-	-	-	-	-	3	3	-	2	-	3	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

பாடத்திட்டங்கள்:

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம் 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்

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அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் மற்றும் சங்க காலத்தில் வீட்டுப் பொருட்களின் வடிவமைப்பு – சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும் கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல் – மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாடு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை

அலகு III உற்பத்தித் தொழில்நுட்பம் 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருகுதல், எக்கு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள் – கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்

அலகு V அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி – கணினித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக் கழகம் – தமிழ் மின்நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்

Contact Periods:

Lecture: 15 Periods	Tutorial: - Periods	Practical: – Periods	Project	– Periods
			Total	15 Periods

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)

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9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

மதிப்பீட்டு முறை:

தொடர்ச்சியான உள் மதிப்பீடு	மொத்தம்
	100

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SEMESTER II

		Category: ESC				
U21EC201	CIRCUIT ANALYSIS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the basic concepts and different methods of circuit analysis for DC and AC circuits
- To understand the concept of network theorems and transient response
- To study the basic concepts of resonance circuits and two port network parameters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Solve the DC and AC circuits using basic laws (Apply)
CO2: Apply network theorems for complex network reduction (Apply)
CO3: Examine the transient response of RL, RC and RLC circuits (Analyze)
CO4: Illustrate the concepts of resonance and coupled circuits (Understand)
CO5: Explain the characteristics of two port network (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I BASIC CIRCUITS ANALYSIS 9

Basic electrical components – Resistor, capacitor, inductor – DC and AC circuits – Resistors in series and parallel circuits – Ohm's law – Kirchhoff's laws – Mesh current and node voltage method of analysis for DC and AC circuits – Network reduction – Voltage and current division, source transformation, star and delta conversion

UNIT II NETWORK THEOREMS FOR DC AND AC CIRCUITS 9

Network theorems – Superposition theorem, Thevenin's theorem, Norton's theorem, reciprocity theorem, Millman's theorem, maximum power transfer theorem

UNIT III TRANSIENT ANALYSIS 9

Natural response and forced response – Transient response of RC and RL for step input – Complete response of RLC circuits for step input

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UNIT IV RESONANCE AND COUPLED CIRCUITS 9

Series and Parallel resonance – Variation of impedance and current with frequency, bandwidth, Q-factor, selectivity – Coupled circuits – Self–inductance, mutual inductance, dot rule, coefficient of coupling

UNIT V NETWORK PARAMETERS 9

Network parameters – Z-parameters, Y-parameters, transmission (ABCD) parameters, hybrid parameters – Interconnection of two port networks – Interrelationship between two port network parameters

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. William H. Hayt, Jr. Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis", 8th edition, McGraw Hill, 2018
2. Joseph Edminister and Mahmood Nahvi, "Electric Circuits", Schaum's Outline Series, 5th edition,Tata McGraw Hill, New Delhi, 2018

REFERENCES:

1. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", 6th edition, McGraw Hill, 2019
2. A.Bruce Carlson, "Circuits: Engineering Concepts and Analysis of Linear Electric Circuits", 2nd edition, 2017
3. Sudhakar.A and Shyammohan S Palli, "Circuits and Networks: Analysis and Synthesis", 5th edition, McGraw Hill, 2015
4. Allan H.Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", 5th edition, Cengage Learning, 2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21PH201	MATERIALS SCIENCE	Category: ESC				
		L	T	P	J	C
		2	0	0	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To gain the knowledge of conducting and semiconducting materials
- To understand the concepts of magnetic, dielectric and optical properties of materials
- To enhance the knowledge of new engineering materials

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the electrical characteristics of conducting materials (Understand)

CO2: Apply the properties and types of semiconducting materials for the design of various semiconductor devices (Apply)

CO3: Examine the various types of magnetic materials for engineering applications (Analyze)

CO4: Develop the fundamental concepts of dielectric and optical materials (Apply)

CO5: Examine the properties and preparations of new engineering materials and make use of characterization techniques for industrial applications (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-	1	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I CONDUCTING MATERIALS 6

Classical free electron theory – Expression for electrical conductivity and thermal conductivity – Wiedemann - Franz law – Drawbacks – Fermi distribution function – Density of energy states in metals

UNIT II SEMICONDUCTING MATERIALS 6

Intrinsic and Extrinsic semiconductor – Carrier concentration in n-type semiconductor – P-type semiconductor(qualitative) – Applications of semiconductors – Solar cell – LED – Hall effect and its experimental determination

UNIT III MAGNETIC MATERIALS 6

Origin of magnetism – Dia, para and ferro magnetic materials – Domain theory – Soft and hard magnetic materials – Magnetic bubble memories – GMR sensor

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UNIT IV DIELECTRIC AND OPTICAL MATERIALS 6

Dielectrics – Types of polarisation – Electronic polarisation – Dielectric breakdown – Ferroelectrics – Applications of dielectrics – Classification of optical materials – Nonlinear optics – Applications

UNIT V NEW ENGINEERNG MATERIALS AND CHARACTERIZATION TECHNIQUES 6

SMA – SiC – GaN – Rheological materials – Nanomaterials – Synthesis (Ball milling and CVD) – Quantum dot, quantum wire and quantum well(qualitative) – Characterisation techniques – Powder XRD(qualitative) – SEM

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 30 Periods

TEXT BOOKS:

1. Wahab M A, "Solid State Physics: Structure and Properties of Materials", 3rd edition, Narosa Publishing House, Chennai, 2018
2. Marikani A, "Materials Science", 1st edition, PHI publishers, Chennai, 2017

REFERENCES:

1. Pillai S O "Solid State Physics", 9th edition, New Age International Publishers, New Delhi, 2020
2. Bangwei Zhang, "Physical Fundamentals of Nanomaterials", Chemical Industry Press, China, 2018
3. Joginder Singh Galsin, "Solid State Physics – An Introduction to Theory", Academic Press, India, 2019
4. https://nptel.ac.in/courses/108/108/108108122/
5. https://nptel.ac.in/courses/113/105/113105081/

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21EN201	PERSONALITY ENHANCEMENT (Common to AD, BM, CH , CE, CS, CS(AIML),EE,EC,ME,MI and IT)	Category: HSMC				
		L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop of personality traits that contributes in the professional environment
- To create a basic awareness about the significance of soft skills in professional and interpersonal communications
- To enhance the level of self-confidence that helps to excel in the leadership skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Nurture a deep understanding of personality development and interpersonal relationship for overall self-development (Understand)

CO2: Communicate proficiently in high-end interviews and in all social situations (Understand)

CO3: Synthesize complex concepts and present them clearly in speech and writing with logical organization and coherence (Analyze)

CO4: Negotiate effectively and lead teams towards successful outcomes in collaborative situations (Understand)

CO5: Present ideas in an effective manner using web tools (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	1	-	-
CO2	-	-	-	-	-	-	-	1	2	3	-	1	-	-
CO3	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO5	-	-	-	-	-	-	-	1	-	3	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I LEXICAL REASONING 3

Module:1 Establishing Associations

Activity: Verbal Analogy, Logical Reasoning

Module:2 Lateral Thinking

Activity: Reasoning and Assertions

Module:3 Sentence Completion

Activity: Cloze Test, Single Word Substitutes

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UNIT II SOCIAL CORRESPONDENCE 3

Module: 4 Etiquettes
Activity: Brain storming & performing in actions
Module: 5 Introspection
Activity: SWOT Analysis, Goal Setting
Module: 6 Co-verbal Gesture
Activity: Body Language, Nonverbal cues

UNIT III ART OF NETWORKING 3

Module: 7 Addressing a Multitude
Activity: Welcome address, Vote of Thanks, Public Speaking
Module: 8 Persuasive Communication
Activity: Making Technical Presentation
Module: 9 Career Oriented Communication
Activity: Face to face Conversation, Mock Interview

UNIT IV CRITICAL THINKING 3

Module:10 Organizing ideas
Activity: Mind Mapping
Module:11 Problem Solving Skills
Activity: Conflict management, Case Study
Module:12 Critical Review
Activity: Book/ Movie Review, Comparative Analysis

UNIT V CONTENT WRITING 3

Module:13 Reports
Activity: Writing Event Report, Project Report
Module:14 Writing for Digital platform
Activity: Writing Posts, Blogs
Module:15 Developing Content
Activity: Product Description, Writing Proposals

LIST OF EXERCISES

1. Listening to Inspirational Speech
2. Listening to Product Description
3. Book/Movie Review
4. Presentation
5. Mock Interview
6. Public Speaking

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 45 Periods

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TEXT BOOKS:

1. Meenakshi Raman & Sangeetha Sharma. "Professional English: for AKTU",1st edition, Oxford University Press. 2018
2. Barun. K.Mitra. "Personality Development and Soft Skills", OUP India. 2nd edition, 2016

REFERENCES:

1. Mathew Allen. "Smart Thinking: Skills for Critical Understanding and Writing", 2nd edition,OUP India, 2016
2. Means, Thomas L, "English and Communication for Colleges", 4th edition, Cengage 2017
3. Using English, "A Coursebook for Undergraduate Engineers and Technologists", 1st edition,Orient Black Swan, 2017

EVALUATION PATTERN:

Continuous Internal Assessments				**End Semester Examinations**	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21MA206	LINEAR ALGEBRA AND COMPLEX VARIABLES (for EC)	Category: BSC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of vector space for solving time domain control theory
- To use the concepts of complex analysis electrostatics
- To understand the concepts of singularities in the various domains of engineering fields

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply linear system solution techniques (LU decomposition, matrix methods) to solve circuit analysis and control system problems in electronics engineering (Apply)

CO2: Explain concepts of linear independence, basis, and dimension of vector spaces in the context of signal space theory for communications (Understand)

CO3: Compute analytic functions and verify Cauchy-Riemann equations for modelling electromagnetic field problems in electronics (Apply)

CO4: Apply Cauchy's integral theorem and formula to evaluate contour integrals in complex circuit analysis applications (Apply)

CO5: Compute residues and apply the residue theorem to evaluate integrals in signal processing and filter design problems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	1	-	-	-	-	-	-	-	-	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS

UNIT I LINEAR SYSTEMS 9

Geometric interpretation of linear system in 2 and 3 unknowns – Row reduction and echelon forms – Vector equation – Matrix equation Ax=b-LU decomposition – Applications of linear systems

UNIT II VECTOR SPACES 9

Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions – General linear transformations – Kernel and range – Matrices of general linear transformation – Geometry linear operators – Change of basis

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UNIT III COMPLEX DIFFERENTIATION 9

Functions of a complex variable – Analytic functions: Cauchy – Riemann equations (Cartesian form) and sufficient conditions (excluding proof) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Bilinear transformation

UNIT IV COMPLEX INTEGRATION 9

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula

UNIT V SINGULARITIES AND RESIDUES 9

Taylor's and Laurent's series expansions – Singular points – Classification of singularities – Residues – Cauchy's residue theorem

LIST OF EXPERIMENTS

1. Entering row vector, column vector, accessing blocks of elements in MATLAB
2. Entering matrices to locate matrix elements and entering any entry through indexing in MATLAB
3. Find the sum, product, transpose, inverse, determinant and rank of matrices using MATLAB
4. Solving system of linear equations in MATLAB using Gauss elimination method
5. Solving system of linear equations in MATLAB using Inverse method
6. Solving system of linear equations in MATLAB using linsolve
7. Find the poles and zeros of a transfer function using MATLAB

Contact Periods:

Lecture: 45 Periods	Tutorial : – Periods	Practical: 30 Periods	Project: – Periods Total: 75 Periods

TEXT BOOKS

1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publishers, 44th edition, 2017
2. Howard Anton and Chris Rorres, "Elementary Linear Algebra", 11th edition, John Wiley & Sons, 2011

REFERENCES:

1. Bali N.P and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications; 12th edition, 2016
2. Thomas G.B and R.L Finney, "Calculus and Analytic Geometry", Pearson Education India; 14th edition, 2010
3. Gilbert Strang, "Linear Algebra and its Applications", Thomson Learning, 2009
4. Steven J. Leon, "Linear Algebra with Applications", 9th edition, Pearson College Division, 2014

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		35	15
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21CSG02	PYTHON PROGRAMMING (Common to all Programmes)	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand syntax and semantics of python programming
- To implement programs using python data structures
- To gain expertise in using python libraries for solving real time problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the basic concepts of tokens, data types, operators, expressions, and input–output operations in Python (Understand)

CO2: Demonstrate Python programs using control statements and user-defined functions (Apply)

CO3: Solve engineering problems using built-in data structures such as strings, lists, tuples, sets, and dictionaries (Apply)

CO4: Implement exception handling and file-handling mechanisms in Python (Apply)

CO5: Use NumPy and Pandas libraries for data manipulation and computation (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	1	1	-	1	-	-
CO2	3	2	1	1	-	-	-	-	1	1	-	1	-	-
CO3	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO4	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO5	3	2	1	1	2	-	-	-	1	1	1	2	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I LANGUAGE BASICS 6

Python interpreter and interactive mode – Tokens – Data types – Numbers and math functions – Input and Output operations – Comments – Reserved words – Indentation – Operators and expressions – Precedence and associativity – Type conversion – Debugging – Common errors in Python

UNIT II CONTROL STATEMENTS, FUNCTIONS AND MODULES 6

Selection – Conditional branching statements – if – if-else – Nested-if – if-elif-else statements – Iterative statements – while – for loop – break – continue and pass statements – Functions – Function Definition and Function call – Variable scope and Lifetime – Return statement – Lambda functions or Anonymous functions – Recursion – Modules and Packages

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UNIT III PYTHON DATA STRUCTURES 6

Strings – Slicing – Immutability – Built-in string methods and functions – Concatenating – Appending and Multiplying strings – String modules – List – Creation – Accessing values – Slicing – List methods – In-built functions for Lists – Tuples – Creation – Operations on tuples – Traversing – Indexing and Slicing – Tuple assignment – In-built functions for tuples – Sets – Creation – Operations – Dictionaries – operations and methods

UNIT IV EXCEPTION AND FILE HANDLING 6

Exceptions – Errors and Exceptions – Handling exception – Built-in and User-defined exceptions – Files – Types – Operations – Open – Read – Write – Close

UNIT V NUMPY AND PANDAS 6

Numpy – Introduction – Computations using NumPy functions – Computation on Arrays – Aggregation – Indexing and Sorting – Pandas – Introduction and Basic Pandas Concepts – Data frames – Data Handling

LIST OF EXPERIMENTS (INDICATIVE)

1. Programs on selection and Iteration operations.
2. Get an integer input from a user. If the number is odd, then find the factorial of a number and find the number of digits in the factorial of the number. If the number is even, then check the given number is palindrome or not.
3. Strings and its operations.
4. Given two strings, PRINT (YES or NO) whether the second string can be obtained from the first by deletion of none, one or more characters.
5. List and its operations.
6. Programs for positive and negative indexing.
7. Program to check if the given list is in Ascending order or Not.
8. Tuples and its operations.
9. Python program to convert a tuple to a string.
10. Python program to reverse a tuple.
11. Sets and its operations.
12. Python program to check if a set is a subset of another set.
13. Dictionaries and its operations.
14. Python program to iterate over dictionaries using for loops.
15. Computations using NumPy functions.
16. NumPy program to convert a list of numeric value into a one-dimensional NumPy array.
17. NumPy program to convert a list and tuple into arrays.
18. Data manipulations using Pandas.
19. Program to convert a NumPy array and series to data frames.
20. Program to add, subtract, multiple and divide two Pandas Series.
21. Program to retrieve and manipulate data using dataframes.

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

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TEXT BOOKS:

1. Reema Thareja, "Python programming: Using problem solving approach", 1st Edition, Oxford Press, 2017
2. William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition, Shroff/O'Reilly Publication, 2017

REFERENCES:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
2. Ashok Namdev Kamthane and Amit Ashok Kamthane, "Programming and Problem Solving with Python", 2nd Edition, McGrawHill Education, 2018
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach",1st Edition, Pearson India Education Services Pvt. Ltd., 2016
4. https://python-iitk.vlabs.ac.in/List%20of%20experiments.html
5. http://greenteapress.com/wp/think-python/

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td>Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21EC202	ELECTRONIC DEVICES AND CIRCUITS	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the fundamentals of semiconductor devices
- To familiarize the application of diode and transistor
- To analyze the performance of transistor amplifier

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamental properties and current conduction mechanisms of semiconductors (Understand)

CO2: Construct simple electronic circuits applications using semiconductor diodes (Apply)

CO3: Demonstrate the operation and characteristics of BJT and FET devices in basic electronic circuits (Apply)

CO4: Apply biasing techniques and small-signal models to analyze the performance of BJT CE amplifiers (Apply)

CO5: Analyze the high-frequency behavior and frequency response of CE amplifiers (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	1	-
CO3	3	2	1	1	-	-	-	-	2	2	-	1	1	-
CO4	3	2	1	1	-	-	-	-	2	2	-	1	1	-
CO5	3	3	2	2	2	-	-	-	2	2	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SEMICONDUCTOR FUNDAMENTALS 6

Classification of semiconductors – Conductivity of semiconductors – Carrier concentration in intrinsic semiconductor and extrinsic semiconductor – Law of mass–action – Variation in semiconductor parameters with temperature – Drift and diffusion current – Carrier life-time

UNIT II DIODES AND ITS APPLICATIONS 6

Characteristics of PN junction diode and Zener diode – Rectifier circuits – Clipper and Clamper circuits – Voltage regulators

UNIT III BJT and FET 6

NPN and PNP Transistors – Early effect – Input and output characteristics of CE configuration – Construction and operation of JFET and MOSFET

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UNIT IV LOW FREQUENCY BJT AMPLIFIERS 6

DC load line – Stability factor – Biasing methods – Collector to base bias, voltage divider bias – h-parameter transistor model – Small signal analysis of BJT CE amplifier using hybrid π model

UNIT V FREQUENCY RESPONSE OF AMPLIFIERS 6

High frequency CE transistor Model – Miller effect – Frequency response of CE amplifiers – CE short circuit current gain, cut off frequency, gain bandwidth product

LIST OF EXPERIMENTS (INDICATIVE)

1. Study the volt-ampere characteristics of PN diode and Zener diode
2. Applications of PN diode like rectifiers, clippers and clampers
3. Application of Zener diode
4. Characteristics of BJT
5. Characteristics of JFET
6. Audio amplifier using BJT
7. DC motor speed control using MOSFET
8. Frequency response analysis of RC coupled CE amplifier using simulation tool
9. Transient analysis of Wave shaping circuits using simulation tool

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. Donald A Neaman, "Semiconductor Physics and Devices", 4th edition, Tata McGraw–Hill Inc. 2012
2. S. Salivahanan, N.Sureshkumar, A. Vallavaraj, "Electronic Devices and Circuits", 3rd edition, Tata McGraw–Hill Inc., 2010

REFERENCES:

1. Yang, "Fundamentals of Semiconductor devices", 1st edition, McGraw Hill International, 2017
2. Jacob Millman, Christos C Halkias, Satyabrata Jit, "Electronic Devices and Circuits", 4th edition, McGraw Hill India, 2015
3. Robert Boylestad and Louis Nashelsky, "Electron Devices and Circuit Theory", 11th edition, Pearson Prentice Hall, 2014
4. R.S.Sedha, "A Text Book of Applied Electronics", 3rd edition, S. Chand Publications, 2006

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21MEG01	ENGINEERING GRAPHICS	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES

- To expose the standards and conventions followed in preparation of engineering drawings
- To develop graphic skills for communication of concepts, ideas and engineering drawings
- To expose on 2D & 3D drawings and its projections

COURSE OUTCOME:

Upon completion of the course, the student will be able to

CO1: Sketch the curves and orthographic projections of points as per BIS conventions (Understand)

CO2: Illustrate the orthographic projections of straight lines and plane surfaces (Understand)

CO3: Sketch the orthographic projections of solids, lateral surfaces of frustums, truncated solids and its development (Apply)

CO4: Develop the lateral surfaces of simple solids (Apply)

CO5: Interpret the orthographic and isometric views of simple components (Understand)

CO PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	-	-	1	-	-	-	1	-	-
CO2	2	1	-	-	2	-	-	-	-	-	-	1	-	-
CO3	3	2	1	1	2	-	-	-	-	-	-	2	-	-
CO4	3	2	1	1	2	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	2	-	-	-	-	-	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

BASICS OF ENGINEERING DRAWING AND CAD (Not for examination)

Introduction – Drawing instruments and its uses – Sheet layout – BIS conventions – Lines – Lettering and dimensioning practices – Lines – Co – Ordinate points – Axes – Poly lines – Square – Rectangle – Polygons – Splines – Circles – Ellipse – Text – Move – Copy – Off – Set – Mirror – Rotate – Trim – Extend – Break – Chamfer – Fillet – Curves – Constraints viz. agency – Parallelism – Inclination and perpendicularity

UNIT I CONICS, SPECIAL CURVES AND PROJECTION OF POINTS 12

Construction of parabola – Ellipse and hyperbola using eccentricity method – Construction of involutes for squares and circles – Construction of Tangent and normal to the above curves – Introduction – Method of projection – Planes of projection – Reference line and notations – Orthographic Projection of points – Points in all four quadrants

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UNIT II PROJECTION OF STRAIGHT LINES AND SURFACES 12

Projection of straight lines – Lines inclined to HP / VP plane – Inclined to both HP and VP planes (straight lines are assumed to be in first quadrant only) – Projection of planes – Projection of square – Rectangle – Pentagon – Hexagon and circular plane – Inclined to both the plane by change of position method

UNIT III PROJECTION OF SOLIDS 12

Introduction – Projection of solids – Prisms – Pyramids – Cylinders and cones with axis inclined to both the planes (Solids resting on HP only)

UNIT IV DEVELOPMENT OF LATERAL SURFACES OF SOLIDS 12

Introduction – Cutting plane – Sectional views of right regular solids resting with base on HP – Prisms – Pyramids – Cylinder and cone – True shapes of the sections – Development of lateral surfaces of right regular prisms – pyramids – Cylinders – Cones resting with base on HP only – Development of the frustums and truncations

UNIT V ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS 12

Orthographic projection – Simple machine components using free hand sketching – Isometric projection – Simple Solid exercises and combination of solids

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. ND Bhat & VM Panchal, "Engineering Drawing", 51st edition, Charotar Publishing House, Gujarat, 2013
2. Venugopal K. and Prabhu Raja V, "Engineering Graphics", 6th edition, New Age International (P) Limited,2019

REFERENCE BOOKS:

1. Natrajan K.V., A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 21st edition 2017
2. Sam Tickoo, AutoCAD 2013 for Engineers and Designers, Dream tech Press, 1st edition 2013
3. M.H.Annaiah & Rajashekar Patil, Computer Aided Engineering Drawing, New Age International Publishers,4th edition,2012
4. Basant Aggarwal, Engineering Drawing, Tata Mc Graw Hill Education Private Limited, 1st edition, 2010
5. D.M.Kulkarni, A.P.Rastogi, A.K.Sarkar, "Engineering Graphics with AutoCAD", PHI Learning Private Limited, New Delhi, Revised edition.,2010

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

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SEMESTER III

U21MA304	PROBABILITY AND RANDOM PROCESSES (for EC)	Category: BSC				
		L	T	P	J	C
		3	0	0	0	3

PREREQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the mathematical concepts of probability, one and two-dimensional random variables and distributions
- To understand the concepts of random processes with real life examples
- To understand the concept of spectral density in communication systems, networks, signal processing systems, and control systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply probability axioms to compute conditional probabilities and moments of random variables for solving engineering problems (Apply)

CO2: Apply discrete and continuous probability distributions including binomial, Poisson, exponential, uniform and normal distributions to engineering applications (Apply)

CO3: Apply correlation and linear regression techniques for two-dimensional random variables in data analysis scenarios (Apply)

CO4: Apply concepts of discrete random processes including Markov chains, Bernoulli and Poisson processes to model random arrivals in communication systems (Apply)

CO5: Apply correlation functions and spectral density functions in signal processing applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	-	-	-	-	-	-	2	-	-
CO2	3	2	1	2	2	1	-	-	-	-	-	2	-	-
CO3	3	2	1	3	2	1	-	-	-	-	-	2	-	-
CO4	3	3	2	3	3	2	-	-	-	-	-	3	-	-
CO5	3	3	2	3	3	2	-	-	-	-	-	3	-	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)			

SYLLABUS:

UNIT I PROBABILITY AND RANDOM VARIABLES 9

Probability – Axioms of probability – Conditional probability – Total probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions

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UNIT II DISTRIBUTION FUNCTIONS 9

Binomial distribution – Poisson distribution – Exponential distribution – Uniform distribution – Normal distribution – Applications

UNIT III TWO DIMENSIONAL RANDOM VARIABLES 9

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression

UNIT IV RANDOM PROCESSES 9

Classification – Stationary process – Markov chain – Bernoulli and Poisson process

UNIT V CORRELATION AND SPECTRAL DENSITIES 9

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXTBOOKS:

1. Oliver C.Ibe, "Fundamentals of Applied Probability and Random Processes", Elsevier Academic Press, 2nd edition, 2014
2. Peebles P.Z., "Probability, Random Variables and Random Signal Principles", 4th edition, Tata McGraw Hill, New Delhi, 2002
3. Dimitri P. Bertsekas and John N. Tsitsiklis., "Introduction to Probability", 2nd edition, Athena Scientific, 2008

REFERENCES:

1. Cooper G.R. and McGillem C.D, "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian edition, 2012
2. Stark. H., and Woods J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd edition, Pearson Education, Asia, 2002
3. Miller S L and Childers D G, "Probability and Random Processes with Applications to Signal Processing and Communications", 2nd edition, Elsevier, 2012

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21EC301	SIGNALS AND SYSTEMS	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basic properties of signals & systems
- To analyze continuous time and discrete time signals using various transforms
- To analyze continuous time systems using Laplace transform and discrete time systems using Z-transform

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Classify continuous-time and discrete-time signals and systems based on their fundamental properties (Understand)

CO2: Compute Fourier series, Fourier and Laplace transforms of continuous time signals (Apply)

CO3: Analyze linear time-invariant continuous-time systems using convolution and Laplace transform to obtain system responses (Analyze)

CO4: Determine Fourier transform and Z-transform of discrete time signals (Apply)

CO5: Examine linear time-invariant discrete-time systems using convolution and Z-transform to determine system responses (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS **9+3**

Introduction – Standard signals – Operations on signal – Classification of continuous time (CT) and discrete time (DT) signals – Periodic and aperiodic signal, odd and even signal, energy and power signal, deterministic and random signal, causal and non-casual signal – Classification of CT and DT systems – Linear and non-linear, static and dynamic, time variant and time invariant, causal and non-causal, stable and unstable

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UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9+3

Fourier series representation – Trigonometric Fourier series – Continuous time Fourier transform (CTFT) – Properties – Inverse continuous time Fourier transform – Laplace transform – ROC and properties – Inverse Laplace transform

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9+3

Introduction to LTI-CT system – Convolution integral – Properties – CT system analysis using Laplace transform – Impulse and step response

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9+3

Baseband signal sampling – Discrete time Fourier transform (DTFT) and properties – Z transform – ROC and properties – Inverse Z transform

UNIT V LINEAR TIME INVARIANT DISCRETE TIME SYSTEMS 9+3

Introduction to LTI-DT system – Convolution sum – Properties – DT system analysis using Z transform – Impulse and step response

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Practical: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Simon Haykin and Barry Van Veen, "Signals and Systems", 2nd edition, Wiley, 2021
2. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", 2nd edition, Pearson, 2015

REFERENCES:

1. Michael J. Roberts, "Fundamentals of Signals and Systems", 2nd edition, Tata McGraw Hill, 2017
2. R.E. Zeimer, W.H. Tranter and R.D. Fannin, "Signals and Systems – Continuous and Discrete", 4th edition, Pearson, 2014
3. H P Hsu, "Signals and Systems", 3rd edition, Tata McGraw Hill, 2014
4. B.P. Lathi,"Principles of Linear Systems and Signals", 2nd edition, Oxford, 2009

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

U21EC302	ANALOG ELECTRONICS	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC202: Electron Devices and Circuits

COURSE OBJECTIVES:

- To learn the fundaments of multistage amplifiers
- To study effects of feedback concept
- To understand the operation of tuned and power amplifiers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Design high gain amplifiers using the concepts of differential and multistage amplifiers (Apply)
CO2: Illustrate the working principle of feedback topologies (Understand)
CO3: Analyze the performance of various LC and RC oscillators (Analyze)
CO4: Explain the fundamentals of tuned amplifier and multivibrators (Understand)
CO5: Classify power amplifiers based on efficiency (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1	1	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I HIGH GAIN BJT AMPLIFIERS 9

Differential amplifier – DC transfer characteristics and CMRR – Darlington amplifier – Bootstrap technique – Small signal analysis of cascade and cascode configurations – Multistage frequency effect

UNIT II FEEDBACK AMPLIFIERS 9

General feedback structure – Effects of negative feedback – Feedback topologies – Feedback amplifier types – voltage-series, voltage-shunt, current-series, current-shunt – Stability analysis of feedback – Frequency compensation

UNIT III OSCILLATORS 9

Classification of oscillator, Barkhausen criterion – General form of an oscillator, Analysis of LC oscillators – Hartley, Colpitts – Analysis of RC oscillators – Phase-shift, Wienbridge – Crystal oscillator and Blocking oscillator

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UNIT IV TUNED AMPLIFIERS AND MULTIVIBRATORS 9

Single tuned capacitive coupled amplifier, quality factor of a tank circuit, gain and bandwidth – Stagger tuned amplifier – Astable multivibrator – Monostable multivibrator – Bistable multivibrators – Schmitt trigger

UNIT V POWER AMPLIFIERS 9

Class A power amplifier – Class B power amplifier – Push pull and complementary symmetry configuration – Class AB power amplifier – Class C power amplifier – Distortions in Power Amplifier

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Jacob Millman, Christos C Halkias and Satyabrata Jit, "Electronic Devices and Circuits", 4th edition, McGraw Hill Education India, 2015
2. Donald A Neamen, "Electronic Circuits Analysis and Design", 3rd edition, McGraw Hill Education India, 2014

REFERENCES:

1. Adel S. Sedra and Kenneth C. Smith, "Microelectronic Circuits Theory and Applications", 7th edition, Oxford University Press India, 2018
2. David A. Bell, "Electronic Devices and Circuits", 5th edition, Oxford University Press India, 2014
3. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4th edition, Tata Mc Graw-Hill, 2016
4. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th edition, Pearson Education / PHI, 2008

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21EC303	ANALOG COMMUNICATION	L	T	P	J	C
		2	0	0	0	2

PRE–REQUISITES:

- U21EC202: Electronic Devices and Circuits

COURSE OBJECTIVES:

- To learn the concepts of various amplitude modulation techniques and noise effects
- To study the fundamentals of angle modulation and pulse modulation systems
- To understand the working of different transmitters and receivers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify suitable amplitude modulation techniques for specific applications (Apply)
CO2: Outline the performance of angle modulation techniques (Understand)
CO3: Explain the types of pulse modulation systems (Understand)
CO4: Examine the performance of different transmitters and receivers (Analyze)
CO5: Summarize the effects of noise in AM and FM systems (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1	-	1
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I AMPLITUDE MODULATION SYSTEMS 6

Introduction to communication system – Principles of amplitude modulation – Time and Frequency domain representations – Power relations – Generation and detection of DSB-FC and DSB-SC – Balanced modulator – SSB-SC – VSB Modulation

UNIT II ANGLE MODULATION SYSTEMS 6

Introduction to angle modulation – FM and PM – Narrow band FM and wideband FM – Generation of FM Signal – Direct and indirect methods – Detection of FM – Phase discriminator, ratio detector

UNIT III PULSE MODULATION SYSTEMS 6

Sampling and reconstruction – Aliasing – Quantization – Uniform and non-uniform quantization – Pulse amplitude modulation – Pulse width modulation – Pulse position modulation

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UNIT IV TRANSMITTERS AND RECEIVERS 6

AM broadcasting transmitters – FM transmitter – Receiver characteristics – Super heterodyne receiver – FM receiver – Automatic Gain Control (AGC) – Automatic Frequency Control (AFC) – Time division multiplexing – Frequency division multiplexing

UNIT V NOISE EFFECTS 6

Noise sources and types – Gaussian and white noise characteristics – Noise margin – Noise temperature – Noise figure – Noise performance in AM systems – DSB-SC – Noise performance in FM systems – Pre-emphasis and de-emphasis

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 30 Periods

TEXT BOOKS:

1. Herbert Taub, Donald L Schilling, Goutam Saha, "Principles of Communication Systems", 4th edition, McGraw Hill Education, 2017
2. George Kennedy, Bernard Davis, S R M Prasanna, "Electronic Communication Systems", 5th edition, McGraw Hill Education, 2016

REFERENCES:

1. Simon Haykin, "Communication Systems", 4th edition, Wiley, 2014
2. B.P. Lathi, Zhi Ding, "Modern Digital and Analog Communication Systems", 4th edition, Oxford University Press, 2013
3. A. Bruce Carlson, Paul B. Crilly, Janet C. Rutledge, "Communication Systems", 4th edition, McGraw Hill Education, 2013
4. Dennis.Roody, John Coolen, "Electronic Communications", 4th edition, Prentice Hall of India, 2012

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
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40	60	40	60	200	100
Total				40	60
				100	

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SEMESTER III

U21CSG03	DATA STRUCTURES (Common to AM,BM,CB,EC,EE and IT)	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21CSG01: Problem Solving and C Programming

COURSE OBJECTIVES:

- To understand the concepts of ADT and list operations
- To Learn linear data structures – stacks and queues
- To apply Tree and Graph structures

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Implement linear data structures and their operations for the given applications (Apply)
CO2: Apply various operations on stack and queue data structures for suitable applications (Apply)
CO3: Perform searching, sorting, and hashing techniques to organize and retrieve the data efficiently (Apply)
CO4: Utilize tree structures to organize and manipulate hierarchical data (Apply)
CO5: Apply various graph-based operations for solving real-time problems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO2	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO3	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO4	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO5	3	2	1	1	-	-	-	-	1	1	-	2	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I LINEAR DATA STRUCTURES – LIST **6**

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list-based implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of linked list

UNIT II LINEAR DATA STRUCTURES – STACKS, QUEUES **6**

Stack ADT – Operations – Applications – Evaluating arithmetic expressions – Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – DeQueue – Applications of queues

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UNIT III SEARCHING, SORTING AND HASHING TECHNIQUES 6

Introduction to Searching – Types of search – Linear Search – Binary Search – Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort – Hashing – Hash Functions – Separate Chaining – Open Addressing – Rehashing

UNIT IV NON LINEAR DATA STRUCTURES – TREES 6

Tree ADT – Tree traversals – Binary Tree ADT – Expression trees – Implementation of expression tree – Applications of trees – Binary search tree ADT – Operations in binary search tree – Introduction to Heap – Properties

UNIT V NON LINEAR DATA STRUCTURES - GRAPHS 6

Introduction to Graph – Types of graph – Graph traversal – Breadth-first traversal – Depth-first traversal – Topological Sort – Minimum spanning tree algorithms – Shortest path algorithm – Dijkstra's algorithm

LIST OF EXPERIMENT (INDICATIVE)

1. Write a function program to perform the following operations on a singly linked list
   i. Create a list cube
   ii. Insert an element to the list
   iii. Delete the maximum element from the list
   iv. Arrange the list in a sorted order
   v. Display the elements of the list
2. Write a main method to demonstrate the above functionalities
3. Creation of Array and linked list implementation of Stack and Queue ADTs
4. Implementation of quick, heap, and shell sort
5. Program to sort the elements in ascending order using selection sort and bubble sort
6. Implementation of hashing technique
7. Develop a program to perform a linear and binary search
8. Program to construct an expression tree for a given expression and perform various tree traversal methods.
9. Implement Prim's algorithm with the following functionalities
   i. Read a set of vertices minimum of six from the keyboard
   ii. Get the number of edges and form the graph
   iii. Find the value of each edge by using the distance formula for two points.
   iv. Develop a Minimum Spanning Tree for the graph
   v. Find the total length of all edges. Write a main method to execute the above functionalities
10. Choose an appropriate data structure and create a token system for banking service (withdrawal, deposit, and money transfer)
11. Create a food delivering system that allocates the path for the delivery of food using appropriate data structures
12. Create a book rack allocation system in a library, which allocates appropriate space for the books based on category using appropriate data structures

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Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Reema Thareja, "Data structures using C", 1st edition, Oxford University Press, 2018
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, "Fundamentals of Data Structures in C", 2nd edition, University Press, 2017

REFERENCES:

1. R. Venkatesan, S. Lovelyn Rose, "Data Structures", 1st edition, Wiley, 2019
2. Seymour Lipschutz, "Data structures with C", 4th edition, McGraw Hill Education, 2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="2">Assessment II (Practical) (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations (Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations (Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

U21EC304	LINEAR INTEGRATED CIRCUITS	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC202: Electronic Devices and Circuits

COURSE OBJECTIVES:

- To study the characteristics of operational amplifier
- To learn different applications of op-amp and timers
- To understand the operation of A/D and D/A converters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the DC and AC characteristics of operational amplifier (Understand)

CO2: Build linear circuits using op-amp (Apply)

CO3: Construct waveform generators using op-amp (Apply)

CO4: Design a timer circuit using op-amp (Apply)

CO5: Examine the performance of different ADC and DAC conversion techniques (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	1	1	-	-	-	-	2	2	-	1	1	-
CO3	3	2	1	1	-	-	-	-	2	2	-	1	1	-
CO4	3	2	1	1	-	-	-	-	2	2	-	1	1	-
CO5	3	3	2	2	-	-	-	-	2	2	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I OP–AMP CHARACTERISTICS 6

N Introduction – Ideal op-amp – Differential amplifier – Current mirror – DC characteristics – Bias, offset, thermal drift – AC characteristics – Frequency response, slew rate

UNIT II OP–AMP APPLICATIONS 6

Inverting and non-inverting amplifier – Adder – Subtractor – Instrumentation amplifier – Integrator – Differentiator – Active filter – First order LPF and HPF

UNIT III COMPARATORS AND WAVEFORM GENERATORS 6

Comparator – Schmitt trigger – Multivibrators – Astable, monostable – Sine wave oscillators – RC phaseshift, wein bridge – IC voltage regulator

UNIT IV TIMERS AND PLL 6

IC 555 timer – Astable and monostable operation – Basic principles of PLL – VCO – PLL applications – Frequency multiplier, AM and FM detection

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UNIT V D/A AND A/D CONVERTERS 6

DAC and ADC specifications – D/A conversion techniques – Weighted resistor, R-2R ladder – A/D conversion techniques – Flash, successive approximation, dual slope converters

LIST OF EXPERIMENTS (INDICATIVE)

1. Design and construct inverting and non-inverting amplifiers using op-amp
2. Design and construct integrator and differentiator using op-amp
3. Design and construct active low-pass and high-pass filters using op-amp
4. Design and implement Schmitt trigger using op-amp
5. Generate a sinusoidal waveform generator using op-amp
6. Construct the D/A converter using op-amp
7. Automatic Street Light using IC741
8. Touch Sensor Switch using IC555

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", 5th edition, New Age International Pvt. Ltd., 2018
2. Ramakant A. Gayakwad, "Op-amps and Linear Integrated Circuits", 4th edition, PHI, 2015

REFERENCES:

1. S.Salivahanan, V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", 4th reprint, Tata Mc Graw-Hill, 2018
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4th edition, Tata Mc Graw-Hill, 2016
3. Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", 5th edition, Wiley International, 2012
4. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", 6th edition, PHI, 2009

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
		L	T	P	J	C
U21ECG01	DIGITAL ELECTRONICS (Common to EC, BM, CS, CSBS , AI & ML , IT and AD : For CS, CSBS , AI & ML , IT and AD, It is offered during II Semester and For EC and BM, It is offered during III Semester)	2	0	2	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To understand the fundamentals of digital logic circuits
- To design the combinational logic circuits.
- To design the synchronous and asynchronous sequential circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply various reduction methods to simplify logic expressions (Apply)
CO2: Implement the combinational logic circuits using logic gates (Apply)
CO3: Examine the performances of latches and flip-flops (Analyze)
CO4: Construct sequential logic circuits using flip-flops (Apply)
CO5: Design a counters using shift register and realize hazard free logic circuits (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO5	3	3	2	2	-	-	-	-	2	2	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I BOOLEAN THEOREMS AND LOGIC REDUCTION 6

Number system – Complements – Boolean theorems – Codes – Logic gates – NAND and NOR gates – Representation of boolean expression – SOP, POS, canonical form – Simplification of logic functions using K-map, Quine McCluskey method

UNIT II COMBINATIONAL LOGIC DESIGN 6

Adder-1 Bit adder/subtractor, parallel adder, 2's complement adder/subtractor – Implementation of combinational circuits – Multiplexers, decoders, encoders, demultiplexers – Code converters – Error detection and correction codes – Parity generator and checker

UNIT III LATCHES AND FLIPFLOPS 6

Latches – NOR, NAND – Digital pulses – Clocked flip-flops – Master/Slave flip-flop – Asynchronous inputs – Flip-flop timing considerations – Conversion of flip-flop

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UNIT IV SEQUENTIAL CIRCUITS 6

General model of sequential circuits – Mealy/Moore models, excitation table, state table, state diagram – Design of synchronous sequential circuits – Synchronous up/down counters, modulus counters – Asynchronous counter – Sequence detector

UNIT V REGISTERS AND HAZARDS 6

Shift registers – Ring counter, Johnson counter – Hazards and Essential Hazards in logic circuits – Design of Hazard free circuits

LIST OF EXPERIMENTS (INDICATIVE)

1. Characteristics of digital IC's
2. Implementation of combinational logic design using MUX IC's
3. Design and implementation of various data path elements (Adder/Subtractor)
4. Characteristics of flip-flop
5. Design and implementation of synchronous sequential circuit (Counters/ Shift registers)
6. Design and implementation of asynchronous mod counters
7. Design of real time clock using BCD-to-7 segment decoder

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. M.Morris Mano, Michael D Ciletti, "Digital Design", 6th edition, Pearson, 2018
2. Charles H. Roth, Jr, Larry L. Kinney" Fundamentals of logic design",7th edition, Kluwer Academic Publishers,2014

REFERENCES:

1. Thomas L.Floyd, "Digital Fundamentals", 11th edition, Prentice Hall, 2015
2. A.Anand Kumar, "Fundamentals of Digital Circuits", 2nd edition, PHI Learning, 2013
3. Ronald J Tocci, Neal S Widmer, Gregory L Moss, "Digital Systems Principles and Applications", 10th edition, Pearson, 2009
4. D. Donald Givone, "Digital Principles and Design", 4th edition, Tata McGraw Hill, 2008

EVALUATION PATTERN:

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SEMESTER III

U21EC305	ANALOG ELECTRONICS LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	2	2	2

PRE–REQUISITES:

- U21EC202: Electronic Devices and Circuits

COURSE OBJECTIVES:

- To design multistage amplifier circuits using BJT
- To analyze feedback amplifier circuits
- To apply the feedback topologies for oscillator circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply fundamental concepts of semiconductor devices and analog circuit theory to analyze and design amplifier and oscillator circuits (Apply)

CO2: Build analog amplifier and oscillator circuits to meet specified performance requirements (Apply)

CO3: Examine the circuit performance against theoretical results using experimental or simulation methods (Analyze)

CO4: Demonstrate individual competency or effective teamwork in designing, implementing, and documenting analog circuit experiments (Apply)

CO5: Design and implement simple electronic systems to address real-world applications using analog and digital components (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	3	2	1	1	-	-	-	-	-	-	-	1	1	-
CO3	3	3	2	2	2	-	-	-	-	-	-	1	1	-
CO4	-	-	-	-	-	-	-	2	2	2	-	1	1	-
CO5	3	2	1	1	2	2	-	2	2	2	2	2	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

LIST OF EXPERIMENTS

1. Design a differential amplifier and calculate its CMRR
2. Construct voltage series feedback amplifier and obtain its bandwidth
3. Design and construct MOSFET amplifier
4. Design and verify Hartley oscillator for the given specifications
5. Design and verify RC phase shift oscillator for the given specifications
6. Construct single stage tuned amplifier and obtain the frequency response
7. Design and verify low noise amplifier for the given specifications

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8. Simulate Cascade amplifier and calculate its maximum gain
9. Simulate Astable multivibrator for the given clock frequency
10. Simulate Class A and Class B Power amplifier compare its performance
11. Design of name board display using Multivibrator

AUGMENTED EXPERIMENTS

1. Simulate a suitable Preamplifier for biomedical signal processing.
2. Simulate a suitable Audio amplifier using BJT
3. Simulate a bandpass filter for EMG signal
4. Simulate amplitude modulator for the given message signal and carrier signal frequencies

TYPICAL PROJECTS (INDICATIVE)

1. Rain alarm system using Darlington pair circuit.
2. Dual-Tone Multi Frequency based Door Locking System
3. Water level indicator
4. Binary storage device using transistors
5. Bluetooth controlled robot car
6. DTMF Based DC Motor Control
7. Touch switch light system
8. Low Power Emergency Light Circuit
9. Uninterruptible Power Supply system
10. MOSFET Audio Equalizer Circuit

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project 30 Periods

Total 60 Periods

EVALUATION PATTERN:

<table>
<tr><td colspan="5">Continuous Internal Assessments</td><td>End Semester Examinations</td></tr>
<tr><td colspan="2">Assessment I (Practical) (100 Marks)</td><td colspan="3">Assessment II (Project) (100 Marks)</td><td rowspan="3">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td></tr>
<tr><td colspan="5">200</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER III

		Category: EEC				
U21EC306	DESIGN STUDIO I	L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- U21ECG03: Engineering Studio

COURSE OBJECTIVES:

- To inculcate the problem-solving & Innovation mindset
- To provide a platform for self-learning, experimenting, solving the real-world problems and to develop a product.
- To enable hands-on experience for active learning.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Examine existing engineering problems through literature review to identify key issues, trends, and societal needs (Analyze)

CO2: Analyze alternative solution approaches and select an appropriate method (Analyze)

CO3: Demonstrate teamwork and project management skills to effectively coordinate tasks and present the problem statement professionally (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	1	-	-	-	-	-	-	1	2	2
CO3	-	-	-	-	-	-	-	2	2	2	2	2	2	2
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

Course conduction:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor
- With the guidance of assigned mentor, the students will find & validate a problem statement, map to UNSDG, identify the skills required for the project and self-learn
- Applying the design thinking concept, the students will provide a solution and produce the version 1 of prototype
- The student will learn teamwork, project management, technical report writing and presentation skills through this course

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: – Periods Project 30 Periods

Total 30 Periods

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EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

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SEMESTER IV

U21EC401	ELECTROMAGNETIC FIELDS AND WAVEGUIDES	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study electric and magnetic fields in free space and in materials
- To understand relation between electric and magnetic fields through Faraday's law and Maxwell's equation
- To learn the general wave behaviors in different waveguides

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain coordinate systems and vector calculus concepts used in static electric field analysis (Understand)

CO2: Illustrate the fundamental laws and field quantities of static magnetic fields (Understand)

CO3: Summarize electric and magnetic boundary conditions in conducting and dielectric materials (Understand)

CO4: Apply Maxwell's equations for time varying fields to analyze electromagnetic wave propagation in various media (Apply)

CO5: Examine the wave behavior in rectangular and cylindrical waveguides (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO4	3	2	1	-	-	-	2	-	-	-	-	1	-	1
CO5	3	3	2	-	-	-	2	-	-	-	-	1	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I STATIC ELECTRIC FIELD **10**

Vector algebra – Coordinate systems – Differential operators – Divergence theorem – Stokes theorem – Coulomb's law and field Intensity – Electric field intensity due to a straight line – Electric flux density – Gauss's law – Applications of Gauss's law – Electric potential – Electric dipole – Electrostatic energy and energy density

UNIT II STATIC MAGNETIC FIELD **8**

Biot-Savart law – Magnetic field intensity for a straight wire – Magnetic flux density – Ampere's circuital law and its applications – Scalar and vector magnetic potentials

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UNIT III BOUNDARY CONDITIONS OF ELECTRIC AND MAGNETIC FIELDS 9

Conductors and dielectrics in electric field – Continuity equation – Boundary conditions for electric field – Parallel plate, coaxial and spherical capacitors – Poisson and Laplace equation – Polarization– Forces on magnetic field – Magnetic boundary conditions – Magnetization – Inductance for solenoid and toroid

UNIT IV TIME VARYING FIELDS AND MAXWELL'S EQUATIONS 9

Forces due to magnetic fields – Maxwell's equations – Electromagnetic boundary conditions – Wave equations and their solutions – Poynting theorem – Wave propagation on different media.

UNIT V WAVEGUIDES 9

General wave behaviours – Transverse electric waves, transverse magnetic waves, transverse electromagnetic waves – TM and TE waves between parallel plates – TM and TE waves in rectangular wave guide – Bessel's differential equation and Bessel function, TM and TE waves in circular wave guides – Cavity resonators.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. John.D.Ryder, "Networks, Lines and Fields", 2nd edition, Pearson Education, 2016
2. Matthew.N.O.Sadiku and S.V.Kulkarni, "Principles of Electromagnetics", 6th edition, Oxford, 2015

REFERENCES:

1. W.H.Hayt, J.A.Buck, M.Jaleel Akhtar, "Engineering Electromagnetics", 9th edition Mc-Graw-Hill, 2018
2. David.J.Griffiths, "Introduction of Electrodynamics", 4th edition, Pearson Education, 2013
3. David.K.Cheng, "Field and Wave Electromagnetics", 2nd edition, Pearson Education, 2013
4. G.S.N Raju, "Electromagnetic Field Theory and Transmission Lines", 1st edition, Pearson Education, 2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21EC402	DIGITAL SIGNAL PROCESSING	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC301: Signals and Systems

COURSE OBJECTIVES:

- To learn various techniques of DFT
- To design IIR and FIR filters using different techniques
- To learn finite word length effects and the architecture of digital signal processors

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply FFT algorithms for DFT computations (Apply)

CO2: Design digital IIR filters using suitable techniques (Apply)

CO3: Examine the characteristics of digital FIR filters (Analyze)

CO4: Explain the finite word length effects in digital filters (Understand)

CO5: Illustrate the architecture of DSP Processor (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I DISCRETE FOURIER TRANSFORM 9

Introduction to DFT and IDFT – Properties of DFT – Computation of DFT using direct method – Fast computation of DFT using fast fourier transform (FFT) – Radix-2 decimation-in-time (DIT) and decimation-in-frequency (DIF) algorithms – Filtering long data sequences – Overlap save and overlap add methods

UNIT II INFINITE IMPULSE RESPONSE FILTERS 9

Introduction to filters – Analog filter design – Butterworth and Chebyshev filters – Design of digital IIR filters (LPF, HPF) – Impulse invariance and bilinear transform methods – Structure of IIR filter – Direct form I, direct form II and cascade realizations

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UNIT III FINITE IMPULSE RESPONSE FILTERS 9

Introduction to FIR – Linear phase characteristics – Design of linear phase FIR filters – Fourier series, windows (Rectangular, Hamming and Hanning) – Structure of FIR filter – Direct forms and linear phase realization

UNIT IV FINITE WORD LENGTH EFFECTS 9

Number representation – Fixed point and floating point – Quantization – Truncation and rounding – Types of quantization errors – Estimation of quantization noise power – Input, product and co-efficient quantization methods – Limit cycle oscillations – Dead band effect – Scaling to prevent overflow

UNIT V DIGITAL SIGNAL PROCESSORS 9

Introduction – Selection of processor – Von-Neumann, Harvard and VLIW architectures – Pipelining – DSP processor – TMS320C50, TMS3206713 – Architecture and addressing modes

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. John G.Proakis and Dimitris G.Manolakis, "Digital Signal Processing – Principles, Algorithms & Applications", 4th edition, Pearson Education, 2013
2. B.Venkataramani, M.Bhaskar, "Digital Signal Processors : Architecture, Programming and Applications", 2nd edition, Tata Mc Graw Hill, 2011

REFERENCES:

1. A.V.Oppenheim, R.W. Schafer and J.R. Buck, "Discrete-Time Signal Processing", 3rd edition, Pearson Education, 2019
2. Emmanuel C.Ifeachor and Barrie.W.Jervis, "Digital Signal Processing: A Practical Approach", 2nd edition, Pearson Education, 2017
3. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", 4th edition, Tata McGraw Hill, 2017
4. Andreas Antoniou, "Digital Signal Processing: Signals, Systems and Filters", 1st edition, Tata McGraw Hill, 2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(100 Marks)</th><th colspan="2">Assessment II
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21EC403	DIGITAL COMMUNICATION	Category: PCC				
		L	T	P	J	C
		2	0	0	0	2

PRE–REQUISITES:

- U21EC303: Analog Communication

COURSE OBJECTIVES:

- To study the principles of waveform coding schemes and channel coding
- To learn various baseband transmission schemes
- To understand different band pass signalling schemes

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concepts of source coding techniques (Understand)

CO2: Summarize various waveform coding schemes (Understand)

CO3: Examine the performances of pulse shaping and signaling methods (Analyze)

CO4: Illustrate different digital modulation and demodulation techniques (Understand)

CO5: Apply suitable error detection and correction techniques for digital communication (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	1
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I INFORMATION THEORY 6

Discrete memory less source – Entropy, mutual information, channel capacity – Hartley-Shannon's law – Source coding theorem – Shannon-Fano and Huffman coding

UNIT II WAVEFORM CODING AND REPRESENTATION 6

Elements of digital communication system – PCM – DPCM – ADPCM – Delta modulation – ADM – Linear predictive coding – Principles of line coding schemes

UNIT III BASEBAND TRANSMISSION AND RECEPTION 6

Inter symbol interference – Nyquist criterion for distortion less transmission – Pulse shaping – MAP rule – Correlative coding – Eye pattern – Matched filter

UNIT IV DIGITAL MODULATION SCHEMES 6

Geometric representation of signals – Generation and detection of ASK, FSK, PSK, QPSK, QAM – Carrier synchronization

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UNIT V ERROR CONTROL CODING 6

Channel coding theorem – Linear block codes – Hamming codes – Cyclic codes – Convolutional codes – Viterbi algorithm

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. John G. Proakis, "Digital Communication", 5th edition, Tata Mc Graw Hill, 2018
2. S. Haykin, "Digital Communications", 4th edition, John Wiley, 2016

REFERENCES:

1. B. P. Lathi, "Modern Digital and Analog Communication Systems", 3rd edition, Oxford University Press, 2017
2. B. Sklar, "Digital Communication Fundamentals and Applications", 2nd edition, Pearson Education, 2014
3. John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems", 2nd edition, Pearson Education, 2014
4. Dennis Silage, "Digital Communication systems using MATLAB and Simulink", 2nd edition, Bookstand Publishing, 2009

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21CSG04	JAVA PROGRAMMING (Common to AM, BM, CB, EC, EE and IT)	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21CSG01: Problem Solving and C Programming

COURSE OBJECTIVES:

- To describe object-oriented programming paradigm and its principles
- To implement programs with Core Java features and API
- To develop applications with Java Collections

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply basic java constructs to build simple Java applications (Apply)

CO2: Implement object oriented programming concepts for real time applications and create packages (Apply)

CO3: Utilize Java exception handling techniques to ensure robust program execution (Apply)

CO4: Implement multithreaded programming for concurrent applications and various I/O streams for file handling (Apply)

CO5: Develop Java collection framework to manage and process the data (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO2	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO3	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO4	3	2	1	1	-	-	-	-	1	1	-	2	-	-
CO5	3	2	1	1	-	-	-	-	1	1	-	2	-	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I OBJECT ORIENTED DEVELOPMENT AND JAVA BASICS **6**

Object Oriented Programming – Concepts – Abstraction – Encapsulation – Comparison with function oriented programming – Characteristics of Java – Java Environment – JVM and JDK – Classes – Constructors – Methods – Static members – Comments – Data Types – Variables – Operators – Control Flow

UNIT II PACKAGES AND INHERITANCE **6**

Defining a Package – Importing Packages – Inheritance – Creating super classes and sub classes – Access modifiers – Constructors in sub classes – Polymorphism – Method overloading – Method overriding – Abstract classes and abstract methods – Interfaces – Defining an interface – Implementing interface – Extending interfaces – Object class

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UNIT III EXCEPTION HANDLING 6

Exceptions – Throwing and catching exceptions – Checked and unchecked exceptions – Exception hierarchy – Built in exceptions – Creating own exception – Chained exceptions – Stack Trace Elements

UNIT IV I/O STREAMS AND MULTITHREADING 6

Input / Output Basics – Scanner class – Streams – Byte streams and Character streams comparison – Reading from and Writing to Console and Files – Multithreaded Programming – The Java Thread Model – Creating multiple threads – Thread class – Runnable Interface

UNIT V COLLECTIONS 6

Collections Framework Overview – Basics of List – Set – Queue – Programs using Array list – HashMap and HashSet – Hashcode and equals methods

LIST OF EXPERIMENTS

1. Write a Java program to create a class Student with private data members and public methods to implement encapsulation and abstraction
2. Develop a Java program to implement constructor overloading and method overloading
3. Develop a Java program to implement run-time polymorphism with inheritance
4. Develop a Java program to implement inheritance using Interfaces and Abstract classes. Use packages
5. Develop a Java program to demonstrate exception handling
6. Develop a multithreaded java program using a Thread class and Runnable interface
7. Develop a Java program to implement basic console IO and File IO
8. Develop a Java program to store multiple objects in an Array List and to implement search and sort operations

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Herbert Schildt, "Java: The Complete Reference", 11th Edition, McGraw Hill Education, 2018
2. Cay.S.Horstmann and Gary Cornell, "Core Java 2, Vol 1, Fundamentals", 11th Edition, Pearson Education, 2020

REFERENCES:

1. J.Nino and F.A. Hosch , "An Introduction to Programming and OO Design using Java", 1st Edition, John wiley & Sons,2018
2. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition, Pearson, 2015
3. E Balagurusamy, "Programming with Java",6th Edition, McGraw Hill Education,2019

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record . **(Rubrics Based Assessments)**	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21EC404	MICROPROCESSORS AND MICROCONTROLLERS	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21ECG01: Digital Electronics

COURSE OBJECTIVES:

- To study the architecture and programming of microprocessors and microcontrollers
- To learn the instruction set for writing assembly language programs
- To understand the interfacing concepts of 8086 microprocessor and 8051 microcontrollers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Implement Arithmetic and logical operations using 8086 microprocessor (Apply)

CO2: Apply peripheral interfacing techniques for 8086 microprocessor (Apply)

CO3: Compare various addressing modes and instruction sets of the 8051 microcontroller (Analyze)

CO4: Explain the concepts of timer, interrupts and serial communication in 8051 microcontroller (Understand)

CO5: Develop simple applications using 8051 microcontrollers by interfacing appropriate peripheral devices (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	2	2	-	1	3	-
CO2	3	2	1	1	-	-	-	-	2	2	-	1	3	-
CO3	3	3	2	2	-	-	-	-	2	2	-	1	3	-
CO4	2	1	-	-	-	-	-	-	2	2	-	1	2	-
CO5	3	2	1	1	-	-	-	-	2	2	-	1	3	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I MICROPROCESSORS 9

Architecture and signals of 8085 – 8086 microprocessor – Internal architecture and signals, addressing modes, instruction sets, timing diagrams, assembly language programming

UNIT II INTERFACING 8086 MICROPROCESSOR 9

Overview of memory interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – Timer – Keyboard /display controller – Interrupt controller – DMA controller

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UNIT III 8051 MICROCONTROLLER 9

Harvard architecture – 8051 microcontroller – Internal architecture and signals, special function registers (SFR), I/O ports and circuits – Instruction set – Addressing modes – Assembly language programming

UNIT IV PROGRAMMING 8051 MICROCONTROLLER 9

8051 timers – Modes, registers, timer programming – Serial communication – Registers, RS232 standards, programming – Interrupts – Types, ISR, timer, hardware and serial communication interrupt programming – Introduction to embedded C programming

UNIT V INTERFACING 8051 MICROCONTROLLER 9

Interfacing of simple I/O systems – Switches – LEDs – Buzzers – Interfacing character and graphical LCD displays – Interfacing external ADC and DAC – DC motor speed control system – Stepper motor interfacing – Relays

LIST OF EXPERIMENTS

I. 8086 Experiments

1. Basic arithmetic and logical operation
2. Computation of maximum and minimum marks in the database
3. Sorting an array in ascending and descending order
4. String manipulations for an input stream
5. Scrolling display using 8279

II 8051 Experiments

1. Calculation of area and volume of the object
2. Design of robotic arm control system using stepper motor
3. Speed control of DC motor using 8051
4. LED switch control using A/D interface using 8051
5. Waveform generation using D/A interface using 8051

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 75 Periods

TEXT BOOKS:

1. Krishna Kant, "Microprocessor and Microcontrollers Architecture, Programming and System Design using 8085, 8086, 8051, 8096", 1st edition, Prentice Hall of India, 2013
2. Kris Schindler, "Introduction to Microprocessor Based Systems Using the ARM Processor", 2nd edition, Pearson Learning Solutions, 2013

REFERENCES:

1. Mazidi Muhammed Ali, Mazidi Janice Gillispie, "The 8051 Microcontrollers and Embedded Systems", 2nd edition, Pearson Education India, 2012
2. Soumitra Kumar Mandal,"Microprocessors and Microcontrollers Architecture Programming and Interfacing using 8085 8086 & 8051", 1st edition, Tata McGraw Hill, 2011
3. Kenneth Ayala, "The 8051 Microcontrollers",3rd edition, Cengage Learning India, 2007

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**35**	**15**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: HSMC				
U21SSG01	SOFT SKILLS – I	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate potential skills and to work as a team effectively
- To develop confidence and enhance interpersonal skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Enhance decision making and negotiation skills (Analyze)

CO2: Maintain open, effective, and Professional Communication (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	2	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I VERBAL COMPETENCE **10**

Verbal Analogy – Spotting Errors – Ordering of Sentences – Cloze Test – Effective Listening – Reading Comprehension

UNIT II EFFECTIVE COMMUNICATION **10**

Overcoming Communication Barriers – Body Language and its Etiquettes – Contextual Communication – 7C's of Communication – Listening to Documentaries

UNIT III INTERPERSONAL SKILLS **10**

Group Decision Making – Paralanguage – Negotiation Skills – Preparation & Planning, Bargaining & Problem Solving –Self Grooming – SWOT Analysis

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Prashant Sharma,"Soft Skills: Personality Development for Life Success",1st edition, BPB Publications,2022
2. Suresh Kumar E, Sreehari P and Savithri J, "Communication Skills and Soft Skills: An Integrated Approach", 1st edition, Dorling Kindersley, 2011

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REFERENCES:

1. Jeff Butterfield, "Problem Solving and Decision Making", 2nd edition, Course Technology, 2010
2. Wushow Bill Chou, "Fast-Tracking your Career: Soft Skills for Engineering and IT Professionals", 1st edition, IEEE Press, 2013

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

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SEMESTER IV

U21EC405	ANALOG AND DIGITAL COMMUNICATION LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21EC303: Analog Communication
- U21EC403: Digital Communication

COURSE OBJECTIVES:

- To analyze analog and digital modulation techniques
- To understand various waveform coding schemes
- To learn pulse modulation and error control coding schemes

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply fundamental concepts of analog and digital communication to design and analyze communication systems (Apply)

CO2: Analyze the performance of modulation techniques and evaluate parameters such as bandwidth, SNR, and spectrum efficiency (Analyze)

CO3: Examine the system performance against theoretical values using experimental or simulation methods (Analyze)

CO4: Demonstrate individual competency or effective teamwork in designing and implementing the experimental results (Apply)

CO5: Apply ethical standards and present experimental results effectively (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	2	2	-	1	-	1
CO2	3	3	2	2	2	-	-	-	2	2	-	1	-	1
CO3	3	3	2	2	2	-	-	-	2	2	-	1	-	1
CO4	-	-	-	-	-	-	-	-	2	-	-	1	-	1
CO5	-	-	-	-	-	-	-	2	2	2	-	1	-	1
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)					3: Substantial (High)			

LIST OF EXPERIMENTS

1. Design and Performance Evaluation of an End-to-End Communication System under Noiseless and Noisy Channel Conditions
2. Performance Analysis of AM, FM, and PM under Noisy and Noiseless Conditions with SNR Evaluation and Bandwidth Comparison.
3. Analysis of Signal Sampling and Reconstruction: Under-Sampling, Nyquist Sampling, Over-Sampling, and Flat-Top Sampling
4. Performance Evaluation of PCM, DPCM, DM, and ADM (CVSD): Quantization Error Analysis and Bandwidth Requirement Comparison

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5. Verification of Information Theory Concepts and Shannon Channel Capacity Theorem
6. Waveform Analysis and Comparative Study of Pulse Analog Modulation and Digital Modulation Techniques.
7. Spectrum Efficiency Analysis of BPSK, QPSK, and QAM: Relationship between Symbol Rate, Bit Rate, and Baud Rate
8. Waveform Generation and Performance Analysis of Line Coding Techniques with Impact on Signal Recovery and Channel Capacity
9. Performance Analysis of Channel Coding Techniques: CRC, Hamming Codes, Linear Block Codes, Convolutional Codes, and LDPC
10. Comparative Study of TDM and TDMA in Multiplexing and Multiple Access Systems

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER IV

U21EC406	DIGITAL SIGNAL PROCESSING LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	2	2	2

PRE–REQUISITES:

- U21EC301: Signals and Systems

COURSE OBJECTIVES:

- To perform convolution, correlation and filtering in MATLAB
- To analyze ECG and EEG signals using MATLAB
- To implement basic signal operations using DSP processor

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply Digital Signal Processing principles to perform signal processing operations (Apply)

CO2: Implement digital signal processing algorithms using software tools and DSP processors to meet specified performance requirements (Apply)

CO3: Examine DSP algorithm performance by validating experimental results against theoretical analysis (Analyze)

CO4: Implement signal processing experiments independently and collaboratively with proper technical documentation (Apply)

CO5: Solve real world problems using digital signal processing algorithms (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	-	-	-	1	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	1	-	-
CO3	3	3	2	2	2	-	-	-	-	-	-	1	-	-
CO4	-	-	-	-	-	-	-	2	2	2	-	1	-	-
CO5	3	2	1	1	2	2	-	2	2	2	2	2	-	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

LIST OF EXPERIMENTS

CYCLE – I

1. Generation of elementary discrete time sequences
   i. Write a MATLAB program to generate step, ramp, impulse and exponential signals
2. Convolution of discrete sequence
   i. Write a MATLAB program to perform linear convolution of two discrete sequence and plot the response
   ii. Write a MATLAB program to perform circular convolution of two discrete sequence and plot the response

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3. Correlation of discrete sequence
    i. Write a MATLAB program to perform auto correlation of two discrete sequence and plot the response
    ii. Write a MATLAB program to perform cross correlation of two discrete sequence and plot the response
4. Computation of DFT and FFT
    i. Write a MATLAB program to perform DFT of two discrete sequence and plot magnitude spectrum and phase spectrum
    ii. Write a MATLAB program to perform 8-point FFT and plot magnitude spectrum and phase spectrum
5. IIR filter design
    i. Design digital Butterworth filter for the given specification and plot the response
    ii. Design digital Chebyshev filter for the given specification and plot the response
6. FIR filter design
    i. Design FIR filter using Rectangular window for the given filter order and plot the response
    ii. Design FIR filter using Hamming window for the given filter order and plot the response
    iii. Design FIR filter using Hanning window for the given filter order and plot the response
7. Design of up conversion and down conversion for speech signals
8. Analysis of ECG and EEG signal
    i. Perform noise cancellation of ECG and EEG signal using adaptive filters

CYCLE – II

1. Generation of discrete time signals
    i. Write an ALP to generate ramp, impulse and exponential signals and implement in TMS320C50 processor
2. Linear convolution and circular convolution
    i. Write an ALP to perform linear and circular convolution for two discrete sequence and implement in TMS320C50 processor
3. Implementation of DFT and FFT
    i. Write an ALP to perform DFT and FFT for the given sequence and implement in TMS320C50 processor

AUGMENTED EXPERIMENTS

1. Signal processing methods for music signals
    i. Write a MATLAB program to perform adaptive noise cancellation for music signal.
2. Signal processing methods for radar signals
    i. Write a MATLAB program to track the targets present in the radar signal.

TYPICAL PROJECTS (INDICATIVE)

1. Adaptive RLS and LMS filter for noise cancellation
2. Disease detection in ECG signal
3. Speech recognition
4. Target tracking and detection in radar
5. Watermarking in audio signal
6. Cochlear implant
7. Video tracking and stabilization
8. Velocity estimation using Kalman filter
9. Time delay estimation in radar using Continuous Wavelet Transform
10. Cancer detection using wavelets

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Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods

Total: 60 Periods

EVALUATION PATTERN:

<table>
<tr><th colspan="6">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I (Practical) (100 Marks)</td><td colspan="3">Assessment II (Project) (100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="5">200</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER IV

U21EC407	DESIGN STUDIO II	Category: EEC				
		L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- U21EC306: Design Studio I

COURSE OBJECTIVES:

- To inculcate the problem-solving & Innovation mindset
- To provide a platform for self-learning, experimenting, solving the real-world problems and to develop a product.
- To enable hands-on experience for active learning.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply design thinking to implement the refined solution through simulation or hardware development (Apply)

CO2: Analyze the performance of the proposed solution using simulation tools (Analyze)

CO3: Demonstrate teamwork and project management skills to effectively coordinate tasks and present the solutions professionally (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	2	2	-	1	2	2
CO2	3	2	2	2	3	-	-	2	2	2	-	1	2	2
CO3	-	-	-	-	-	-	-	2	2	2	-	1	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

Course conduction:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor for this design clinic 2 course.
- With the guidance of assigned mentor, the students will find & validate a problem statement, map to UNSGD, identify the skills required for the project and self-learn.
- Applying design thinking & system thinking concept the students will solve the problem and produce the version 1 of prototype. (TRL 4)
- The student will learn teamwork, project management, technical report writing and presentation skills through this course.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: – Periods Project: 30 Periods

Total: 30 Periods

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EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

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SEMESTER V

		Category: PCC				
U21EC501	TRANSMISSION LINES AND ANTENNAS	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- U21EC401: Electromagnetic Fields and Waveguides

COURSE OBJECTIVES:

- To learn the concept of transmission lines and signal propagation at radio frequencies
- To solve real time impedance matching problems using Smith chart
- To understand the radiation characteristics of different types of antennas

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the characteristics of transmission lines and signal propagation at high frequencies (Understand)

CO2: Examine the various transmission lines parameters using Smith chart (Analyze)

CO3: Summarize parameters and the characteristics of antennas (Understand)

CO4: Design antenna arrays and aperture antennas to achieve desired radiation patterns and gain (Apply)

CO5: Explain the construction, operation, and applications of special antennas (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	2
CO2	3	3	2	-	-	-	-	-	-	-	-	1	-	2
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	2
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I TRANSMISSION LINE THEORY **9+3**

General solution of transmission lines – The infinite line – Input and transfer impedance – Open and short circuited lines – High frequency transmission lines – Line of zero dissipation – Voltage and current equations – Open and short circuit impedance – Standing waves

UNIT II IMPEDANCE MATCHING IN HIGH FREQUENCY LINES **9+3**

Impedance matching – Quarter wave transformer – Impedance matching by stubs – Single stub matching – Double stub matching – Smith chart and its applications – Problems based on Smith chart

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UNIT III FUNDAMENTALS OF RADIATION 9+3

Antenna parameters – Radiation pattern, gain, directivity, effective aperture, radiation resistance, beam width, bandwidth, input impedance – Wire antenna – Radiation from short dipole, half-wave dipole - folded dipole – Yagi-Uda antenna

UNIT IV ANTENNA ARRAYS AND APERTURE ANTENNAS 9+3

Uniform linear array – N element linear array – Broadside and end fire array – Binomial arrays – Pattern multiplication – Horn antenna – Reflector antenna – Aperture blockage, feeding structures – Patch antenna – Slot antenna, micro strip antenna

UNIT V SPECIAL ANTENNAS 9+3

Principle of frequency independent antennas – Spiral antenna – Helical antenna – Log-periodic antenna – Modern antennas – Reconfigurable antenna, 5G antenna – Antenna measurements.

Contact Periods:

Lecture: 45 Periods Tutorial: – 15 Periods Practical: – Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. John D Ryder, "Networks, lines and fields", 2nd edition, Pearson Education India, 2017
2. John D Kraus, "Antennas and Wave Propagation", 4th edition, Mc Graw Hill, 2017

REFERENCES:

1. Constantine.A.Balanis, "Antenna Theory Analysis and Design", 4th edition, Wiley, 2016
2. K. D. Prasad, "Antenna and Wave Propagation", 3rd edition, Satya Prakashan, 2016
3. Edward C.Jordan and Keith G.Balmain, "Electromagnetic Waves and Radiating Systems", 2nd edition, Pearson Education, 2015
4. S. Drabowitch., "Modern Antennas", 2nd edition, Springer Publications, 2007

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER V

U21EC502	CONTROL SYSTEM THEORY	Category: PCC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- U21EC301: Signals and Systems

COURSE OBJECTIVES:

- To comprehend the components and their representation of control systems
- To learn various methods to analyze the time response, frequency response and stability of the systems
- To understand various methods for the state variable analysis

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Determine the transfer function of electrical and mechanical systems (Understand)
CO2: Illustrate the controller design and time domain responses (Understand)
CO3: Examine the stability of linear time invariant systems using various techniques (Analyze)
CO4: Design compensators using frequency response plots (Apply)
CO5: Model control systems using state variables (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	2	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SYSTEMS AND THEIR REPRESENTATION **9+3**

Components of control system – Open loop and closed loop – Mathematical models of electrical and mechanical systems – Electrical analogous of mechanical systems – Block diagram reduction – Signal flow graph

UNIT II TIME RESPONSE ANALYSIS **9+3**

Transient response – Steady state response – Time response of the standard first order and second order system for unit step input – Basics of time domain specifications – Steady state error and error constant – Controllers – PD, PI and PID

UNIT III STABILITY ANALYSIS **9+3**

Concepts of stability – Necessary conditions for stability – Routh Hurwitz criterion – Root locus – Nyquist stability criterion – Nyquist plot

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UNIT IV FREQUENCY RESPONSE AND COMPENSATOR DESIGN 9+3

Frequency domain specification of standard second order system – Bode plot – Polar plot – Design of compensators using Bode plots – Cascade compensation – Lead, lag, lag-lead compensation – Stability analysis using simulation tool

UNIT V STATE VARIABLE ANALYSIS 9+3

State space model – Representation using physical and phase variable – Conversion between state variable models and transfer functions – State space representation using canonical variables – Concepts of controllability and observability – Kalman's and Gilbert's Test

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. K. Ogata, "Modern Control Engineering", 5th edition, Prentice Hall of India, 2012
2. J.Nagrath and M.Gopal, "Control System Engineering", 6th edition, New Age International, 2011

REFERENCES:

1. R. Anandha Natarajan and B. Ramesh Babu "Control System Engineering", 3rd edition, Scitech Publication, 2015
2. Smarajit Ghosh, "Control Systems Theory and Applications", 2nd edition, Pearson Education, New Delhi, 2013
3. S.K.Bhattacharya, "Control System Engineering", 3rd edition, Pearson, 2013
4. M.Gopal, "Control System – Principles and Design", 4th edition, Tata McGraw Hill, 2012

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER V

U21EC503	COMPUTER COMMUNICATION NETWORKS	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire knowledge about protocol layering and physical layer performance
- To describe the functions of data link and network layers
- To outline transport layer services and application layer protocols

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Demonstrate network topologies and transmission concepts for physical layer communication (Apply)

CO2: Apply error detection and correction techniques to ensure data-link layer reliability (Apply)

CO3: Implement suitable routing protocols for network layer communication (Apply)

CO4: Examine transport layer protocols and congestion control mechanisms (Analyze)

CO5: Compare application layer protocols based on functionality and performance (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	2	2	-	1	1	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	1	-
CO3	3	2	1	1	2	-	-	-	2	2	-	1	1	-
CO4	3	3	2	2	2	-	-	-	2	2	-	1	1	-
CO5	3	3	2	2	2	-	-	-	2	2	-	1	1	-
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I PHYSICAL LAYER 9

Fundamentals of data communication – Networks – Internet protocols and standards – Topologies – OSI model – TCP/IP protocol suite – Transmission media – Circuit, datagram and virtual networks – Modem

UNIT II DATA-LINK LAYER & MEDIA ACCESS 9

Error detection and correction : Parity Check, CRC, Hamming Code and Checksum – Sliding window protocols – HDLC – PPP – Wired LANs – Ethernet – Bridges and LAN switches – IEEE 802.11 – Bluetooth – Connecting devices

UNIT III NETWORK LAYER 9

Internetworking – IPv4 – Subnetting – IPv6 – Distance vector (RIP) and link state (OSPF) routing algorithms – Inter-domain Routing (BGP) – Basics of IP support protocols (ARP, RARP, DHCP, ICMP) – Network address translation (NAT)

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UNIT IV TRANSPORT LAYER 9

Functions of transport layer – UDP – TCP – SCTP – TCP congestion control – Congestion avoidance mechanisms – Quality of Service – Integrated services – Differentiated services

UNIT V APPLICATION LAYER 9

Domain name system (DNS) – Electronic mail (SMTP, MIME, IMAP) –Telnet – File transfer (FTP) – REST– WWW (HTTP, HTTPS) – SNMP– SSH – VPN

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 75 Periods

LIST OF EXPERIMENTS:

1. Network topology - Star, Bus, and Ring
2. Error Detection / Error Correction Techniques
3. IP address configuration and execution of IP commands
4. Distance vector routing algorithm
5. Link state routing algorithm
6. Stop and wait and sliding window protocols
7. Go-back-N and selective repeat protocols
8. TCP congestion control algorithm
9. Implementation of Network address translation
10. Implementation of Virtual Private Network

TEXT BOOKS:

1. J.F. Kurose, K.W. Ross, "Computer Networking: A Top-Down Approach", 5th edition, Addison-Wesley, 2017
2. Behrouz A Forouzan, "Data Communications and Networking", 5th edition, Tata McGraw–Hill, New Delhi, 2015

REFERENCES:

1. William Stallings, "Data and Computer Communications", 10th edition, Pearson Education, 2013
2. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", 5th edition, Morgan Kaufmann Publishers Inc., 2012
3. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, "Computer Networks: An Open Source Approach", 1st edition, McGraw Hill Publisher, 2011

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**35**	**15**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER V

U21SSG02	SOFT SKILLS - II	Category: HSMC				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the importance of communication and enhance self confidence
- To acquire employability skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Actively participate in Group Discussion (Analyze)

CO2: Enhance interview skills and make effective Presentation (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I PRESENTATION SKILLS **10**

Presentation Techniques – Time Management Techniques – Body language – Managerial Skills – Making Effective Presentation

UNIT II GROUP DISCUSSION AND PUBLIC SPEAKING **10**

Introduction to Group Discussion – Understanding Group Dynamics – Group Discussion Strategies– Activities to Improve GD Skills – Public Speaking Techniques – Public Speaking Activiti

UNIT III INTERVIEW SKILLS **10**

Listening to Interviews – Preparation for the Interview – Interview Techniques and Etiquettes – Handling Stress Interview – Mock Interview – Online Interview Techniques

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 30 Periods

TEXT BOOKS:

1. Prashant Sharma, "Soft Skills: Personality Development for Life Success", BPB Publications, 1st edition,2022
2. Leader Interpersonal and Influence Skills: The Soft Skills of Leadership." Routledge Publications, 2014

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REFERENCES:

1. Ghosh B N, "Managing Soft Skills for Personality Development", 1st edition ,Tata McGraw-Hill,2012
2. Nitin Bhatnagar and Mamta Bhatnagar, "Effective Communication and Soft Skills Strategies for Success", 1st edition, Pearson Education, 2012

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

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SEMESTER V

U21EC504	RF AND ANTENNA DESIGN LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	2	2	2

PRE–REQUISITES:

- U21EC401: Electromagnetic Fields and Waveguides

COURSE OBJECTIVES:

- To study the characteristics of RF filters, couplers and isolators
- To measure various antenna parameters such as radiation pattern, gain, directivity, beam width and polarization
- To design modern antennas using EM simulation tools

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply fundamental concepts of RF and antenna theory to analyze the characteristics of antennas (Apply)

CO2: Design RF components and antennas to meet specified performance requirements (Apply)

CO3: Analyze the performance of RF and antenna parameters using experimental and simulation results (Analyze)

CO4: Implement RF and antenna experiments individually and collaboratively with proper technical documentation (Apply)

CO5: Design RF and antenna systems to address practical wireless communication applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	-	1
CO3	3	3	2	2	2	-	-	-	-	-	-	1	-	1
CO4	-	-	-	-	-	-	-	2	2	2	-	1	-	1
CO5	3	2	1	1	2	2	-	2	2	2	2	2	-	1
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)						3: Substantial (High)			

LIST OF EXPERIMENTS

I. HARDWARE EXPERIMENTS

1. Measurement of radiation pattern of horn antenna
2. Measurement of radiation pattern of parabolic reflector antenna
3. Characteristics of RF low pass and high pass filters

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II. SIMULATION EXPERIMENTS

1. Measurement of antenna parameters of dipole antenna
2. Design of couplers and isolators for RF systems
3. Design of microstrip antenna for Wi-Fi application
4. Design and testing of spiral antenna (End to end product)

AUGMENTED EXPERIMENTS

1. Parametric analysis of helical antenna using time domain solver
2. Design and implementation of circular patch antenna
3. Development and parametric analysis of slot antenna using time domain solver
4. Design of 5G antennas for base station application
5. Design and analysis of rectangular patch antenna

TYPICAL PROJECTS

1. Design of dual band rectangular microstrip antenna at 2.4 & 5.8 GHz
2. Coaxial fed patch antenna design
3. Cylindrical dielectric resonator antenna design
4. Design of inset-feed microstrip antenna and analysis of radiation pattern and gain plot
5. Rectangular patch antenna design at 5.7 GHz for Wi-Fi applications
6. Design of circular patch antenna with slots
7. Design of microstrip patch antenna with slots

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods

Total: 60 Periods

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I (Practical) (100 Marks)</td><td colspan="3">Assessment II (Project) (100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="5">200</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER V

U21EC506	PROTO STUDIO I	Category: EEC				
		L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- U21EC407: Design Studio II

COURSE OBJECTIVES:

- To inculcate the problem-solvixng & Innovation mindset
- To provide a platform for self-learning, experimenting, solving the real-world problems and to develop a product.
- To enable hands-on experience for active learning.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Develop electronic based prototype model as a team to provide solutions for societal needs (Apply)

CO2: Analyze the performance of the proposed solutions to evaluate their effectiveness and feasibility (Analyze)

CO3: Demonstrate teamwork and project management skills to effectively coordinate tasks and present the solutions professionally (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	3	-	-	-	-	-	-	1	2	2
CO3	-	-	-	-	-	-	-	2	2	2	2	2	2	2

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course conduction:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor for this Proto clinic 1 course.
- With the guidance from assigned mentor, the students will find & validate a problem statement, map to UNSGD, identify the skills required for the project and self-learn.
- The students will learn and apply design thinking, system thinking concept to solve the problem and produce the version 1 of MVP. (TRL 5)
- The student will learn teamwork, project management, product development, technical report writing and pitching through this course.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: – Periods Project 30 Periods

Total 30 Periods

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EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

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SEMESTER VI

U21ECG05	EMBEDDED SYSTEMS AND IOT (Common to EC,CSBS and IT)	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC404: Microprocessors and Microcontrollers

COURSE OBJECTIVES:

- To learn about embedded processor, its hardware and software
- To acquaint with interfacing of sensors and actuators with controllers
- To apply Internet of Things techniques in real time applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the components of real time embedded systems (Understand)
CO2: Illustrate the architecture of microcontroller based devices (Understand)
CO3: Compare various communication technologies for IoT applications (Analyze)
CO4: Develop an IoT based system for specific applications (Analyze)
CO5: Apply the concepts of IoT and Cloud interface for application development (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	2	3	-
CO2	2	1	-	-	-	-	-	-	-	-	-	2	3	-
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	-
CO4	3	3	2	-	2	-	-	-	-	-	-	2	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	2	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I FUNDAMENTALS OF EMBEDDED SYSTEM DESIGN 9

Embedded system (ES) – Architecture, characteristics, types – Embedded system on chip (SOC) – Components of embedded system – Hardware and software – Power supply – Types, characteristics, selection criteria – Design process

UNIT II OVERVIEW OF MICROCONTROLLER 9

8-bit Micro controllers - ARM: ARM Architecture and Organization – Registers – ARM Instruction Set – Timers – Interfacing – LED – ADC – ARM programming in embedded C – IDE's for ARM- Interrupt Handling --External Memory Interface

UNIT III IoT ARCHITECTURE AND COMMUNICATION TECHNOLOGIES 9

Internet of Things – IoT architectural overview – M2M and IoT technology fundamentals – Devices and gateways – IoT protocols – MQTT – CoAP – XMPP – IoT Communication technologies – Bluetooth – Zigbee

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UNIT IV IoT DESIGN AND PROGRAMMING 9

Types of sensors – Temperature, humidity and PIR – Introduction to ESP8266 – Tools used for programming-Functions and loops used in programming- Creating a Webserver on NodeMCU– Analog and Digital sensor interfacing with NodeMCU

UNIT V IoT- CLOUD INTERFACING AND CASE STUDY 9

Cloud storage models – Communication API – Cloud for IoT – Case Studies – Home intrusion detection – Weather monitoring system – Air pollution monitoring – Smart irrigation

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, VPT, 2017
2. Lyla B. Das, " Embedded Systems: An Integrated Approach" , 1st edition, Pearson Education, 2013

REFERENCES:

1. Dogan Ibrahim, "ARM Based Microcontroller Projects using mbed", 1st edition, Newnes Publications, 2019
2. Raj Kamal, "Embedded Systems Architecture, Programming and Design", 3rd edition, McGraw-Hill Higher Education, 2017
3. T. Bansod, Pratik Tawde, "Microcontroller Programming (8051, PIC, ARM7 ARM Cortex)", Original edition, Shroff Publishers & Distributors Pvt. Ltd, 2017
4. Steve Furber, "ARM System-on-Chip Architecture", 2nd edition, Pearson Education, 2015.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VI

U21EC601	VLSI Design	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21ECG01: Digital Electronics

COURSE OBJECTIVES:

- To understand the IC fabrication techniques and low power logic circuits
- To design sequential logic circuits
- To learn various arithmetic circuits and testing methodologies

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Examine the different characteristics of MOS transistors (Analyze)
CO2: Construct stick and layout diagrams of CMOS circuits (Apply)
CO3: Model sequential logic circuits and memories using CMOS (Apply)
CO4: Design arithmetic circuits using suitable subsystems (Apply)
CO5: Examine the performance of combinational and sequential circuits using FPGA (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	2	2	-	1	-	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO3	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO4	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO5	3	3	2	2	2	-	-	-	2	2	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I MOS TRANSISTOR THEORY 6

Basic MOS transistors – I-V and C-V characteristics, DC transfer characteristics, Non ideal I-V effects –Fabrication of CMOS integrated circuits – BICMOS

UNIT II COMBINATIONAL LOGIC CIRCUITS 6

Stick diagram – Layout design rules – Circuit families – Pass transistors, transmission gates – Various forms of CMOS logic – Pseudo, dynamic, domino, NP domino – Delay estimation – Logical efforts and transistor sizing – Power dissipation – Scaling

UNIT III SEQUENTIAL LOGIC CIRCUITS 6

Timing metrics – Static latches and registers – Dynamic latches and registers – Pipelining – Array subsystems – SRAM, DRAM, CAM and PLA

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UNIT IV ARITHMETIC BUILDING BLOCKS 6

Data path subsystems – Manchester carry chain adder – 4-bit adder – Array multiplier – Modified Booth multiplier, Wallace tree multiplier – Barrel and logarithmic shifters – Power and speed trade off – Case study

UNIT V PROGRAMMABLE ASIC 6

ASIC Design flow – Types of ASICs – Full custom – Standard cell-based ASICs – Gate array-based ASIC – FPGA – Programmable ASIC – Anti fuse, SRAM, EPROM, EEPROM technology – Programmable ASIC logic cells – Xilinx3000 CLB, Xilinx4000 logic block – HDL programming for FPGA

LIST OF EXPERIMENTS

1. Simulation of combinational circuits using CMOS logic
2. Simulation of sequential circuits using CMOS logic
3. Layout design of combinational circuits and sequential circuits
4. Design and Implementation of combinational circuits using FPGA
5. Design and Implementation of sequential circuits using FPGA
6. Post lay-out simulation for combinational and sequential circuits

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. Jan Rabaey, Anantha Chandrakasan, B. Nikolic, "Digital Integrated circuits: A Design Perspective", 2nd edition, Pearson, 2019
2. N. E. Weste, David Harris, Ayan Banerjee, "Principles of CMOS VLSI Design, A Circuits and System Perspective", 3rd edition, Pearson, 2012

REFERENCES:

1. Bhattacharya S.K., "Electrical Machines", 4th edition, McGraw-Hill Education, New Delhi, 2017
2. Mitchel E Schultz, "Basic Electronics", 10th edition, McGraw Hill Publishers, 2017
3. Douglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design", A Circuits and System Perspective", 3rd edition, Pearson, 2012
4. Bali S P, "Consumer Electronics", 1st edition, Pearson Education Asia Pvt. Ltd., 2008

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		35	15
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VI

U21AMG01	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (For EC)	Category: ESC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21CSG02 : Python Programming

COURSE OBJECTIVES:

- To learn the different search strategies in AI
- To apply supervised and unsupervised methods to develop decision systems
- To familiarize the advanced machine learning techniques

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply problem-solving and search algorithms along with knowledge representation techniques to solve AI problems (Apply)

CO2: Summarize local search and planning algorithms in artificial Intelligence (Understand)

CO3: Solve dimensionality reduction problem using supervised and unsupervised learning algorithms (Apply)

CO4: Apply ensemble model, SVM, Neural networks to solve complex problems (Apply)

CO5: Select appropriate machine learning techniques for applications in NLP, computer vision, and healthcare domains (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	2	2	-	2	2	-
CO2	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	1	1	2	-	-	-	2	2	-	2	2	-
CO4	3	2	1	1	2	-	-	-	2	2	-	2	2	-
CO5	3	2	1	1	2	-	-	-	2	2	-	2	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

Overview of AI – Definition – History and evolution applications and Impact – Problem Solving and Search – Problem formulation – Informed search algorithms – Knowledge representation and Reasoning – Propositional and first-order logic – Semantic networks and frames – Inference in AI

UNIT II LOCAL SEARCH PROBLEMS AND PLANNING 9

Local search algorithms and optimization problems – Local search in continuous spaces – Searching with nondeterministic actions – Searching with partial observations – Planning graphs – Planning and acting in the real world – Time, schedules and resources – Hierarchical planning

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UNIT III INTRODUCTION TO MACHINE LEARNING 9

Overview of Machine Learning – Supervised learning – Regression and classification – Unsupervised learning – Clustering algorithms – K-means – Dimensionality reduction techniques – PCA – Model evaluation and validation – Cross-validation – Bias-Variance tradeoff – Over fitting and under fitting

UNIT IV ADVANCED MACHINE LEARNING TECHNIQUES 9

Ensemble Learning – Introduction to ensemble methods – Random forest – Gradient boosting – Bagging and boosting techniques – Support Vector Machines (SVM) – Understanding the SVM algorithm – Kernel methods in SVM – Neural networks and deep learning – Reinforcement learning basics

UNIT V MACHINE LEARNING APPLICATIONS AND FUTURE TRENDS 9

Natural Language Processing (NLP) – Introduction to NLP – Text classification and sentiment analysis – Image processing and computer vision – Image recognition and classification – Object detection – Applications of computer vision – Machine Learning in Healthcare

LIST OF EXPERIMENTS

1. Implementation of a basic search algorithm
2. Implement propositional and first-order logic
3. Develop a simple regression model
4. Implement classification algorithms
5. Implement Dimensionality reduction using PCA
6. Implement a basic Neural Network from scratch

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 75 Periods

TEXT BOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Systems Approach", Prentice Hall, 4th Edition, 2022
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd edition, CRC Press, 2015,

REFERENCES:

1. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", 1st edition, MIT Press, 2012
2. Ethem Alpaydin,"Introduction to Machine Learning", The MIT Press, 3rd Edition, 2014, ISBN 978-0-262-02818-9
3. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das," Machine Learning", Pearson Education India,2018

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		35	15
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VI

U21SSG03	SOFT SKILLS - III	Category: HSMC				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To improve language adeptness and to enhance fluency in language
- To Gain emotional intelligence and to manage stress

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Write reports and make reasoning and assertions (Apply)

CO2: Overcome stress and attain work-life balance (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	1	3	-	-	-	-
CO2	-	-	-	-	-	-	-	1	-	3	-	2	-	-
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)				3: Substantial (High)				

SYLLABUS:

UNIT I LANGUAGE ADEPTNESS **10**

Sentence Completion – Report Writing – Logical Reasoning – Cause and Effect – Assertion and Reasoning – Digital Profiling – Creative Resume

UNIT II STRESS MANAGEMENT **10**

Factors Causing Stress – Positive and Negative Stress – Effects of Stress – Stress Overcoming Techniques – Context Based Tasks

UNIT III INTERVIEW SKILLS **10**

Leadership effectiveness – Self-awareness – Self-management – Self-motivation – Empathy and Social Skills

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 30 Periods

TEXT BOOKS:

1. Daniel Goleman, "Emotional Intelligence: Why it Can Matter More Than IQ", 1st edition, Bloomsbury, 2009
2. Alan Barker, "Improve Your Communication Skills: Present with Confidence; Write with Style; Learn Skills of Persuasion",1st edition, Kogan Page, 2010

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REFERENCES:

1. Jeremy Stranks,"Stress at Work: Management and Prevention", 1st edition, Butterworth-Heinemann,2005
2. Edward J Watson, "Emotional Intelligence: A Practical Guide on How to Control Your Emotions and Achieve Lifelong Social Success", 1st edition, Amazon Digital Services LLC, 2016

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test – I	50
Test – II	50
Total	100

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SEMESTER VI

U21ECG06	EMBEDDED SYSTEMS AND IoT LABORATORY (Common to EC,CSBS and IT)	Category: EEC				
		L	T	P	J	C
		0	0	2	2	2

PRE–REQUISITES:

- U21EC404: Microprocessors and Microcontrollers

COURSE OBJECTIVES:

- To understand the working of Arduino and ARM processor
- To write programs to interface the peripheral devices with ARM processor
- To design and develop IoT based projects for real time application

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply fundamental concepts of embedded systems and microcontrollers to develop embedded applications (Apply)

CO2: Develop embedded programs to interface sensors, actuators and peripheral devices for specific applications (Apply)

CO3: Analyze the performance of embedded and IoT systems using experimental results (Analyze)

CO4: Demonstrate individual competency or teamwork in implementing and documenting embedded system experiments (Apply)

CO5: Design simple embedded and IoT-based solutions for real-time monitoring and control applications (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	-	-	-	1	1	-
CO2	3	2	1	1	2	-	-	-	-	-	-	1	1	-
CO3	3	3	2	2	2	-	-	-	-	-	-	1	1	-
CO4	-	-	-	-	-	-	-	2	2	2	-	1	1	-
CO5	3	2	1	1	2	2	-	2	2	2	2	2	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

LIST OF EXPERIMENTS

1. Temperature Monitoring and Control System Using LPC2148
2. Password-Based Door Lock System Using LPC2148 and Keypad
3. Display a character in 16x2 LCD
4. Real time clock using LPC2148
5. MQTT communication using an ESP32 interfaced with a DHT sensor

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6. Relay control system using the ESP8266 microcontroller
7. Real-time motion-based relay control system using ESP8266 interfaced with a PIR sensor
8. Cloud-based data communication using NodeMCU for IoT applications

AUGMENTED EXPERIMENTS

1. Study and implement an Arduino based IoT application with Thing Speak Cloud
2. IoT based Smart power saving system for home automation.
3. Firebase web app for home automation.

TYPICAL PROJECTS (INDICATIVE)

1. Temperature Logging System using ESP8266
2. Air Pollution Meter.
3. ESP8266 based Colour Sorting Machine.
4. Humidity controller
5. Distance measurement
6. Flame detection and E - notification
7. Smart blind stick
8. Water level monitoring system
9. Smart dust bin
10. Temperature monitoring system using MQTT protocol

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods

Total: 60 Periods

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Practical) (100 Marks)</th><th colspan="3">Assessment II (Project) (100 Marks)</th><th rowspan="3">Practical Examinations
(Examinations will be conducted for 100 Marks)</th></tr>
<tr><th>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</th><th>Test</th><th>Review I</th><th>Review II</th><th>Review III</th></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td></tr>
<tr><td colspan="5">200</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER VI

U21EC602	PROTO STUDIO II	Category: EEC				
		L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- U21EC506: Proto Studio I

COURSE OBJECTIVES:

- To inculcate the problem-solving & Innovation mindset
- To provide a platform for self-learning, experimenting, solving the real-world problems and to develop a product.
- To enable hands-on experience for active learning.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Build a minimum viable prototype to provide a solution for societal needs (Apply)

CO2: Demonstrate teamwork and project management skills to effectively coordinate tasks and present the solutions professionally (Apply)

CO3: Develop a structured technical report presenting the project findings and outcomes (Apply)

CO-PO MAPPING:

Cos \ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	2	2	-	-	-	2	2	2	2
CO2	-	-	-	-	-	-	-	2	2	2	2	2	-	-
CO3	-	-	-	-	-	-	-	2	2	2	2	2	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

COURSE CONDUCTION:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor for this Proto clinic 2 course.
- With the guidance from assigned mentor, the students will find & validate a problem statement, map to UNSGD, identify the skills required for the project and self-learn.
- The students will apply design thinking, system thinking concepts to solve the problem and produce the version 2 of MVP. (TRL 6)
- The student will learn teamwork, project management, product development, technical report writing and pitching through this course.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: – Periods Project: 30 Periods
Total: 30 Periods

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EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

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SEMESTER VII

U21EC701	WIRELESS COMMUNICATION	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21EC403: Digital Communication

COURSE OBJECTIVES:

- To learn the characteristics of wireless channels and digital signalling techniques
- To understand the design of a cellular system
- To study multipath mitigation and smart antenna techniques

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Implement various multiple access techniques using simulation tool (Apply)
CO2: Examine the performance of mobile radio propagation models (Analyze)
CO3: Compare various digital modulation schemes based on error probability in fading channel (Analyze)
CO4: Apply multipath mitigation techniques to analyze error performance in fading channels (Apply)
CO5: Apply multiple antenna techniques to evaluate MIMO system performance and channel capacity (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	2	2	-	2	-	2
CO2	3	3	2	2	2	-	-	-	2	2	-	2	-	2
CO3	3	3	2	2	2	-	-	-	2	2	-	2	-	2
CO4	3	2	1	1	2	-	-	-	2	2	-	2	-	2
CO5	3	2	1	1	2	-	-	-	2	2	-	2	-	3
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)				3: Substantial (High)					

SYLLABUS:

UNIT I CELLULAR ARCHITECTURE **9**

Multiple Access techniques – FDMA, TDMA, CDMA, SDMA – Capacity calculations – Cellular concept – Frequency reuse – Channel assignment – Hand off strategies – Interference and system capacity – Trunking and grade of service – Coverage and capacity improvement

UNIT II MOBILE RADIO PROPAGATION **9**

Free space propagation and two-ray models – Link budget design – Outdoor propagation models – Indoor propagation models – Small scale fading – Parameters of mobile multipath channels – Time dispersion parameters – Coherence bandwidth – Doppler spread and coherence time – Types of small scale fading

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UNIT III DIGITAL MODULATION SCHEMES FOR FADING CHANNELS 9

Structure of a wireless communication link – Offset QPSK – π/4 QPSK – Minimum shift keying – Gaussian minimum shift keying – Error performance in fading channels – OFDM principle – Cyclic prefix, windowing and PAPR

UNIT IV MULTIPATH MITIGATION METHODS 9

Equalization – Linear and non-linear equalization – Adaptive equalization – Zero forcing algorithm, LMS algorithms – Diversity techniques – Micro and macro diversity, diversity combining techniques – Error probability in fading channels with diversity reception – Rake receiver

UNIT V MULTIPLE ANTENNA TECHNIQUES 9

Introduction to MIMO systems MIMO systems – Spatial multiplexing – System model – Pre-coding – Beam forming – Space time Coding – Alamouti scheme – Channel state information – Capacity in fading and non-fading channels

LIST OF EXPERIMENTS

1.Simulation of Multiple access techniques
   i. Frequency division multiple access
   ii. Code division multiple access
   iii. Time division multiple access

2.Mobile radio propagation
   i. Calculate the carrier to noise ratio for a wireless communication
   ii. Compute the propagation path loss using Okumara model and Hata Model

3. Simulation of Digital modulation schemes for fading channels
   i. Error performance in fading channel
   ii. Signal constellation and error probability of a minimum shift keying technique
   iii. Orthogonal frequency division multiplexing using simulation tool

4.Multipath fading
   i. Analyze the performance of rake receiver using multipath channels with diversity reception using simulation tool

5. Performance comparison of spatial multiplexing and spatial diversity techniques in MIMO systems

Contact Periods:

Lecture: 45 Periods	Tutorial: – Periods	Practical: 30 Periods	Project: – Periods
			Total: 75 Periods

TEXT BOOKS:

1. Rappaport T.S, "Wireless Communications", 2nd edition, Pearson Education, 2018
2. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", 1st edition, Cambridge University Press, 2005

REFERENCES:

1. Andrea Goldsmith, "Wireless Communication", 2nd edition, Cambridge University Press, 2015
2. Andreas.F.Molisch, "Wireless Communications", 2nd edition, John Wiley, 2014
3. Upena Dalal, "Wireless Communication", 1st edition, Oxford University Press, 2009
4. Van Nee.R and Ramji Prasad, "OFDM for Wireless Multimedia Communications", 1st edition, Artech House, 2000

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		35	15
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VII

U21EC702	OPTICAL AND MICROWAVE ENGINEERING	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21EC501: Transmission Lines and Antennas

COURSE OBJECTIVES:

- To learn about optical fiber sources and transmission techniques
- To study the different microwave active and passive components
- To understand the basic principles in microwave measurements

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the principles and classification of fiber optic system (Understand)
CO2: Select appropriate source and detector for efficient optical communication (Apply)
CO3: Use suitable passive and active devices for microwave applications (Apply)
CO4: Demonstrate the generation of RF signals using microwave sources (Apply)
CO5: Examine the performance of microwave propagation through test bench (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	2	2	-	1	-	1
CO2	3	2	1	1	-	-	-	-	2	2	-	1	-	1
CO3	3	2	1	1	-	-	-	-	2	2	-	1	-	1
CO4	3	2	1	1	-	-	-	-	2	2	-	1	-	1
CO5	3	3	2	2	-	-	-	-	2	2	-	1	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I FUNDAMENTALS OF OPTICAL FIBER SYSTEM 9

Element of an optical fiber system – Basic laws and definitions – Total internal reflection, acceptance angle, numerical aperture, V-number, ray optics representation – Fiber optic cable structures – Types of optical fiber – Single mode and multimode , step index fiber and graded index fiber

UNIT II FIBER OPTICAL SOURCES AND RECEIVERS 9

Light sources – LED structures, modulation of a LED, types of LED, power and quantum efficiency – LASER diodes – Modes and threshold condition, external quantum efficiency – Fundamental receiver operation – Photo detectors – Photo diode, PIN diode, APD

UNIT III PASSIVE AND ACTIVE MICROWAVE DEVICES 9

Microwave passive components – Attenuator, isolator, dielectric phase shifter, directional couplers, E-plane Tee, H-plane Tee, magic Tee – Microwave active devices – Schottky barrier diodes, IMPATT diode and BARITT diode

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UNIT IV MICROWAVE SOURCES 9

Microwave linear beam tubes – Limitations of conventional tubes at microwave frequencies – Two cavity klystron – Reflex klystron – Helix traveling wave tube – Microwave cross field tubes – Cylindrical magnetron – Gunn oscillator

UNIT V MICROWAVE MEASUREMENTS 9

Microwave bench – Tunable detector, slotted line carriage, VSWR meter, power meter – Microwave measurements – Power, insertion loss and attenuation, VSWR, return loss measurement by a reflectometer, frequency and impedance measurements

LIST OF EXPERIMENTS

1. Determination of numerical aperture in optical fibers
2. Measurement of losses in the fiber optic link
3. DC characteristics of LED
4. VI and PI characteristics of PIN photo diode
5. Characteristics of Reflex klystron and Gunn diode
6. Measurement of VSWR, frequency and wavelength using Reflex klystron
7. S–parameter analysis of E–plane Tee, H–plane Tee, Magic Tee and directional coupler

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 75 Periods

TEXT BOOKS:

1. Gerd Keiser, "Optical Fiber Communication", 5th edition, McGraw Hill Publishing Company Ltd, India, 2017
2. Samuel Y Liao, "Microwave Devices & Circuits", 3rd edition Prentice Hall of India, 2006

REFERENCES:

1. Annapurna Das and Sisir K Das, "Microwave Engineering", 4th edition, McGraw Hill Publishing Company Ltd, India, 2020
2. David M. Pozar, "Microwave Engineering", 4th edition, John Wiley and Sons, India, 2012
3. John M. Senior, "Optical Fiber Communication", 3rd edition, Pearson Education, India, 2010
4. Robert. E. Collin, "Foundations for Microwave Engineering", 2nd edition, John Wiley and Sons, India, 2005

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		35	15
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VII

U21EC704	PROJECT WORK PHASE - I	Category: EEC				
		L	T	P	J	C
		0	0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To identify the real life problems and to design solutions using the concepts of electronics and communication engineering
- To develop communication skills to work in a collaborative environment
- To demonstrate ethical and professional attributes

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Examine existing engineering problems through literature review to identify key issues, trends, and societal needs (Analyze)

CO2: Develop engineering solutions in core and related domains using simulation tools (Apply)

CO3: Analyze the performance of the proposed solutions to evaluate the effectiveness and feasibility (Analyze)

CO4: Demonstrate teamwork and project management skills to effectively coordinate tasks and present the solutions professionally (Apply)

CO5: Develop a structured technical report presenting the project findings and outcomes (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	1	1	-	-	-	-	2	3	3
CO2	3	2	1	1	3	1	1	-	-	-	-	2	3	3
CO3	3	3	2	2	3	-	-	-	-	-	-	2	3	3
CO4	-	-	-	-	-	-	-	3	3	3	3	2	-	-
CO5	-	-	-	-	-	-	-	3	3	3	3	2	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

EVALUATION PATTERN:

Internal Assessment (60 Marks)			End semester Examinations (40 Marks)			
Review I	Review II	Review III	Project Report		Viva-Voce	
			Supervisor	External	Internal	External
10	20	30	10	10	10	10

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SEMESTER VIII

U21EC802	PROJECT WORK PHASE - II	Category: EEC				
		L	T	P	J	C
		0	0	0	20	10

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To identify the real life problems and to design solutions using the concepts of electronics and communication engineering
- To develop communication skills to work in a collaborative environment
- To demonstrate ethical and professional attributes

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Develop engineering solutions in core and related domains using modern tools and equipment (Apply)

CO2: Analyze and validate the performance of the solutions to assess the effectiveness and feasibility (Analyze)

CO3: Demonstrate teamwork and project management skills to effectively coordinate tasks and present the solutions professionally (Apply)

CO4: Develop a structured technical report presenting the project findings and outcomes (Apply)

CO5: Implement project outcomes to generate impactful contributions such as research publications, patent filings, technology transfer or commercialization initiatives (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	1	1	-	-	-	-	2	3	3
CO2	3	3	2	2	3	1	1	-	-	-	-	2	3	3
CO3	-	-	-	-	-	-	-	3	3	3	3	2	-	-
CO4	-	-	-	-	-	-	-	3	3	3	3	2	-	-
CO5	-	-	-	-	-	-	-	3	3	3	3	2	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

EVALUATION PATTERN:

Internal Assessment (60 Marks)			End semester Examinations (40 Marks)			
Review I	Review II	Review III	Project Report		Viva-Voce	
			Supervisor	External	Internal	External
10	20	30	10	10	10	10

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VERTICAL 1: IC Design and Testing

U21ECP01	VERILOG PROGRAMMING	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21ECG01: Digital Electronics

COURSE OBJECTIVES:

- To learn various types of modelling techniques in Verilog HDL
- To understand the concept of delays and switches in Verilog HDL
- To study the basic concept of system Verilog

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize different modeling concepts in Verilog HDL (Understand)
CO2: Construct combinational and sequential circuits using Verilog HDL (Apply)
CO3: Compare the delay performance of various modelling techniques (Analyze)
CO4: Explain the basic concepts of system Verilog (Understand)
CO5: Apply the concept of system Verilog in real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO3	3	3	2	2	2	-	-	-	2	2	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	1	2	-	-	-	2	2	-	1	-	-
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I HIERARCHICAL MODELING CONCEPTS 6

Overview of digital design with Verilog HDL – Modules and ports – Gate level modeling – Dataflow modeling – Behavioural modeling

UNIT II VERILOG HDL MODELS 6

Verilog HDL Models – Decoders, encoders – Multiplexers and de-multiplexers – Comparators, adders and subtractors – Latches and flip-flops, counters, shift register

UNIT III DELAYS AND SWITCH LEVEL MODELING 6

Types of delay models – Path delay modelling – Timing checks – Delay back annotation switch modelling elements – Implementation of CMOS NAND, NOR, multiplexer, flip-flop

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UNIT IV SYSTEM VERILOG CONCEPTS 6

System Verilog variables – Structures – Union – Arrays – Tasks and functions – Design hierarchy – Module prototype, net aliasing – Interfaces

UNIT V COMPLETE DESIGN MODEL USING SYSTEM VERILOG 6

System Verilog ATM example – Data abstraction – Interface encapsulation – Receivers and transmitters – Test bench for ATM

LIST OF EXPERIMENTS (INDICATIVE)

Design and verification using Verilog HDL

1. Adder and subtractor
2. Encoder and Decoder
3. Multiplexer and demultiplexer
4. Flip flops
5. Shift Registers
6. Counters
7. Traffic light controller
8. Finite State Machine
9. ALU using system Verilog

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Stuart Sutherland, Simon Davidmann and Peter Flake, "System Verilog for Design: A Guide to Using System Verilog for Hardware Design and Modeling", 2nd edition, Springer, 2006
2. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd edition, Pearson Education, New Delhi, 2003

REFERENCES:

1. Cem Unsalan and Bora Tar, "Digital System Design with FPGA: Implementation using Verilog andVHDL" 1st edition, Tata McGraw Hill, 2017
2. Douglas A.Pucknell and Kamran Eshraghian, "Basic VLSI Design", 3rd edition, Prentice Hall of India, 2015
3. S.Brown and Z. Vranesic, "Fundamental of digital logic with Verilog design", 3rd edition, Tata McGraw Hill, 2014
4. Chris Spear, "System Verilog for Verification: A Guide to Learning the Test bench Language Features", 3rd edition , Springer, 2012

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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KPRIET
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U21ECP06	SYSTEM DESIGN USING FPGA	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21ECG01: Digital Electronics

COURSE OBJECTIVES:

- To study the fundamentals of ASIC
- To understand the different FPGA architectures with interconnects
- To learn low level design languages

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamental concepts of ASIC (Understand)
CO2: Examine the performance of different programmable FPGAs (Analyze)
CO3: Analyze the design consideration of FPGA (Analyze)
CO4: Implement combinational and sequential logic circuits in FPGA (Apply)
CO5: Apply the low-level design coding in real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	2	2	-	-	-	2	2	-	1	-	-
CO3	3	3	2	2	2	-	-	-	2	2	-	1	-	-
CO4	3	2	1	1	2	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	2	2	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I BASICS OF ASIC 6

Types of ASICs – Design flow – Economics of ASICs – ASIC cell library – Library cell design – Library architecture - Gate array design

UNIT II PROGRAMMABLE FPGA 6

Anti-fuse – Metal-metal anti-fuse –FPGAs in use – Specifications – PREP benchmarks – FPGA economics – FPGA pricing – Pricing examples – Actel ACT – Xilinx LCA – Implementation – Combinational logic circuits

UNIT III PROGRAMMABLE I/O CELLS 6

DC output – AC output – DC Input – AC input – Clock input – Power input – Xilinx I/O block - Implementation – Sequential logic circuits

UNIT IV PROGRAMMABLE INTERCONNECT 6

Actel ACT – Xilinx LCA – Xilinx EPLD – Altera MAX 5000 and 7000 – Altera MAX 9000 – Altera flex – Design systems – Example – Multiplier – Traffic light controller

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UNIT V LOW LEVEL DESIGN ENTRY 6

Schematic entry – Hierarchical design – Schematic icons and symbols – Nets – Vectored instances and buses – Netlist screener – Low level design languages

LIST OF EXPERIMENTS (INDICATIVE)

Implementation and estimation of power, area, delay and LUT using FPGA

1. N-bit adder and subtractor
2. Code converter
3. Priority encoder
4. Synchronous counter
5. Shift register
6. Traffic light control using FSM
7. Array multiplier

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Ming-Bo Lin, "Digital System Designs and Practices using Verilog HDL and FPGAs", 7th edition, Wiley, 2012
2. M.J.S.Smith, "Application Specific Integrated Circuits", 2nd edition ,Pearson Education, 2008

REFERENCES:

1. J.Bhaskar, "A Verilog Primer", 5th edition, Prentice Hall- 2005
2. Samir Palnitkar, "Verilog HDL", 2nd edition Pearson Education, 2004
3. Bob Zeidman, "Designing with FPGAs and CPLDs", 4th edition, Elsevier, CMP Books, 2002
4. J.Bhaskar, "A VHDL Primer", 3rd edition, Prentice Hall- 1998

EVALUATION PATTERN:

Continuous Internal Assessments				**End Semester Examinations**	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP04	CMOS ANALOG CIRCUIT DESIGN	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC302: Analog Electronics
- U21EC304: Linear integrated circuits

COURSE OBJECTIVES:

- To study the basics of MOS devices and amplifiers
- To analyze the different performance parameters of operational amplifiers
- To learn the operations of band gap references and switched capacitor circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply MOS transistor concepts for single stage amplifiers (Apply)
CO2: Design differential amplifiers and current mirror circuits (Apply)
CO3: Examine the frequency response and noise effects in MOS amplifiers (Analyze)
CO4: Determine the performance parameters of op-amp (Apply)
CO5: Analyze the frequency response of switched capacitor amplifiers (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO3	3	3	2	2	2	-	-	-	2	2	-	1	-	-
CO4	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO5	3	3	2	2	2	-	-	-	2	2	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I MOS DEVICE PHYSICS 6

MOS I/V characteristics – Second-order effects – MOS device capacitances – MOS small-signal model – Long channel and short channel devices – Common source stage with resistive load – Diode connected load – Current source load – Source follower

UNIT II DIFFERENTIAL AMPLIFIERS AND CURRENT MIRRORS 6

Single ended and differential operation – Common mode response – Differential pair with MOS loads – Gilbert cell – Current sink and sources – Basic current mirrors – Cascade current mirrors – Active current mirrors – Large signal analysis and small signal analysis

UNIT III FREQUENCY RESPONSE OF AMPLIFIERS 6

Miller effect – Frequency response of common source stage – Common gate stage and source followers – Noise in single-stage amplifiers – Noise in differential pairs – Noise bandwidth – Effect of feedback on noise

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UNIT IV OPERATIONAL AMPLIFIERS AND FREQUENCY COMPENSATION 6

Performance parameters – One-stage op-amps – Two-stage op-amps – Input range limitation – Power supply rejection – Multipole systems – Phase margin – Frequency compensation of two – stage op-amps

UNIT V BANDGAP REFERENCES AND SWITCHED CAPACITOR CIRCUITS 6

Temperature independent references – PTAT current generation – Constant GM biasing – sampling switches – Switched capacitor amplifiers – Switched capacitor common mode feedback amplifiers

LIST OF EXPERIMENTS (INDICATIVE)

Simulation using EDA tools

1. Common source amplifier with resistive load
2. Gilbert cell multiplier
3. Current mirror
4. Frequency response analysis of source follower
5. One stage op-amp
6. Two stage op-amp
7. Switched capacitor filter
8. PTAT current generation

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 2nd edition, McGraw Hill, 2017
2. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", 5th edition, Wiley, 2009

REFERENCES:

1. Philip E.Allen, "CMOS Analog Circuit Design", 3rd edition, Oxford University Press, 201
2. David A.Johns, Ken Martin, "Analog Integrated Circuit Design", 2nd edition, John Wiley & Sons, 2013
3. Tony Chan Carusone, David A. Johns and Ken Martin, "Analog Integrated Circuit Design", John Wiley and Sons, 2nd edition, 2011
4. Jacob Baker, "CMOS Circuit Design Layout and Simulation", 3rd edition, Wiley IEEE Press,2010

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP03	PHYSICAL DESIGN AUTOMATION	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC601: VLSI Design

COURSE OBJECTIVES:

- To understand various stages of VLSI physical design process
- To learn logic simulation, synthesis and verification
- To design FPGA and MCM automation systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain graph theory and optimization algorithms (Understand)

CO2: Develop the algorithms for partitioning, placement and floor planning (Analyze)

CO3: Implement the algorithms for routing and compaction (Apply)

CO4: Apply the optimized gate level representation to combinational circuits (Apply)

CO5: Formulate CAD design problems using scheduling algorithmic methods (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	2	2	-	-	-	2	2	-	1	-	-
CO3	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO4	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I VLSI DESIGN FLOW 6

Introduction to VLSI design methodologies – Review of VLSI design automation tools – Algorithmic graph theory and computational complexity – Tractable and Intractable problems – General purpose methods for combinatorial optimization problems.

UNIT II PARTITIONING, PLACEMENT AND FLOOR PLANNING 6

Circuit representation – Placement algorithms – KL partitioning algorithm – Floor planning – Linear programming algorithm – Representation and optimization

UNIT III ROUTING AND COMPACTION 6

Routing – Types of local routing problems, clock routing, power routing, channel routing – Global routing – Algorithms for global routing

Compaction – Problem formulation – Classification – Algorithms for 1D, 2D compaction, performance driven compaction

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UNIT IV LOGIC SIMULATION AND SYNTHESIS 6

Simulation – Gate-level modeling – Switch-level modeling – Combinational logic synthesis using simulation tool – Binary decision diagrams – ROBDD – Two level logic synthesis

UNIT V HIGH-LEVEL SYNTHESIS 6

Hardware model for high level synthesis – Internal representation of input algorithms – Allocation, assignment and scheduling – Scheduling algorithms

LIST OF EXPERIMENTS (INDICATIVE)

Simulation using EDA tools

1. Analyze and optimize floor planning to enhance spatial efficiency and functionality
2. Implementation of placement algorithms
3. Assess the performance of routing Algorithms
4. Design and verify the arithmetic circuits
5. Synthesis of combinational circuits

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Gerez, S.H., "Algorithms for VLSI Design Automation", 2nd edition, John Wiley & Sons, 2006
2. Sherwani, N.A., "Algorithms for VLSI Physical Design Automation", 3rd edition, Kluwar Academic Publishers, 2002

REFERENCES:

1. Andrew B. Kahng, Jens Lienig, Igor L. Markov and Jin Hu, "VLSI Physical Design: from graph partitioning to timing closure", 2nd edition, Springer, 2011
2. Drechsler, R., "Evolutionary Algorithms for VLSI CAD", 3rd edition, Kluwer Academic Publisher, 2010
3. Stephen Trimberger, "Introduction to CAD for VLSI", 2nd edition, Kluwer Academic, 2002
4. Charles J Alpert, Dinesh P Mehta, Sachin S. Sapatnekar, "Handbook of Algorithms for Physical Design Automation", 1st edition, CRC Press, 2009

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="2">Assessment II (Practical) (100 Marks)</th><th rowspan="2">Theory Examinations (Examinations will be conducted for 100 Marks)</th><th rowspan="2">Practical Examinations (Examinations will be conducted for 100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP07	DESIGN FOR TESTABILITY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC601: VLSI Design

COURSE OBJECTIVES:

- To understand logic fault models
- To learn test generation for combinational and sequential circuits
- To familiarize with logic level and system level fault diagnosis

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize the concepts of fault simulation and fault diagnosis (Understand)

CO2: Interpret the test generation for combinational and sequential circuits (Understand)

CO3: Test for fault identification using DFT approach (Apply)

CO4: Illustrate various BIST architecture and different test algorithms (Understand)

CO5: Identify the faults in combinational circuits (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I TESTING AND FAULT MODELLING 9

Introduction to testing – Faults in digital circuits – Modelling of faults – Logical fault models – Fault detection – Fault location – Fault dominance – Logic simulation – Types of simulation – Delay models – Gate level event – Driven simulation

UNIT II TEST GENERATION 9

Test generation for combinational logic circuits – Testable combinational logic circuit design – Test generation for sequential circuits – Design of testable sequential circuits

UNIT III DESIGN FOR TESTABILITY 9

Design for Testability – Ad-hoc design – Generic scan based design – Classical scan based design – System level DFT approaches

UNIT IV SELF-TEST AND TEST ALGORITHMS 9

Built-In self-test – Test pattern generation for BIST – Circular BIST – BIST Architectures – Testable Memory design – Test algorithms – Test generation for embedded RAMs

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UNIT V FAULT DIAGNOSIS 9

Logical level diagnosis – Diagnosis by UUT reduction – Fault diagnosis for combinational circuits – Self-checking design – System level diagnosis

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. A.L.Crouch, "Design Test for Digital IC"s and Embedded Core Systems", Prentice HallInternational, 2002
2. M.Abramovici, M.A.Breuer and A.D. Friedman, "Digital systems and Testable Design", JaicoPublishing House, 2002

REFERENCES:

1. M.L.Bushnell and V.D.Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits", Kluwer Academic Publishers, 2002
2. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP02	VLSI VERIFICATION METHODOLOGIES	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC601: VLSI Design

COURSE OBJECTIVES:

- To understand the basic concepts in UVM Testing
- To learn various methods of UVM verification
- To familiarize with self-checking UVM test benches

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the basic concepts of UVM (Understand)
CO2: Build actual verification components (Apply)
CO3: Model the register layer classes (Apply)
CO4: Develop code test benches using UVM (Analyze)
CO5: Explain advanced peripheral bus test benches (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO3	3	2	1	1	2	-	-	-	2	2	-	1	-	-
CO4	3	3	2	2	2	-	-	-	2	2	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I INTRODUCTION **6**

Overview – Typical UVM test bench architecture – UVM class library –Transaction level modeling (TLM) – Implementation of TLM-1 and TLM-2.0

UNIT II DEVELOPING REUSABLE VERIFICATION COMPONENTS **6**

Modeling data items for generation – Transaction-level components – Creating the driver – Creating the sequencer – Connecting the driver and sequencer – Creating the monitor – Instantiating components – Creating the agent – Creating the environment – Enabling scenario creation – Managing of test – Implementing checks and coverage

UNIT III UVM USING VERIFICATION COMPONENTS **6**

Creating a top-level environment – Instantiating verification components – Creating test classes – Verification component configuration – Creating and selecting a user defined test – Creating meaningful tests – Virtual sequences – Checking for DUT correctness – Scoreboards – Implementing a coverage model

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UNIT IV UVM USING THE REGISTER LAYER CLASSES 6

Register layer classes – Back-door access – Special registers – Integrating a register – Model in a verification environment – Integrating a register model – Randomizing field values – Pre-defined sequences

UNIT V ASSIGNMENTS IN TESTBENCHES 6

Assignment – APB protocol, Test bench architecture – Driver and sequencer – Monitor, agent and Env – Creating sequences – Building test – Design and testing of top module

LIST OF EXPERIMENTS (INDICATIVE)

1. Simulate a simple UVM test bench and DUT
2. Examining the UVM test bench
3. Design and simulate sequence items and sequence
4. Design and simulate a UVM driver and sequencer
5. Design and simulating UVM monitor and agent
6. Design, simulate and examine coverage
7. Design and simulate a UVM scoreboard and environment, and verifying the outputs of a DUT
8. Design and simulate a test to run multiple sequences

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Ray Salemi, "The UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology", 1st edition, Boston Light Press, 2013
2. Benjamin Ting, "UVM Test bench Workbook", 1st edition, 2016

REFERENCES:

1. Srivatsa Vasudevan, "Practical UVM: Step by Step Examples", 3rd edition, 2016.
2. Mitesh Khadgi, "An Introduction to Universal Verification Methodology (UVM)", 1st edition, Shine Book Publishing, 2019
3. Sharon Rosenberg, Kathleen Meade, "A Practical Guide to Adopting the Universal Verification Methodology (UVM)", 2nd edition, 2012
4. Vanessa R. Cooper, "Getting Started with UVM: A Beginner's Guide", 1st edition, Verilab Publishing, 2013

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP05	SYSTEM ON CHIP	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the principles of SOC design methodology and system-level design of complex SOC
- To study the principles of software modelling and hardware implementation
- To design advanced processors in system-on-chip

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize the major challenges in SOC design (Understand)

CO2: Illustrate the hardware interconnect mechanisms of complex SOC (Understand)

CO3: Examine the performance of processor for software approach (Analyze)

CO4: Implement configurable processor design using suitable hardware approach (Apply)

CO5: Summarize the concept of pipelining for SOC design (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SOC DESIGN METHODOLOGY 9

Introduction – Hardware system structure – Software structure – SOC design flow – Impact of semiconductor economics – Major issues in SOC design – Accelerating processors for traditional software tasks – System design with multiple processors

UNIT II SYSTEM-LEVEL DESIGN OF COMPLEX SOC 9

Complex SOC system architecture – Processor-centric SOC organization – Communication design using software mode – Hardware interconnect mechanisms – Performance-driven communication design – Non-processor building blocks in complex SOC system architecture

UNIT III CONFIGURABLE PROCESSOR DESIGN: SOFTWARE APPROACH 9

Introduction to system C – Processor hardware and software cogeneration – Process of instruction definition and application tuning – Basics of instruction extension – Programmer's model, processor performance factors

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UNIT IV CONFIGURABLE PROCESSOR DESIGN: HARDWARE APPROACH 9

Introduction to configurable processors – Introduction to pipelines and processors – Hardware blocks to processors – Designing the processor interface – Hardware implementation – Verification flow – Validation and testing

UNIT V PIPELINING FOR SOC DESIGN 9

Pipelining for processor performance – Processor pipeline stalls – Optimizing processors to match hardware – Multiple processor debug and trace – Issues in memory systems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Wayne Wolf, "Modern VLSI Design – System – on – Chip Design", Prentice Hall, 3rd edition 2008
2. S. Furber, "ARM System-on-Chip Architecture", 2nd edition, AW, 2000

REFERENCES:

1. C. Rowen, "Engineering the Complex SOC: Fast, Flexible Design with Configurable Processors", Prentice Hall, 2004
2. M. Keating, R. J. Rickford and P. Bricaud, "Reuse Methodology Manual for System-on-a-Chip Designs", 3rd edition, Springer, 2006
3. D. Black, J. Donovan, "System C: From the Ground Up", Springer, 2004
4. D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, "Embedded System Design: Modeling, Synthesis, Verification", Springer, 2009

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP08	CMOS MEMORY DESIGN	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the concepts of volatile and non-volatile memory architectures
- To analyze various testing methods of semiconductor memories
- To understand the advanced semiconductor memory packaging technologies

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the micro level operations of Random Access Memories (Understand)

CO2: Compare the performance of various non-volatile memories (Analyze)

CO3: Identify the suitable fault modeling technique for memory testing (Apply)

CO4: Outline the radiation effects of memory (Understand)

CO5: Summarize the concepts of advanced memory technologies (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)			

SYLLABUS:

UNIT I RANDOM ACCESS MEMORY TECHNOLOGIES 9

SRAM cell structures – MOS SRAM architectures – MOS SRAM cell – Bipolar SRAM technologies – Silicon On Insulator (SOI) technology – DRAM technology development – CMOS DRAMs – DRAMs cell theory – Bi-CMOS – DRAMs, soft error failures in DRAMs

UNIT II NON-VOLATILE MEMORIES 9

Masked read-only memories – High density ROMs – Programmable read-only memories – Bipolar PROMs – CMOS PROMs – EPROMs – Floating-gate EPROM cell – One-time programmable EEPROMs – EEPROM technology and architectures, non-volatile SRAM – Flash memories

UNIT III MEMORY FAULT MODELING AND TESTING 9

RAM fault modeling – Electrical testing – Pseudo random testing – Megabit DRAM testing non-volatile memory modeling and testing – IDDQ fault modeling and testing – Application specific memory testing

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UNIT IV CONFIGURABLE PROCESSOR DESIGN: HARDWARE APPROACH **9**

Radiation effects – Single event phenomenon – Radiation hardening techniques – Radiation hardening process and design issues – Radiation hardened memory characteristics – Radiation hardness assurance and testing – Radiation dosimetry – Water level radiation testing and test structures

UNIT V ADVANCED MEMORY TECHNOLOGIES **9**

Introduction to memory technologies – High-density memory packing technologies – Gallium Arsenide (GaAs) FRAMs – Analog Memories – Magneto resistive random access memories – Experimental Memory Devices – Ferroelectric random access memories – Memory hybrids and MCMs (2D) – Memory stacks and MCMs (3D)

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Ashok.K.Sharma, "Semiconductor Memories: Technology, Testing and Reliability", Wiley IEEE press, New York, 2nd edition, 2010
2. Brent Keeth, R. Jacob Baker, Brian Johnson, Freng Lin, "DRAM Circuit Design: Fundamental and High Speed Topics", Wiley-IEEE Press, 2nd edition, 2012

REFERENCES:

1. Ashok K. Sharma, "Semiconductor Memories", Two-Volume Set, Wiley-IEEE Press, 2003
2. Betty Prince, "High Performance Memories: New Architecture DRAMs and SRAMs Evolution and Function", Wiley, Revised Edition, 1999
3. Tegze P. Haraszti, "CMOS Memory Circuits", Kluwer Academic publishers, 2nd edition, 2007

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL 2: Signal Processing

U21ECP10	STATISTICAL SIGNAL PROCESSING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC402: Digital Signal Processing

COURSE OBJECTIVES:

- To understand the basic concepts of linear signal models
- To comprehend optimum linear filters and their algorithms
- To learn various adaptive filters and the concept of array processing

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Classify various linear signal models (Understand)

CO2: Design optimum linear filters for MSE estimation (Analyze)

CO3: Summarize different optimum linear filter algorithms (Understand)

CO4: Apply appropriate adaptive filtering algorithm for real time applications (Apply)

CO5: Illustrate the concept of array processing (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I LINEAR SIGNAL MODELS 9

Introduction – All pole models – All zero models – Pole zero models – Models with poles on unit circle – Cepstrum of pole zero models.

UNIT II OPTIMUM LINEAR FILTERS 9

Optimum signal estimation – Linear mean square error estimation – Optimum finite impulse response filters – Linear prediction – Optimum infinite impulse response filters – Inverse filtering and deconvolution

UNIT III ALGORITHMS FOR OPTIMUM LINEAR FILTERS 9

Fundamentals of order recursive algorithms – Interpretations of algorithmic quantities – Levinson – Durbin algorithm – Schur algorithm – Kalman filtering algorithm

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UNIT IV ADAPTIVE FILTERS 9

Principles of adaptive filters – Typical applications of adaptive filters – LMS – RLS – RLS algorithms for array processing – Fast RLS algorithms for FIR filtering

UNIT V ARRAY PROCESSING 9

Array fundamentals – Conventional spatial filtering – Optimum array processing – Adaptive beamforming – Angle estimation – Space time adaptive processing

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Robert M.Gray, Lee D.Davisson, "An Introduction to Statistical Signal Processing", 1st edition, Cambridge University Press, 2010
2. Dimitris G.Manolakis, Vinay K.Ingle, Stephen M.Kogon, "Statistical and Adaptive Signal Processing", 1st edition, Artech House, 2005

REFERENCES:

1. Spagnolini, Umberto, "Statistical Signal Processing in Engineering", 1st edition, John Wiley and Sons, 2018
2. Omid S.Jahromi, "Multirate Statistical Signal Processing", 1st edition, Springer, 2007
3. Stergios Stergiopoulos, "Advanced Signal Processing Handbook", 1st edition, CRC Press, 2000
4. Monson H.Hayes, "Statistical Digital Signal Processing and Modeling", 1st edition, John Wiley and Sons, 1996

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
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Total				40	60
				100	

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U21ECP11	SPEECH PROCESSING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC402: Digital Signal Processing

COURSE OBJECTIVES:

- To study the fundamentals of the speech processing
- To learn about speech modelling and processing
- To understand the methods of speech identification and recognition

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamentals of speech processing (Understand)

CO2: Summarize various speech models and algorithms (Understand)

CO3: Illustrate the types of phonetic in speech signal (Understand)

CO4: Design the system for speech synthesis using appropriate algorithm (Analyze)

CO5: Apply feature extraction techniques for speech recognition (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT 1 FUNDAMENTALS OF SPEECH PROCESSING **9**

Introduction – Knowledge in speech and language processing – Ambiguity – Models and algorithms – Language thought understanding – Regular expression and automata – Words and transducers – N grams

UNIT II SPEECH MODELLING **9**

Word classes and part of speech tagging – Hidden Markov model – Computing likelihood - Forward algorithm – Training hidden Markov model – Maximum entropy model – Transformation based tagging – Evaluation and error analysis – Issues speech tagging – Noisy channel model for spelling

UNIT III SPEECH CODING IN TIME AND FREQUENCY DOMAIN **9**

Time domain parameters – Extracting methods – Short time energy – Average magnitude – Short time average zero crossing rate – Short-time Fourier analysis – Fourier transform and linear filtering interpretations – Sampling rates – Pitch and formant extraction

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UNIT IV SPEECH IDENTIFICATION 9

Speech synthesis – Text normalization – Phonetic analysis – Prosodic analysis – Diphone waveform synthesis – Unit selection waveform synthesis – Evaluation

UNIT V SPEECH RECOGNITION 9

Automatic speech recognition – Architecture – Feature extraction – MFCC vectors – Computing acoustic likelihoods – Search and decoding – Embedded training – Context-Dependent acoustic models – Triphones – Discriminative training – Speech recognition by humans

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Lawrence Rabinerand Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2014
2. Daniel Jurafsky and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Person education, 2013

REFERENCES:

1. Rabiner L R and Schafer S W, "Digital Processing of Speech Signals", Pearson Education, 2012
2. Ikrami Eldirawy, Wesam Ashour, "Visual Speech Recognition", Wiley publications, 2011
3. Himanshu Chaurasiya, "Soft Computing Implementation of Automatic Speech Recognition", LAP Lambert Academic Publishing, 2010
4. Claudio Becchetti, Klucio Prina Ricotti,"Speech Recognition: Theory and C++ implementation", Wiley publications 2008

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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U21ECP12	MEDICAL SIGNAL PROCESSING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC402: Digital Signal Processing

COURSE OBJECTIVES:

- To study the fundamentals of biomedical signals
- To learn about ECG and neurological signal processing
- To understand the techniques of biomedical system modelling

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamentals of biomedical signals (Understand)

CO2: Apply the parameter estimation technique for ECG (Apply)

CO3: Examine the performance of data compression algorithms (Analyze)

CO4: Illustrate the EEG processing methods (Understand)

CO5: Summarize the biomedical system modelling techniques (Understand)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT 1 FUNDAMENTALS OF BIOMEDICAL SIGNALS 9

The nature of biomedical signals – Examples of biomedical signals – Objectives and difficulties in biomedical analysis – Simple signal conversion systems – Conversion requirements for biomedical signals – Signal conversion circuits

UNIT II ECG SIGNAL PROCESSING 9

ECG data acquisition – ECG lead system – ECG parameters and their estimation – ECG QRS detection techniques – Template matching – Differentiation based QRS detection techniques – Estimation of R-R interval – Finite first difference method – Arrhythmia analysis monitoring – Long term continuous ECG recording

UNIT III ECG DATA REDUCTION TECHNIQUES 9

Direct data compression techniques – Direct ECG data compression techniques – Turing point algorithm – AZTEC algorithm and FAN algorithm – Data compression by DPCM

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UNIT IV NEUROLOGICAL SIGNAL PROCESSING 9

The brain and its potentials – Electrophysiological origin of brain waves – EEG signal and its characteristics (EEG rhythms, waves, and transients) – Correlation – Detection of EEG rhythms – Template matching for EEG – Spike and wave detection

UNIT V BIOMEDICAL SYSTEM MODELLING 9

Optimal signal processing – Wiener filters – Adaptive signal processing – Adaptive noise cancellation - Parametric system modelling – Autoregressive or all-pole modelling – Pole-zero modelling.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Reddy D C, "Biomedical Signal Processing Principles and Techniques", McGraw- Hill publications 2012
2. Willis J Tompkins, "Biomedical Digital Signal Processing", 1st edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2011

REFERENCES:

1. Rangayyan R M, "Biomedical signal analysis" 4th edition John Wiley & Sons, 2015
2. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", 4th edition, Tata Mc GrawHill Pvt. Ltd, 2011
3. Eugene N Bruce, "Biomedical Signal Processing and Signal Modelling", 1st edition, Wiley India, New Delhi, 2007
4. John G Proakis and Dimitris G Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", 4th edition, Prentice Hall of India, New Delhi, 2007

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP45	MEDICAL ELECTRONICS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn about bio-medical signals and recording instrumentation
- To understand various modern imaging systems
- To familiarize in therapeutic equipment and recent trends in medical electronics

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamentals of bio medical signals (Understand)

CO2: Analyze the performance of different measurement techniques for biomedical signals (Analyze)

CO3: Illustrate the operations of modern imaging system (Understand)

CO4: Summarize the principles of various therapeutic equipment with safety measures (Understand)

CO5: Implement the principles of medical electronics in real time applications (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I BIO-MEDICAL SIGNALS AND RECORDING 9

Biomedical signals and types – Bio-potential electrodes – ECG, EEG, EMG, PCG, typical waveforms and signal characteristics.

UNIT II BIO-MEDICAL INSTRUMENTATION 9

pH, PO2, PCO2, colorimeter – Blood flow meter – Cardiac output – Respiratory measurement – Blood pressure, temperature and pulse measurement –Blood cell counters

UNIT III MODERN IMAGING SYSTEM 9

X-ray machines and digital radiography – X-ray computed tomography – Endoscopy – Magnetic Resonance Imaging – Ultrasonic imaging systems – Thermal imaging systems

UNIT IV THERAPEUTIC EQUIPMENT 9

Cardiac pacemakers and defibrillator – Dialyzer, ventilators, diathermies – Shortwave, ultrasonic and microwave type and their applications, surgical diathermy – Patient safety

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UNIT V RECENT TRENDS IN MEDICAL ELECTRONICS 9

Laser applications in bio-medical field – Hemodialysis machines – Anesthesia machine – Radiotherapy equipment – Automated drug delivery system

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 2nd edition, Prentice Hall of India, New Delhi, 2015
2. Khandpur, R.S., "Handbook of Biomedical Instrumentation", 3rd edition, Tata McGraw–Hill, New Delhi, 2014

REFERENCES:

1. Vinod Kumar Khanna, "Implantable Medical Electronics", revised edition, Springer 2016
2. Nandhini K.jog, "Electronics in Medicine and Biomedical Instrumentation", 2nd edition, PHI Learning private limited, 2013
3. Joseph J.Carr and John M.Brown, "Introduction to Biomedical Equipment Technology", 4th edition, John Wiley and Sons, New York, 2011
4. John G.Webster, "Medical Instrumentation Application and Design", 3rd edition, Wiley India Edition, 2010

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP14	RADAR SIGNAL PROCESSING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basic concepts of spectral analysis and dynamic models in radar systems
- To learn ambiguity functions in radar signals
- To comprehend various clutter, doppler and adaptive array processing in radar signals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the spectral properties of radar signals (Understand)

CO2: Implement appropriate dynamic model for parametric analysis in radar signals (Apply)

CO3: Summarize various ambiguity functions in radar signals (Understand)

CO4: Illustrate different types of clutters and Doppler for radars (Understand)

CO5: Examine the characteristics of adaptive and non-adaptive arrays (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I RADAR SPECTRAL ANALYSIS **9**

Introduction – Low angle tracking problem – Spectrum estimation background – Thomson's multi taper method – Overview of non-stationary behavior and time frequency analysis – High resolution multi taper spectrograms – Spectrum analysis of radar signals .

UNIT II DYNAMIC MODELS **9**

Statistical nature of sea clutter – Hybrid AM/FM model of sea clutter – Modulation of long waves – Nonstationary AR model – Parametric analysis of texture process – Bayesian direct filtering procedure

UNIT III AMBIGUITY FUNCTION **9**

Introduction – Examples of the ambiguity function – Stepped frequency waveform – Nonlinear FM – Ambiguity diagram contours – Interpretation of range doppler coupling in LFM signals – Discrete code signal representation – Pulse train codes – Phase coding – Frequency codes

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UNIT IV CLUTTER AND DOPPLER PROCESSING 9

Clutter cross section density – Surface clutter – Volume clutter – Clutter RCS – Clutter spectrum – Moving target indicator – PRF staggering – subclutter visibility – Pulsed radars

UNIT V ADAPTIVE ARRAY PROCESSING 9

Introduction – General arrays – Linear arrays – Non-adaptive beamforming – Adaptive array processing

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Bassem R.Mahafza, "Radar Signal Analysis and Processing using MATLAB", 1st edition, CRC Press, 2009
2. Simon Haykin, "Adaptive Radar Signal Processing", 1st edition, Wiley-Interscience, 2007

REFERENCES:

1. Merrill I. Skolnik, "Introduction to Radar Systems", 3rd edition, McGraw Hill, 2015
2. Jian Li, Petre Stoica, "MIMO Radar Signal Processing", 1st edition, Wiley, 2008
3. David Brandwood, "Fourier Transforms in Radar and Signal Processing", 1st edition, Artech House, 2003
4. Stergios Stergiopoulos, "Advanced Signal Processing Handbook", 1st edition, CRC Press, 2000

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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U21ECP15	VLSI SIGNAL PROCESSING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC402: Digital Signal Processing

COURSE OBJECTIVES:

- To learn various methods for critical path reduction
- To design digital filters and arithmetic architectures
- To understand pipelining concepts in digital filters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize various critical path reduction techniques (Understand)

CO2: Construct pipelined and parallel FIR filters (Apply)

CO3: Simplify the design of lattice filters (Apply)

CO4: Outline bit level and redundant arithmetic architectures (Understand)

CO5: Illustrate various synchronous and asynchronous pipelining concepts (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)			

SYLLABUS:

UNIT I METHODS OF CRITICAL PATH REDUCTION 9

Introduction to digital signal processing systems - Iteration bound – Pipelining and parallel processing – Retiming – Unfolding – Systolic architecture design

UNIT II ALGORITHMIC STRENGTH REDUCTION METHODS 9

Fast convolution – Parallel FIR filters – Discrete cosine transform and inverse DCT – Parallel architecture for rank order filters – Pipelined and parallel recursive and adaptive filters

UNIT III DESIGN OF DIGITAL FILTERS 9

Scaling and round off noise – Schur algorithm – Digital basic lattice filters – One multiplier lattice filter – Normalized lattice filter – Pipelining of lattice IIR digital filters

UNIT IV DESIGN OF ARITHMETIC ARCHITECTURES 9

Bit level arithmetic architectures – Redundant number representations – Radix-2 and radix – 4 addition and subtraction – Data format conversion – Redundant to non-redundant converter

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UNIT V PIPELINING CONCEPTS 9

Synchronous pipelining and clock styles – Clock skew and clock distribution – Wave pipelining – Constraint space diagram and degree of wave pipelining – Asynchronous pipelining

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Arrays", Springer, 2nd edition, Indian Reprint, 2014
2. Keshab K.Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation", John Wiley, Indian Reprint, 2007

REFERENCES:

1. J. G. Chung and Keshab K. Parhi, "Pipelined Lattice and Wave Digital Recursive Filters", Springer Publisher, 1996
2. Jose E. France, Yannis Tsividis, "Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing", Prentice Hall, 1994
3. Mohammed Isamail and Terri Fiez, "Analog VLSI Signal and Information Processing", McGrawHill, 1994
4. S.Y. Kung, H.J. White House, T. Kailath, "VLSI and Modern Signal Processing", Prentice Hall, 1985

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP16	DIGITAL IMAGING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the basic elements of image processing and image transforms
- To learn techniques for improving quality of information in spoilt images
- To understand image segmentation for ROI, morphology for feature selection and compression for saving storage space in an image

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the image fundamentals and image transform (Understand)

CO2: Illustrate different pre-processing techniques for image enhancement (Understand)

CO3: Summarize various restoration techniques to recover the degraded image (Understand)

CO4: Develop suitable image segmentation techniques for ROI extraction (Analyze)

CO5: Implement various coding techniques for image compression (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Elements of digital image processing systems – Elements of visual perception, brightness, contrast, hue, saturation, Mach band effect – Colour models – RGB, HSI models – Image sampling and quantization – 2D transforms – DFT, DCT, Walsh transform, DWT – Demonstration of colour image conversion and image transforms using simulation tool

UNIT II IMAGE ENHANCEMENT 9

Fundamentals of spatial filtering – Histogram processing, equalization and specification techniques – Smoothing and sharpening spatial filters – Filtering in frequency domain – Homomorphic filtering – Simulation of histogram equalization for images

UNIT III IMAGE RESTORATION 9

Image Restoration – Noise models – Adaptive filter – Notch filter – Linear, position – Invariant degradation – Inverse filtering – Wiener filtering -- Constrained least square filtering

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UNIT IV IMAGE SEGMENTATION AND MORPHOLOGY 9

Point, Line and Edge detection – Edge linking via Hough transform – Global and multivariable thresholding – Region based segmentation – Region growing, region splitting and merging – Morphological operations – Dilation, erosion, opening and closing – Implementation of image segmentation and thresholding using simulation tool

UNIT V IMAGE COMPRESSION 9

Need for data compression – Huffman coding – Run length encoding – Arithmetic coding – Vector quantization – Transform coding – JPEG and MPEG standard

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 4th edition, Pearson Education, 2018.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", 1st edition, Pearson Education, 2010.

REFERENCES:

1. Jayaraman S, Veerakumar T, Esakkirajan S, "Digital Image Processing", 1st edition, Tata McGraw Hill, 2017
2. S.Sridhar, "Digital Image Processing" , 1st edition, Oxford University press, 2011
3. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing using MATLAB", 1st edition, Pearson Education, 2010
4. Alan C. Bovik, "Handbook of image and Video Processing ", 1st edition, Elsevier Academic press, 2010

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP09	DSP PROCESSOR ARCHITECTURE	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the Programming concept of TMS320C5X Processor
- To understand the basic concept of TMS320C54XX/64XX/6X DSPs
- To study about Advanced Programmable DSP Processors

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the characteristics of real time signals using TMS320C5X Processor (Analyze)

CO2: Summarize the architecture and addressing modes of TMS320C54XX DSPs (Understand)

CO3: Illustrate the concepts of TMS320C64XX DSPs (Understand)

CO4: Explain the perceptions of TMS320C6X DSPs (Understand)

CO5: Infer the features of Advanced DSP family processors (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I TMS320C5X PROCESSOR 9

Review of TMS320C5X processor – Assembly language instructions – Simple ALP – Pipeline structure operation – Block diagram of DSP starter kit – Application programs for processing real time signals

UNIT II TMS320C54XX DSPS 9

Data addressing modes of TMS320C54XX DSPs – Program control – On-chip peripheral – Interrupts of TMS320C54XX processors, pipeline operation of TMS320C54XX processors – Block diagrams of internal hardware, buses, internal memory organization

UNIT III TMS320C64XX DSPS 9

Data addressing modes of TMS320C64XX DSPs, program control – On-chip peripheral – Interrupts ofTMS320C64XX processors – Pipeline operation of TMS320C64XX processors – Internal memory organization

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UNIT IV TMS320C6X DSPS 9

Architecture of TMS320C6X – Pipeline operation of TMS320C6X – Block diagrams of internal hardware, buses, internal memory organization.

UNIT V ADVANCED PROCESSOR 9

Code composer studio – Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Avtar Singh and S. Srinivasan, "Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx", Cengage Learning India Private Limited, Delhi 2012
2. B. Venkataramani and M. Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications", Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003

REFERENCES:

1. Rulph Chassaing and Donald Reay, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", John Wiley and Sons, Inc., Publication, 2012 (Reprint)
2. Emmanuel Ifeachor, Barrie Jervis, "Digital Signal Processing: A Practical Approach", Pearson education, Oct.2002
3. Phil Lapsley, Jeff Bier, Amit Shoham, Edward A. Lee, "DSP Processor Fundamentals: Architectures and Features", Wiley-IEEE Press, 1997(Reprint)
4. https://www.ti.com/microcontrollers-mcus-processors/processors/digital-signal-processors /overview.html

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP13	DSP INTEGRATED CIRCUITS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC402: Digital Signal Processing

COURSE OBJECTIVES:

- To familiarize the concept of DSP and VLSI circuit topologies.
- To learn about digital filters and finite word length effects.
- To understand basic DSP processor architectures and the synthesis of the processing elements.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concepts of Digital Signal Processing and CMOS VLSI circuit technologies (Understand)

CO2: Summarize the digital filters design and the finite word length effects (Understand)

CO3: Illustrate various DSP architectures (Understand)

CO4: Apply DSP algorithms and synthesis procedures for optimal circuit architectures (Apply)

CO5: Design a real time processor for the given specifications (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I DSP INTEGARTED CIRCUITS AND VLSI CIRCUIT TECHNOLOGIES 9

Standard digital signal processors – Application specific IC's for DSP – DSP systems – DSP system design – Integrated circuit design – MOS transistors – MOS logic – VLSI process technologies

UNIT II DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS 9

Overview of Digital filters – FIR filter structures – FIR chips – Mapping of analog filter structures – Parasitic oscillations – Scaling of signal levels – Round-off noise – Measuring round-off noise – Coefficient sensitivity – Sensitivity and noise

UNIT III DSP ARCHITECTURES 9

DSP system architectures – Standard DSP architecture – Harvard and modified Harvard architecture – Ideal DSP architectures – Multiprocessors and multi computers – Systolic and Wave front arrays – Shared memory architectures

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UNIT IV SYNTHESIS OF DSP ARCHITECTURES 9

Synthesis – Mapping of DSP algorithms onto hardware, Implementation based on complex PEs – Shared memory architecture with Bit-serial Pes – Combinational and sequential networks – Storage elements – Clocking of synchronous systems – Asynchronous systems – FSM

UNIT V ARITHMETIC UNIT AND PROCESSING ELEMENTS 9

Conventional number system – Redundant number system – Residue number system – Bit-parallel and bit-serial arithmetic – Basic shift accumulator – Reducing the memory size – Complex multipliers – Layout of VLSI circuits – FFT processor – DCT processor and interpolator as case studies – Cordiac algorithm

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Lars Wanhammer, "DSP Integrated Circuits", Elsevier India Pvt. Ltd, New York, 2012
2. B.Venkatramani, M.Bhaskar, "Digital Signal Processors", Tata McGraw-Hill, 2002

REFERENCES:

1. Phil Lapsley, Jeff Bier, AmitSholam and Edward A.Lee, "DSP Processor Fundamentals-Architectures, and Features", Wiley India, reprint 2011
2. John J. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education, 2002
3. Keshab Parhi, "VLSI Digital Signal Processing Systems design & Implementation", John Wiley & Sons, 1999
4. Lars Wanhammer, "DSP Integrated Circuits", Academic press, New York, 1999

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL 3: IoT for Smart Systems

U21ECP17	SENSORS AND TRANSDUCERS FOR IoT	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand basic concepts of measurement systems
- To learn different types of sensors and transducers
- To acquaint students with selection of sensors for IoT applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the basic concepts of measurement system (Understand)

CO2: Design and implement embedded systems using of non-electrical transducers (Apply)

CO3: Build the embedded systems using of electrical transducers (Apply)

CO4: Design and implement data acquisition for embedded systems (Apply)

CO5: Apply the principles of various sensors for real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I BASICS OF MEASUREMENT SYSTEMS 9

Methods of measurement – Direct methods, indirect methods – Instruments – Mechanical, electrical and electronic instruments – Modes of operation – Functions of instruments and measurement systems – Static and dynamic characteristics – Applications of measurement systems

UNIT II NON-ELECTRICAL TRANSDUCERS 9

Measurement of non-electrical quantities – Linear and rotary displacement using strain gauges, pressure, torque, vibration and temperature measurement – Measurement of flow, thickness and humidity

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UNIT III ELECTRICAL TRANSDUCERS 9

Classification of electrical transducers – Primary and secondary transducers – Active and passive transducers – Analog and digital transducers – Resistive transducers – Potentiometer, thermistor – Inductive transducers – Capacitive transducer

UNIT IV DATA ACQUISITION SYSTEM 9

Components of analog and digital data acquisition systems – Uses of data acquisition systems – Use of recorders in digital systems – Digital recording systems – Input conditioning equipment, digitizer, multiplexer, programme pin board, linearizer – Digital clock

UNIT V APPLICATIONS OF SENSORS AND TRANSDUCERS 9

Asset management – Industrial automation, smart city applications– Sensors for bio-medical applications – Dissolved oxygen and carbon dioxide sensor for blood, blood flow sensor, respiration sensor, heart sound sensor

LIST OF ASSIGNMENTS (NOT LIMITED TO)

1. Implementation of a Temperature Measurement System
2. Implementation of a Resistive and Capacitive Transducer-Based Measurement System
3. Design and Implementation of an Analog and Digital Data Acquisition System for Industrial Monitoring
4. Design and Implementation of a LDR based street light control system
5. Design and Implementation of an Industrial Automation System
6. Design and Implementation of Asset Tracking and Management System for Manufacturing
7. Design and development of Occupancy Detection and Management using Sensor Networks
8. Design and Implementation of a Temperature Measurement System

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Gaofeng Zhou, Yannian Wang and Lujun Cui., "Biomedical Sensor, Device and Measurement Systems", 1st edition, Intech open, 2015
2. Sawhney A.K., "A Course in Electrical and Electronic Measurement and Instrumentation", 12th edition, Dhanpat Rai & Co, 2013

REFERENCES:

1. Shantanu Bhattacharya, Avinash Kumar Agarwal., "Sensors for Automotive and Aerospace Applications", Original edition, Springer, 2019
2. Iansinclair, "Sensors and Transducers", 3rd edition, Newnes, 2009
3. Cooper, "Electronic Instrumentation and Measurement Techniques", 3rd edition, PHI, 2007
4. Doebelin E.O., "Measurement Systems: Applications and Design", 4th edition, Tata McGraw Hill, 2004

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EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP20	EMBEDDED PROGRAMMING FOR IOT	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21CSG02: Python Programming

COURSE OBJECTIVES:

- To understand the fundamental concepts of MicroPython
- To acquire the knowledge of hardware interfacing with given embedded controllers.
- To create the embedded system for real time applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the suitable MicroPython concepts for the given applications (Understand)

CO2: Demonstrate the GPIO interfacing of given embedded controllers (Apply)

CO3: Build a real time sensor data acquisition and control module for IoT applications (Apply)

CO4: Implement an embedded system with advanced Micropython features (Apply)

CO5: Integrate and develop the optimized embedded systems for real time applications (Analyze)

CO- PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO3	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO4	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO5	3	2	2	2	2	-	-	-	2	2	-	1	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I MICROPYTHON BASICS 6

MicroPython syntax – Data types – Variables – Operators – Control structures – Functions and modules

UNIT II INTERFACING WITH GPIO 6

Digital input and output – Pull-up and pull-down resistors – Analog input and output – Interfacing with LEDs and button

UNIT III HARDWARE INTERFACING 6

Digital sensors – Analog sensors – DC motors – Servo motors – OLED – LCD

UNIT IV ADVANCED MICROPYTHON FEATURES 6

PWM – Timers – Interrupts – File system and handling – Error handling and debugging – Power management

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UNIT V CASE STUDIES 6

Home automation system – Weather station – Plant monitoring system – Air quality monitor - Health monitoring system

LIST OF EXPERIMENTS (INDICATIVE)

1. Develop an RFID-based access control system for enterprise-level security management
2. Build a smart traffic light control system for urban traffic optimization
3. Develop a Bluetooth-based home security system for comprehensive residential protection
4. Create a voice-controlled home assistant for enhanced smart home automation
5. Design and implement an IoT-enabled energy meter with data logging for industrial energy management
6. Design and develop an intelligent parking system for smart city infrastructure
7. Create a real-time periodic task scheduler for industrial automation processes
8. Implement reliable UART-based sensor data transmission for robust industrial monitoring

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Tollervey, Nicholas H, "Programming with MicroPython: Embedded Programming with Microcontrollers and Python", United States: O'Reilly Media, 2017
2. Bell, C. , "MicroPython for the Internet of Things: A Beginner's Guide to Programming with Python on Microcontrollers", United States: Apress, 2017

REFERENCES:

1. Norris, D, "Python for Microcontrollers: Getting Started with MicroPython", United States: McGraw Hill LLC, 2016
2. Agus Kurniawan, "Getting Started With MicroPython Development for Raspberry Pi Pico", PE Press, 2021.
3. Halfacree, G., Everard, B, "Get Started with MicroPython on Raspberry Pi Pico: The Official Raspberry Pi Pico Guide", United Kingdom: Raspberry Pi Press, 2021
4. Norris, D., "Python for Microcontrollers: Getting Started with MicroPython", United States: McGraw Hill LLC, 2016

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="2">Assessment II (Practical) (100 Marks)</th><th rowspan="2">Theory Examinations (Examinations will be conducted for 100 Marks)</th><th rowspan="2">Practical Examinations (Examinations will be conducted for 100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP19	IoT ARCHITECTURE AND PROTOCOLS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the fundamentals about IoT architecture and its protocols
- To learn the different IoT connectivity technologies.
- To learn and implement the IoT protocols for commercial and industrial applications.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the IoT architecture and advancement in IoT domain (Understand)

CO2: Develop the IoT system using various communication technologies for industrial applications (Apply)

CO3: Apply communication protocols to develop IoT systems and ensure efficient communication (Apply)

CO4: Design and optimize network systems for diverse IoT applications (Apply)

CO5: Develop IoT data transmission, smart home solutions, and long-range communication systems for industrial applications through real-time projects (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I IoT ARCHITECTURE AND APPLICATIONS 9

Evolution of Internet of Things – Sensors, actuators for IoT-Enabling technologies – M2M communication – IoT world forum (IoTWF) standardized architecture – Simplified IoT architecture – Fog, Edge, and cloud in IoT – Functional blocks of an IoT ecosystem

UNIT II IoT Connectivity Technologies 9

RFID, NFC, Wi-Fi – Bluetooth low energy – ZigBee – Thread – Wireless HART – Z-Wave – LoRa – NB-IoT

UNIT III IoT API PROTOCOLS 9

UPnP – CoAP – MQTT – XMPP – SCADA – WebSocket – IP-based protocols.

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UNIT IV IoT IP-BASED PROTOCOL AND NETWORK STANDARDS 9

6LoWPAN – RPL – IPv6 – NDP – IEEE 802.3 – IEEE 802.15.4 – IEEE 802.15.6

UNIT V CASE STUDIES 9

Efficient Data Transmission in IoT using MQTT – Smart home using BLE and Wi-Fi – Long-Range, Low-Power Communication using LoRaWAN

LIST OF ASSIGNMENTS (NOT LIMITED TO)

1. To implement client-server communication between two IOT nodes
2. Perform communication using MQTT communication protocol to publish messages and subscribe sensor data.
3. Implement a predictive maintenance system for industrial machinery where sensor data is collected and transmitted using MQTT for real-time analysis
4. Develop a smart home system that integrates various appliances and devices using BLE for communication and Wi-Fi for connectivity
5. Develop a system for monitoring and controlling agricultural parameters using BLE
6. Create a smart city infrastructure monitoring system that uses LoRaWAN
7. Create a simple LoRa Sender and LoRa Receiver for agriculture applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti , "Internet of Things – A hands-on approach" , Universities Press, 2015
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry , "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", 1st edition Cisco Press, 2011

REFERENCES:

1. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", 1st edition Cengage India Publication,2019
2. Rajkamal , "Internet of Things: Architecture, Design Principles And Applications", 2nd edition , McGraw Hill Higher Education, 2017
3. Iler, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", 1st edition Elsevier, 2014
4. Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, "The Internet of Things – Key applications and Protocols", 2nd edition, Wiley, 2012

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EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP23	ADVANCED CONTROLLERS FOR IIOT	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21ECP17: Sensors and Transducers for IoT

COURSE OBJECTIVES:

- To understand the fundamentals and advanced concepts of control systems
- To learn about the architecture and components of IIoT
- To design and implement systems using ARM and Jetson controllers.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concept of IIoT and various control techniques (Understand)

CO2: Build the control system using ARM controller for IIoT applications (Apply)

CO3: Build IIoT systems using NVIDIA JETSON platform (Apply)

CO4: Implement the data analytics in IIoT using machine learning concepts (Apply)

CO5: Design and deploy IIoT systems for real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO3	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO4	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO5	3	2	1	1	2	-	-	-	2	2	-	1	3	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO IIoT AND CONTROL SYSTEMS **6**

Overview of IIoT – Components – Architecture – Applications and challenges in IIoT – Introduction to control theory – Types of controllers – PID, PI, PD – Control techniques – Model predictive control, adaptive control

UNIT II ARM CONTROLLERS **6**

Introduction to ARM – Architecture – Instructions – Assembly language programming – Interfacing sensors and actuators.

UNIT III NVIDIA JETSON **6**

Introduction to Jetson – Architecture – Programming Jetson Nano – Integrating Jetson with IIoT systems.

UNIT IV DATA ANALYTICS IN IIoT **6**

Introduction to data analytics – Machine learning techniques – Supervised, semi-supervised, unsupervised and reinforcement techniques

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UNIT V CASE STUDY 6

System design and implementation using ARM and Jetson – Case studies of successful IIoT deployments.

LIST OF EXPERIMENTS (INDICATIVE)

1. Generate a square and triangular waveform using DAC
2. Design a transceiver system using UART with ARM controller.
3. Design and develop physical parameters monitoring system with ARM controllers for IIOT applications.
4. Build the control system for IIOT applications using ARM controller.
5. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples using Jetson Nano
6. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample using Jetson Nano.
7. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets using Jetson Nano.
8. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points using Jetson Nano. Select appropriate data set for your experiment and draw graphs.
9. Implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples using Jetson Nano

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. Sabina Jeschke, Christian Brecher, Houbing Song, and Danda B. Rawat, "Industrial Internet of Things: Cybermanufacturing Systems", Springer Series in Wireless Technology, 2017
2. Norman S. Nise "Control Systems Engineering", 8th edition, Wiley International, 2019

REFERENCES:

1. Lyla b. Das, "Embedded Systems: An Integrated Approach", 1st edition, Pearson Education, 2013
2. Dogan Ibrahim, "ARM Based Microcontroller Projects", 1st edition, Newnes Publications, 2019
3. T. Lookman, Stephan Eidenbennz, "Materials Discovery and Design by Means of Data Science and Optimal Learning", Springer , 2018
4. Y. Cheng, T. Wang ad G. Zhang, "Artificial Intelligence for Materials Science", Springer ,2018

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP18	IoT CLOUD COMPUTING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ECP17: Sensors and Transducers for IoT

COURSE OBJECTIVES:

- To learn cloud fundamentals, service types, and models, including cloud virtualization and the publish-subscribe model.
- To develop cloud solutions using Google Cloud and AWS services, focusing on compute, network, storage, and resource management.
- To apply DevOps practices, Docker containers, Kafka for IoT, and design cloud-based systems for monitoring and assistance applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the applications of cloud virtualization and the publish-subscribe model(Understand)

CO2: Implement the cloud services and data management effectively for IoT systems (Apply)

CO3: Develop the suitable Google Cloud environment for IIoT applications (Apply)

CO4: Build the AWS Cloud services for real-world applications (Apply)

CO5: Deploy end-to-end IoT pipeline for real-time applications (Apply)

CO–PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I OVERVIEW OF CLOUD COMPUTING 9

Introduction to cloud computing – Evolution of cloud computing – Types of cloud services – Cloud characteristics – Publish subscribe model-Cloud virtualization

UNIT II CLOUD ARCHITECTURE AND RESOURCE MANAGEMENT 9

Cloud computing architecture – Service Management in cloud computing – Data management in cloud computing – Resource management in cloud

UNIT III GOOGLE CLOUD 9

Overview of google cloud – Compute, network and storage services – IAM – Database services – AI and ML services

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UNIT IV AMAZON WEBSERVICES 9

AWS fundamentals – IAM – Amazon EC2 – Auto scaling and load balancing – AWS Lambda – AWS IoT – Storage and database services

UNIT V CLOUD DEPLOYMENT 9

Fundamentals of DevOps – Introduction to docker container – Introduction to Kubernetes – Kafka for end-to-end IoT pipeline – Jenkins – Real time deployment

LIST OF ASSIGNMENTS (NOT LIMITED TO)

1. Develop a cloud-based solution for continuously monitoring and analyzing humidity and temperature data from multiple sensors.
2. Design a comprehensive IoT system for monitoring patient health metrics and providing medical assistance through cloud-based analytics and alerts.
3. Create a cloud solution for monitoring and analyzing agricultural data such as soil moisture, weather conditions, and crop health using IoT sensors.
4. Implement a cloud-based object counting system that uses computer vision and real-time data processing to count and track objects.
5. Building and Deploying Machine Learning Models with Google AI Platform
6. Perform End-to-End Continuous Integration and Deployment Pipeline with Jenkins and Docker

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Rittinghouse, John W., and James F. Ransome, "Cloud Computing: Implementation, Management and Security", 1st edition, CRC Press, 2017
2. Geewax, JJ, "Google Cloud Platform in Action", 1st edition, Manning Publications, 2018.
3. Kavis, Michael J., "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS)", 1st edition, Wiley, 2014

REFERENCES:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering Cloud Computing", 1st edition, Tata Mcgraw Hill, 2013
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach", 1st edition, Tata Mcgraw Hill, 2011
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)", 1st edition, O'Reilly, 2011
4. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", 1st edition, Wiley, 2011
5. Piper, Ben, and David Clinton, "AWS Certified Solutions Architect Official Study Guide: Associate Exam", 1st edition, Sybex, 2016

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EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP21	IOT SECURITY AND PRIVACY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ECP19 : IoT Architecture and Protocols

COURSE OBJECTIVES:

- To understand the security threats and challenges in IoT systems
- To gain proficiency in network and device security used in IoT development
- To learn to protect data from security breaches

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concept of IoT security (Understand)

CO2: Secure IoT networks using communication protocols (Apply)

CO3: Build IoT systems using trusted platforms (Apply)

CO4: Implement the Data minimization and anonymization techniques (Apply)

CO5: Design and deploy IoT systems for real time security breaches (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I INTRODUCTION TO IOT SECURITY 9

Overview of IoT – Components – Architecture – Security challenges in IoT – IoT security threats and vulnerabilities – IoT security standards and frameworks

UNIT II NETWORK SECURITY IN IOT 9

IoT communication protocols – MQTT, CoAP – Securing IoT network traffic – IoT specific firewall configurations – Intrusion detection systems

UNIT III DEVICE SECURITY 9

Secure boot – Firmware updates – Hardware security modules – Trusted platform modules – IoT device authentication – Access control mechanisms

UNIT IV DATA PRIVACY IN IOT 9

Privacy regulations and compliance – Data minimization – Data anonymization techniques – Privacy – Preserving data analytics for IoT

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UNIT V CASE STUDIES AND EMERGING TRENDS 9

Analysis of real-world IoT security breaches – Latest trends in IoT security and privacy – Future directions and research areas

LIST OF ASSIGNMENTS (NOT LIMITED TO)

1. Design an IoT system for encryption and decryption
2. Built a system to secure IoT devices using TPM
3. Implement a secure communication between IoT devices and cloud services
4. Construct an IoT network for testing IDS
5. Built a secure communication using MQTT server
6. Design an authentication/authorization mechanism for IoT devices
7. Implement a system for IoT data integrity verification
8. Built a system to securely pair IoT devices
9. Design a system to identify security risks in IoT supply chain
10. Construct a secure mobile application that interact with IoT devices

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. Hernández Ramos, J.L., Skarmeta, A, " Security and Privacy in the Internet of Things: Challenges and Solutions", IOS Press, 2020
2. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", O'Reilly Media, 2016

REFERENCES:

1. Qinghao Tang, Fan Du, "Internet of Things Security: Principles and Practice", Springer, 2021
2. Fei Hu, "AI, Machine Learning and Deep Learning: A Security Perspective", CRC Press, 2023
3. Shancang Li (Author), Li Da Xu, "Securing the Internet of Things", Syngress, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP24	INDUSTRY 4.0 AND INDUSTRIAL IOT	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21ECP19 : IoT Architecture and Protocols

COURSE OBJECTIVES:

- To understand the fundamental principles of Industry 4.0 and applications
- To acquire the knowledge about different versions of Industrial IoT
- To design and develop the various real time applications using Industrial IoT.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamental concepts of Industry 4.0 (Understand)

CO2: Demonstrate the utilization of Industry 4.0 in Cyber Physical Systems (Apply)

CO3: Apply Industrial IoT concepts to develop practical business models (Apply)

CO4: Implement different types of communication layers in Industrial IoT systems. (Apply)

CO5: Apply the Industrial IoT concepts to develop real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO3	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO4	3	2	1	1	2	-	-	-	2	2	-	1	3	-
CO5	3	2	1	1	2	-	-	-	2	2	-	1	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I BASICS OF INDUSTRY 4.0 6

Sensing and actuation – Communication – Part I, Part II – Networking – Part I, Part II – Globalization and emerging issues – Fourth revolution – LEAN production systems – Smart and connected business perspective – Smart factories

UNIT II INDUSTRY 4.0 IN CYBER PHYSICAL SYSTEMS 6

Cyber physical systems and next generation sensors – Collaborative platform and product lifecycle management – Augmented reality and virtual reality – Artificial intelligence – Big data and advanced analysis

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UNIT III INDUSTRIAL IOT 6

IIoT – Introduction: Business model and reference architecture – IIoT – Business models – Part I, Part II – IIoT reference architecture – Part I, Part II

UNIT IV INDUSTRIAL IOT LAYERS 6

IIoT Sensing – Part I, Part II – IIoT processing – Part I, Part II – IIoT communication– Part I – IIoT communication– Part II, Part III – IIoT networking – Part I, Part II

UNIT V APPLICATION DOMAINS OF IIoT 6

Healthcare – Power plants – Inventory management and quality control – Plant safety and security – AR and VR safety applications – Facility management

LIST OF EXPERIMENTS (INDICATIVE)

1. Design and implement a network of sensors to monitor environmental conditions in a manufacturing setup.
2. Set up a local network of IoT devices and ensure communication between them
3. Design of an IIoT system to monitor the viscosity of oils.
4. Build an IIoT-Based Predictive Maintenance System.
5. Design and implement a system for monitoring and analyzing machine vibration levels
6. Integrate and process sensor data in an IIoT environment.
7. Develop a building intrusion detection system using ultrasonic sensors.
8. Implement an IoT-based inventory management system

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, "Introduction To Industrial Internet of Things and Industry 4.0", 1st edition, CRC Press, 2020

REFERENCES:

1. Giacomo Veneri and Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", 1st edition, Packt Publishing, 2018
2. Suresh A., "Industrial IoT Application Architectures and Use Cases", 1st edition, Taylor & Francis Ltd, 2019
3. Alasdair Gilchrist," Industry 4.0: The Industrial Internet of Things" , 1st edition, Apress, 2019
4. Rajkamal, "Internet of Things (IOT): Architecture and Design Principles", 2nd edition, McGraw Hill Education (India) Private Limited, 2022
5. Dr. Amit Mehta, Mr. Jay Bulani, et al, "Introduction to Industry 4.0", 1st edition, Taran Publication, 2024

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP22	IOT BASED SMART SYSTEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ECP18 : IoT Cloud Computing

COURSE OBJECTIVES:

- To apply IoT architecture concepts and data management
- To develop proficiency in using data processing frameworks and machine learning methods for IoT applications
- To analyze time series analysis methods and anomaly detection techniques to forecast and monitor IoT data

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply IoT system components and the data lifecycle from generation to analysis (Apply)

CO2: Apply data collection protocols, pre-processing methods to manage IoT data effectively (Apply)

CO3: Examine the behaviour of IoT systems using Machine Learning approach (Apply)

CO4: Analyze classical and advanced time series models to detect anomalies in IoT time series data (Analyze)

CO5: Inspect IoT-based solutions for predictive maintenance, energy optimization, and supply chain management (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO4	3	3	2	-	-	-	-	-	-	-	-	1	3	-
CO5	3	3	2	-	-	-	-	-	-	-	-	1	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I IoT Analytics 9

IoT architecture and components – Types of IoT data – Challenges in IoT data analysis – Overview of machine learning applications in IoT – IoT data lifecycle: generation, collection, storage, processing, analysis

UNIT II IoT Data Processing and Management 9

Data collection techniques and protocols – MQTT, CoAP, HTTP – Data preprocessing – Cleaning, normalization and feature engineering – Distributed data storage systems – HDFS, NoSQL databases – Batch processing frameworks – Hadoop MapReduce, Spark – Stream processing frameworks – Apache flink, Kafka streams – Data integration and fusion techniques

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UNIT III Advanced Machine Learning for IoT 9

Supervised learning techniques – Unsupervised learning – Semi-supervised and active learning for IoT – Ensemble methods – Deep learning architectures for IoT data – Transfer learning and domain adaptation in IoT contexts – Reinforcement learning for IoT control systems

UNIT IV Time Series Analysis for IoT 9

Characteristics of IoT time series data – Time series preprocessing – Resampling, interpolation, smoothing – Classical time series models – ARIMA, SARIMA, exponential smoothing – Advanced forecasting models – Prophet, TBATS – Deep learning for time series – RNNs, LSTMs, GRUs – Anomaly Detection – Statistical approaches – Z-score, DBSCAN, Isolation forest – Machine learning-based anomaly detection – One-class SVM, auto encoders

UNIT V Case Studies 9

Building an Intelligent IoT System – Predictive maintenance – Energy consumption optimization– Supply chain optimization

LIST OF ASSIGNMENTS (NOT LIMITED TO)

1. Develop a computer vision system using CNNs to detect defects on assembly lines in real-time.
2. Implement a system using sensor data and machine learning to predict equipment failures before they occur.
3. Develop the AI based attendance monitoring system.
4. Create a real-time system to analyze and optimize energy usage across industrial facilities.
5. Use AI and ML to optimize inventory levels, reduce lead times, and improve supply chain efficiency in real-time.
6. Implement a real-time monitoring system for IoT devices in industrial environments to detect and respond to anomalies or failures.
7. Develop an AI-powered chatbot to provide real-time technical support and assistance to customers in various industries.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Hwaiyu Geng, IoT and Data Analytics Handbook, CRC Press, 2017
2. Ajit Jaokar, Charalampos Doukas, and Gianmarco De Francisci Morales, Machine Learning for IoT: A Guide for Data Scientists, Packt Publishing, 2020

REFERENCES:

1. Neeraj Kumar and Yogesh Kumar Sharma, Data Science and IoT: Fundamentals and Applications, Wiley, 2022
2. Aileen Nielsen, Practical Time Series Analysis, O'Reilly Media, 2019
3. Jason Brownlee, Deep Learning for Time Series Forecasting, Machine Learning Mastery, 2018
4. Giacomo Veneri and Antonio Capasso, Hands-On Industrial Internet of Things, Packt Publishing, 2018
5. Wes McKinney, Python for Data Analysis, O'Reilly Media, 2022

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EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL 4: Advanced Communication Technologies

U21ECP25	ADHOC AND WIRELESS SENSORS NETWORKS	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC503: Computer Communication Networks

COURSE OBJECTIVES:

- To understand the MAC and routing protocols of ad hoc wireless networks
- To learn the various transport layer protocols and architectures of wireless sensor networks
- To study about programming platforms and tools

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the MAC protocols based on the time synchronization and reservation approaches (Analyze)

CO2: Use appropriate routing protocols for Ad-hoc wireless networks (Apply)

CO3: Inspect various transport layer and security protocols (Analyze)

CO4: Compare the performance of different sensor network architectures (Analyze)

CO5: Implement the concept of sensor network using various platforms and simulators (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	2	2	-	1	1	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	1	-
CO3	3	3	2	2	2	-	-	-	2	2	-	1	1	-
CO4	3	3	2	2	2	-	-	-	2	2	-	1	1	-
CO5	3	2	1	1	2	-	-	-	2	2	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)			3: Substantial (High)							

SYLLABUS:

UNIT I MAC PROTOCOLS FOR ADHOC WIRELESS NETWORKS 9

Introduction to ad-hoc wireless networks – Key issues and challenges – Classification of MAC protocols – Overview of contention-based protocols with reservation mechanisms – Overview of contention-based protocols with scheduling mechanisms

UNIT II ROUTING PROTOCOLS 9

Issues in designing a routing protocol – Classifications of routing protocols – Table driven routing protocols – Destination sequenced distance vector – Ad-hoc on-demand distance vector routing

UNIT III TRANSPORT LAYER AND SECURITY PROTOCOLS 9

Transport layer issues and design goals – Classification of transport layer protocols – Overview of TCP adaptations for ad-hoc networks –TCP bus, ad-hoc TCP – Security attacks and Key management – Secure routing

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UNIT IV WIRLESS SENSOR NETWORK 9

Comparison with ad-hoc wireless networks – Sensor network architecture – Overview of layered and clustered designs – Data dissemination and data gathering – CSMA based MAC protocol

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor node hardware – Berkeley motes – Introduction to programming challenges in sensor networks – Node level software platforms – TinyOS,nesC – Node level simulators – NS2, COOJA

LIST OF EXPERIMENTS (INDICATIVE)

1. Implementation of Contention-Based MAC Protocols
2. Implementation of Routing Protocols: AODV, DSDV, DSR
3. Secure Routing, QoS Routing
4. Data Dissemination in Ad-hoc and Sensor Network
5. Layered and Clustered Network
6. Energy-Efficient Protocols in Sensor Networks
7. Localization Techniques in Sensor Networks
8. Security Attacks and Mitigation in Ad-hoc Networks
9. Network Topology Control and Management

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", 6th edition, Prentice Hall Professional Technical Reference, 2008
2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", 1st edition, Wiley, 2007

REFERENCES:

1. Kazem Sohraby, Daniel Minoli & Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", 1st edition, John Wiley, 2007
2. Carlos De Morais Cordeiro, "Ad Hoc & Sensor Networks: Theory and Applications", 1st edition, World Scientific Publishing Company, 2006
3. Anna Hac, "Wireless Sensor Network Designs", 1st edition, John Wiley, 2003
4. Feng Zhao and Leonides Guibas, "Wireless Sensor Networks", 1st edition, Elsevier Publication, 2002

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP29	NETWORK SECURITY FOR COMMUNICATION	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC503: Computer Communication networks

COURSE OBJECTIVES:

- To study various cryptographic techniques and data encryption standards
- To learn about the principles of public key and authentication systems
- To understand the security mechanisms of internet and mobile networks

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Use suitable cryptographic techniques for OSI security architecture (Apply)

CO2: Apply the concept of data encryption and dencryption standards (Apply)

CO3: Compare various public key cryptosystems (Analyze)

CO4: Analyze the performance of different authentication system methods (Analyze)

CO5: Identify the threats and attacks in data networks and Mobile security (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	2	2	-	1	2	-
CO2	3	2	1	1	2	-	-	-	2	2	-	1	2	-
CO3	3	3	2	2	2	-	-	-	2	2	-	1	2	-
CO4	3	3	2	2	2	-	-	-	2	2	-	1	2	-
CO5	3	2	1	1	2	-	-	-	2	2	-	1	2	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I BASIC CIPHERS 6

Services, mechanisms and attacks – The OSI security architecture – Network security model – Classical encryption techniques, symmetric cipher model, substitution techniques, transposition techniques, steganography

UNIT II BLOCK CIPHERS 6

Block ciphers – Data encryption standard – Block cipher principles, block cipher modes of operation – Triple DES – Simplified advanced encryption standard – Advanced encryption standard (AES)

UNIT III PUBLIC KEY SYSTEM CIRCUITS 6

Public key cryptography, principles of public key cryptosystems – The RSA algorithm – Key management – Diffie Hellman Key exchange – Elliptic curve arithmetic – Elliptic curve cryptography – Elliptic curve digital signature algorithm

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UNIT IV AUTHENTICATION SYSTEM 6

Authentication requirements and function – MAC – Hash function – Security of hash function – MD5 – SHA– HMAC – CMAC – Digital signature and authentication protocols – DSS –Schnorr digital signature – Kerberos– X.509 Authentication services

UNIT V INTERNET AND MOBILE SECURITY 6

Internet firewalls for trusted System – Roles of firewalls – Firewall related terminology – Types of Firewalls – Intrusion detection system – Virus and related threats – Countermeasures – Email Security, security services for e-mail

LIST OF EXPERIMENTS (INDICATIVE)

1. Implement Caesar cipher encryption-decryption
2. Implement Monoalphabetic cipher encryption-decryption
3. Implement Playfair cipher encryption-decryption
4. Implement Hill cipher encryption-decryption
5. Implement Simple DES or AES
6. Implement Diffi-Hellmen Key exchange Method
7. Implement RSA encryption-decryption algorithm
8. Implement a digital signature algorithm
9. Perform various encryption-decryption techniques
10. Study and use the Wireshark for the various network protocols

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. William Stallings, "Cryptography and Network Security principles and practice", 7th edition, Pearson Education, 2017
2. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security", 3rd edition, Prentice Hall of India, 2012

REFERENCES:

1. Behrouz A Ferouzan, "Cryptography & Network Security", 3rd Edition, Tata McGraw Hill, 2011
2. Charles Pfleeger, "Security in Computing", Prentice Hall of India, 2009
3. Man Young Rhee, "Internet Security: Cryptographic Principles, Algorithms and Protocols", Wiley Publications, 2003
4. Ulysess Black, "Internet Security Protocols", Pearson Education Asia, 2000

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP27	5G WIRELESS STANDARD DESIGN	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC701: Wireless communication

COURSE OBJECTIVES:

- To study various architectures of 5G communication
- To learn the basics of mm Wave communication and massive MIMO systems
- To understand the mobility management and 5G spectrum technologies

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the principles of 5G technology to optimize real time applications and deployments (Apply)

CO2: Examine channel propagation and hardware technologies involved in millimeter wave (mmW) communication (Analyze)

CO3: Compare the spectral efficiency of single user and multi user MIMO system (Analyze)

CO4: Explain interference and mobility management in 5G (Understand)

CO5: Apply the principles of 5G technologies for real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	2	2	-	1	-	1
CO2	3	3	2	2	2	-	-	-	2	2	-	1	-	1
CO3	3	3	2	2	2	-	-	-	2	2	-	1	-	1
CO4	2	1	-	-	2	-	-	-	2	2	-	1	-	1
CO5	3	2	1	1	2	-	-	-	2	2	-	1	-	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)						3: Substantial (High)					

SYLLABUS:

UNIT I 5G ARCHITECTURE **6**

Introduction – Network function virtualization (NFV) – Basics of radio access network (RAN) architecture – Integration of LTE and new air interface – Physical architecture and 5G deployment – Key 5G Technologies – Adaptive Modulation and Coding (AMC) – 5G Numerology – 5G Frame structure

UNIT II MILLIMETER WAVE COMMUNICATION **6**

Spectrum and regulations – Channel propagation – Hardware technologies for mmW systems – Deployment scenarios – Architecture and mobility – Beamforming – Physical layer techniques

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UNIT III 5G MASSIVE MIMO SYSTEMS 6

MIMO in LTE – Single user MIMO – Multi-user MIMO – Massive MIMO Pilot design – Resource allocation and transceiver algorithms – Baseband and RF implementations - MIMO transceiver chain - MIMO codebook design - 5G baseband – RF conversion

UNIT IV INTERFERENCE AND MOBILITY MANAGEMENT IN 5G 6

Network deployment types – Interference management –Ultra dense network (UDN) , moving relay nodes – Interference cancelation – 5G physical downlink control channel (PDCCH) transmit chain – 5G physical uplink control channel – 5G sounding reference signal (SRS) design

UNIT V 5G SPECTRUM 6

Spectrum for 4G – Spectrum challenges in 5G – 5G spectrum landscape and requirements – Bandwidth requirements – Spectrum access modes – 5G spectrum technologies – Spectrum toolbox – Main technology components – 5G FR1/FR2 design – 5G initial access

LIST OF EXPERIMENTS (INDICATIVE)

1. Simulation of OFDM Transmission and Reception for 5G Systems
2. Design and Analysis of Massive MIMO Systems
3. Modeling and Analysis of mmWave Channels for 5G
4. Performance Evaluation of NOMA in 5G Networks
5. Simulation of Ultra-Reliable Low Latency Communication (URLLC)
6. Massive Machine Type Communication (mMTC) for IoT in 5G
7. Implementation of LDPC and Polar Codes for 5G Channel Coding
8. Simulation of 5G Network Deployment and Performance Analysis
9. Waveform Design for 5G: CP-OFDM Vs DFT-s-OFDM
10. Power Control and Energy Efficiency Optimization in 5G

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Erik Dahlman, Stefan Parkvall, Johan Sko'ld, "5G NR: The Next Generation Wireless Access Technology", 1st edition, Elsevier, 2018
2. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", 1st edition, Cambridge University Press, 2016

REFERENCES:

1. Wanshi Chen, Peter Gaal, Juan Montojo, Haris Zismopoulos, "Fundamentals of 5G Communications", 1st edition, Mc Graw Hill, 2021
2. Christopher Cox, "An introduction to 5G: The New Radio, 5G Network and Beyond", 1st edition, Wiley, 2020
3. Saad Asif, "5G Mobile Communication", 1st edition, CRC Press, 2018
4. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", 1st edition, Wiley, 2015

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP31	VEHICULAR COMMUNICATION	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC503 : Computer Communication networks
- U21EC701 : Wireless Communication .

COURSE OBJECTIVES:

- To study sustainable mobility and standards in vehicular communication systems
- To understand driver assistance system
- To learn the information dissemination and security in vehicular networks

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Inspect the standards of various vehicular networks (Analyze)

CO2: Examine transportation inefficiencies problem in smart cities (Analyze)

CO3: Apply the principles of DAS in real time applications (Apply)

CO4: Analyze the operation of information dissemination in vehicular networks (Analyze)

CO5: Apply security and privacy principles in vehicular communication (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	2	2	-	1	-	1
CO2	3	3	2	2	2	-	-	-	2	2	-	1	-	1
CO3	3	2	1	1	2	-	-	-	2	2	-	1	-	1
CO4	3	3	2	2	2	-	-	-	2	2	-	1	-	1
CO5	3	2	1	1	2	-	-	-	2	2	-	1	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I VEHICULAR COMMUNICATIONS STANDARDS 6

Introduction to transportation – Intelligent transport systems – Wireless access for vehicular environments (WAVE) – IEEE 1609 – Overview of key standards – SAE J2735, LED Enabled visible light communications

UNIT II SUSTAINABLE MOBILITY IN SMART CITIES 6

Goals of traffic assessment and Forecasting – Urban transportation inefficiencies – Smart city operations – Sustainable mobility and Mobility as a Service (MaaS) – Case studies – Car pooling, intelligent parking management

UNIT III ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS) 6

Introduction to ADAS – Cooperative mobility– Connectivity in road transport – Information sharing for sustainable multimodal transport – Case studies – Radar based DAS, lane keeping and lane departing

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UNIT IV INFORMATION DISSEMINATION 6

Basics of dissemination concepts – Broadcast based dissemination – Multi-hop dissemination – Intelligent flooding and Geo-casting – Peer-to-peer traffic information system – Cellular multicast

UNIT V SECURITY AND PRIVACY 6

Introduction to security requirements in vehicular networks – Identity management – Privacy protection – Overview of cryptographic schemes – identity-based and symmetric cryptography

LIST OF EXPERIMENTS (INDICATIVE)

1. Implementing IEEE 1609 Wave Protocols
2. Intelligent Parking Management System
3. Lane Keeping Assistance System
4. Multi-hop Data Dissemination
5. Privacy Protection in Vehicular Networks
6. Vehicle-to-Infrastructure (V2I) Communication
7. Vehicle-to-Vehicle (V2V) Communication
8. Simulation of Vehicular Ad Hoc Networks (VANETs)
9. Visible Light Communication (VLC) for Vehicular Networks
10. Security Attack Simulation and Mitigation in Vehicular Networks

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project: – Periods
			Total: 60 Periods

TEXT BOOKS:

1. George Dimitrakopoulos, "Current Technologies in Vehicular Communications", 1st edition, Springer International Publisher, 2017
2. Wai Chen, "Vehicular Communications and Networks", 1st edition, Woodhead Publishing, 2015

REFERENCES:

1. Rappaport T.S, "Wireless Communications", 2nd edition, Pearson Education, 2018
2. Claudia Campolo, "Vehicular ad hoc Networks: Standards, Solutions, and Research", 1st edition, Springer, 2015
3. Christophe Sommer and Falko Dressler, "Vehicular Networking", 1st edition, Cambridge University Press, 2014
4. Radu Popescu, "Vehicular-2-X Communication State-of-the-Art and Research in Mobile Vehicular Ad hoc Networks", 1st edition, Springer, 2010

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP32	BODY AREA NETWORKS AND SENSORS	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC701: Wireless Communication

COURSE OBJECTIVES:

- To study the basics and hardware requirement of Body Area Networks (BAN)
- To understand the communication and security aspects in the BAN
- To learn the applications of BAN in the field of medicine

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the suitable principles of BAN to healthcare applications (Apply)

CO2: Examine the hardware components used for BAN (Analyze)

CO3: Design body area networks using WPAN technologies (Analyze)

CO4: Analyze the regulatory and security issues of BAN (Analyze)

CO5: Apply the concepts of BAN for medical applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	-	2
CO2	3	3	2	2	2	-	-	-	2	2	-	1	-	2
CO3	3	3	2	2	2	-	-	-	2	2	-	1	-	2
CO4	3	3	2	2	2	-	-	-	2	2	-	1	-	2
CO5	3	2	1	1	2	-	-	-	2	2	-	1	-	2

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I FUNDAMENTALS OF BAN 6

BAN and healthcare – Technical challenges – Sensor design – Biocompatibility – Energy supply, optimal node placement, number of nodes, system security and reliability – BAN Architecture – Introduction of BAN

UNIT II HARDWARE FOR BAN 6

Wireless communication – RF communication in body –Antenna design and testing, matching network, propagation, materials, base station, power considerations – Wireless communication technologies for wearable systems, body area network

UNIT III WIRELESS COMMUNICATION AND NETWORK 6

Network topologies – Stand alone BAN, wireless personal area network technologies – Standards – IEEE 802.15.1, IEEE P802.15.13, IEEE 802.15.14 – Zig-bee – 5G Networks – Healthcare system standards

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UNIT IV COEXISTENCE ISSUES WITH BAN 6

Interferences – Effect on transmission, counter measures – Physical layer and data link layer – Network security and self-protection – Bacterial attacks, virus infection, and secured protocols

UNIT V APPLICATIONS OF BAN 6

Monitoring patients with chronic disease – Elderly patients – Cardiac arrhythmias monitoring – Multi patient monitoring systems – Multichannel neural recording – Gait analysis – Sports medicine – Electronic pill

LIST OF EXPERIMENTS (INDICATIVE)

1. Design and analysis of micro strip patch antenna for Wi-Max / WLAN Applications.
2. Design and development of a IoT based flexible and wearable antenna for monitoring breath rate.
3. Design of compact circular printed antenna for high data rate in wireless sensor networks.
4. Analyze the traffic flow in a star, bus, and ring topology scenario.
5. Implementation and analysis of advanced encryption and decryption standards for data integrity.
6. Sensor Integration and data acquisition in BANs.
7. Wireless Communication Protocols in BANs.
8. Energy Efficiency Strategies for Wearable BAN Devices.
9. Data Privacy and Security in Body Area Networks

Contact Periods:

Lecture: 30 Periods	Tutorial: - Periods	Practical: 30 Periods	Project: – Periods
			Total: 60 Periods

TEXT BOOKS:

1. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability", 2nd edition, Cambridge University Press, 2013
2. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems",1st edition, Springer, 2011

REFERENCES:

1. Maheswar, R., G. R. Kanagachidambaresan, Raman Jayaparvathy, and Sabu M. Thampi, "Body area network challenges and solutions", 1st edition, Springer, 2019
2. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", 1st edition, Springer, 2013
3. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", 1st edition, Pan Stanford Publishing, Singapore, 2012
4. Guang-Zhong Yang, "Body Sensor Networks", 2nd edition, Springer, 2006

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP34	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	Category: PEC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EC401: Electromagnetic Fields and Waveguides

COURSE OBJECTIVES:

- To learn the concept of electromagnetic interference and compatibility
- To understand about EMI devices and mitigation techniques
- To study various EMC standards and measurements

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Examine the concepts of electromagnetic interference and compatibility (Analyze)
CO2: Analyze the electromagnetic emissions from various apparatus and circuits (Analyze)
CO3: Apply EM shielding principles to mitigate EMI suppression (Apply)
CO4: Identify suitable electromagnetic transients and ESD in electronic systems (Apply)
CO5: Apply the suitable measurement techniques to measure EM interferences (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	1	-	2
CO2	3	3	2	2	2	-	-	-	2	2	-	1	-	2
CO3	3	2	1	1	2	-	-	-	2	2	-	1	-	2
CO4	3	2	1	1	2	-	-	-	2	2	-	1	-	2
CO5	3	2	1	1	2	-	-	-	2	2	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I BASICS OF EMI AND EMC 6

Concepts of EMI and EMC – Sources of EMI – EMI coupling to victim equipment, intersystem and intrasystem EMI, EMC standards and specifications

UNIT II EMI COUPLING 6

Conducted, radiated and transient coupling – Common ground impedance coupling – Common mode and ground loop coupling – Differential mode coupling – Near field cable to cable coupling – Field to cable coupling

UNIT III MITIGATION TECHNIQUES 6

Principle of EM shielding – Shielding materials, cable shielding, shielding effectiveness, low frequency magnetic shielding – Gasketting types – Principle of grounding – Cable shield grounding

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UNIT IV MEASUREMENT DEVICES FOR EMI 6

Introduction – Measurement by direct connection, Inductively coupled devices, EMC antennas – EMI receiver– Automatic EMC tests – Electromagnetic transient testing – Transient types – ESD – Electrostatic discharge

UNIT V TEST METHODS AND MEASUREMENTS 6

Open field test – Radiated interference measurement – Shielded anechoic chamber, transverse electromagnetic cell – Conducted interference measurement – Power supply noise, equipment interference

LIST OF EXPERIMENTS (INDICATIVE)

1. Basic spectrum measurement and power measurement with markers
2. Perform environment scan and detect various signals available
3. EMI spurious detection and measurement against EMI limit lines
4. Measurement of EMI Shielding effectiveness
5. DPX, Spectrogram and transient capture with mask test and act on violation
6. Use of LISN and measurement concept of Conducted emission
7. Simulation of Common Impedance Coupling
8. Design of electrostatic discharge using suitable simulation tool
9. Simulation of Conducted Emissions from a Motor control
10. Simulation of Conducted Emissions from a DC/DC converter

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Clayton R.Paul "Introduction to Electromagnetic Compatibility", 2nd edition, Wiley, 2006
2. V Prasad Kodali, "Engineering Electromagnetic Compatibility", 2nd edition, IEEE Press, 2001

REFERENCES:

1. Henry W. Ott, "Electromagnetic Compatibility Engineering", 2nd edition, John Wiley & Sons Inc, 2009
2. Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", 3rd edition, CRC Press, 2005
3. Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", 1st edition, Elsevier, 2002
4. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", 1st edition, John Wiley & Sons Inc.,1997

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP30	SOFTWARE DEFINED NETWORKS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the fundamentals of software defined networks
- To understand the separation of the data plane and the control plane
- To study about the SDN Programming
- To study about the various applications of SDN

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize the evolution of software defined networks (Understand)

CO2: Illustrate the various components of SDN (Understand)

CO3: Explain the use of SDN in the current networking scenario (Understand)

CO4: Implement SDN concepts with suitable programming (Apply)

CO5: Develop various applications of SDN (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION TO SDN **9**

History of Software Defined Networking (SDN) – Modern data center – Traditional switch architecture – Evolution – Centralized and distributed control and date planes

UNIT II OPEN FLOW & SDN CONTROLLERS **9**

Open flow specification – Drawbacks of open SDN, SDN via APIs, SDN via Hypervisor – Based Overlays – SDN via Opening up the device – SDN controllers – General concepts

UNIT III DATA CENTERS **9**

Multitenant and virtualized multitenant data center – SDN solutions for the data center network – VLANs – EVPN – VxLAN – NVGRE

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UNIT IV SDN PROGRAMMING 9

Programming SDNs – Northbound application programming interface, current languages and tools, Composition of SDNs – Network Functions Virtualization (NFV) and Software Defined Networks – Concepts, implementation and applications

UNIT V APPLICATIONS OF SDN 9

Juniper SDN framework – IETF SDN framework – Open daylight controller – Floodlight controller – Bandwidth calendaring – Data centre orchestration

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive Approach", 1st edition, Morgan Kaufmann, 2014
2. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks", O'Reilly Media, 2013

REFERENCES:

1. Fei Hu, Editor, "Network Innovation through Open Flow and SDN: Principles and Design", CRC Press, 2014
2. Siamak Azodolmolky, "Software Defined Networking with Open Flow", Packet Publishing, 2013
3. Vivek Tiwari, "SDN and Open Flow for Beginnersll", Amazon Digital Services, Inc., 2013

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP28	OPTICAL NETWORKS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the optical components and architectures in optical communication systems
- To design the traffic models applicable for wavelength routing networks
- To study about packet switching and network management

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the operation of various optical components (Understand)
CO2: Summarize different network architectures (Understand)
CO3: Apply the appropriate wavelength assignment for efficient network design (Apply)
CO4: Explain the concepts of advanced optical networks (Understand)
CO5: Compare the network design and management techniques (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I OPTICAL SYSTEM COMPONENTS 9

Optical transmission basics – Light propagation in optical fibers – Loss and bandwidth – Nonlinear effects – Solitons – Optical components – Couplers, isolators, circulators, multiplexers and filters – switches – Wavelength converters

UNIT II OPTICAL NETWORK ARCHITECTURES 9

Introduction to optical networks – SONET/SDH – Transport networks – Framing procedure – Multiprotocol label switching – Resilient packet ring – WDM network elements

UNIT III WAVELENGTH ROUTING NETWORKS 9

Optical layer cost trade-off – Light path topology design – Routing and wavelength assignment – Wavelength conversion – Dimensioning wavelength – Routing networks

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UNIT IV ADVANCED OPTICAL NETWORKS 9

Visible light and UV communication – Li-Fi – Optical light emitting diode – WOBAN – Optical time division multiplexing – Synchronization – Free space optics – Radio over fiber technology

UNIT V NETWORK DESIGN AND MANAGEMENT 9

Network management functions – Optical layer services and interfacing – Multivendor interoperability – Performance and fault management – Configuration management – Optical safety

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Rajiv Ramaswami and Kumar N. Sivarajan, Galen Sasaki "Optical Networks: A Practical Perspective", 3rd edition, Elsevier/Morgan Kaufmann, 2010
2. C.Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks: Concept, Design and Algorithms", 2nd edition, Prentice Hall of India, 2002

REFERENCES:

1. Gerd Keiser, "Optical Fiber Communications", 5th edition, Mc Graw Hill Education, 2013
2. Govind P.Agrawal, "Fiber–Optic Communication Systems",4th edition, John Wiley and Sons, 2012
3. Thomas E. Stern, Georgios Ellinas, Krishna Bala, "Multiwavelength Optical Networks Architecture, Design and control ", 2nd edition, Cambridge University Press, 2009
4. Biswanath Mukherjee, "Optical WDM Networks", 2nd edition, Springer Science, 2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP35	SATELLITE COMMUNICATION	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the basics of satellite orbits and launching methods
- To understand the satellite subsystems and characteristics of satellite links
- To learn various applications of communication and remote sensing satellites.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply Kepler's laws to calculate satellite orbital parameters (Apply)

CO2: Illustrate the space and earth segment sub systems (Understand)

CO3: Design link power budget in satellite systems (Analyze)

CO4: Summarize the various stages of satellite launches (Understand)

CO5: Explain the different types of communication satellite applications (Understand)

CO–PO MAPPING:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	1
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO5	2	1	-	-	-	-	-	-	-	-	-	1	-	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)			

SYLLABUS:

UNIT I SATELLITE ORBITS 9

Introduction to satellite orbits – Kepler's laws – Orbital elements – Apogee and Perigee –Satellite orbits – Orbital perturbations – Earth eclipse of satellite – Sun transit outage – Look angles – Azimuthangle, elevation angle

UNIT II SPACE AND EARTH SEGMENT 9

Satellite subsystem – Power supply subsystem, attitude and orbit control, tracking-telemetry and command subsystem, satellite transponders – Earth station – Receive-only home TV systems – Master antenna TV systems – Community antenna TV systems, transmitter and receiver earth stations

UNIT III SATELLITE LINK DESIGN 9

Transmission losses – Link power budget – C/N calculation – System noise – Satellite uplink and downlink – Rain induced attenuation and interference – Link design with and without frequency reuse

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UNIT IV SATELLITE LAUNCH 9

Satellite launches and launch vehicles – Spacecraft technology – Structure – Primary power – Orbit control – Thermal control and propulsion – Communication payload and supporting subsystems – Telemetry – Satellite tracking

UNIT V COMMUNICATION SATELLITES 9

Introduction to communication satellites – Satellite services – INTELSAT series – VSAT – Mobile satellite services – GSM – GPS – Directbroadcast satellites (DBS/DTH) – Home receiver indoor and outdoor unit – HDTV

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Dennis Roddy, "Satellite Communications", 4th edition, Mc Graw Hill (Reprint), 2014
2. Tri T. Ha, "Digital Satellite Communications", 2nd edition, Mc Graw Hill, 2009

REFERENCES:

1. Bruce R. Elbert, "The Satellite Communication Applications", 3rd edition, Artech House Bostan 2008
2. Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", 2nd edition, Pearson, 2007
3. Timothy Pratt, Charles W. Bostian, Jeremy E. Allnutt, "Satellite Communication", 2nd edition, Wiley, 2006
4. Richharia M, "Satellite Communication Systems Design Principles", 3rd edition, Macmillan Press Ltd., 2001

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP26	ADVANCED COMMUNICATION SYSTEM	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC403: Digital communication

COURSE OBJECTIVES:

- To understand the concepts of modulation techniques and channel coding methods
- To learn the evolution 5G communication
- To study the principles of mobile cloud and SON

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concepts of baseband and bandpass signaling (Understand)

CO2: Classify the error control techniques based on efficiency (Analyze)

CO3: Outline the basic principles of 5G communication (Understand)

CO4: Illustrate the architecture of mobile cloud enablers (Understand)

CO5: Apply SON architecture for 5G implementation (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1	-	1
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I BASEBAND AND BANDPASS TECHNIQUES 9

Baseband systems – Formatting text, message, character, symbol and analog information – Sources of corruption – Bandpass modulation techniques – Detection of signals in Gaussian noise – Error performance for binary systems

UNIT II CHANNEL CODING 9

Waveform coding and structured sequences – Types of error control – Structured sequences – Interleaving and concatenated codes – Coding and interleaving applied for compact disc digital audio system – Turbo codes – LDPC codes

UNIT III 5G EVOLUTION 9

Historical trend of wireless communication – Evolution of LTE beyond 4G – 5G roadmap – Pillars of 5G – IoT and context awareness in 5G internet – Networking reconfiguration and virtualization support – Mobility and QoS control – Introduction to 6G

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UNIT IV MOBILE CLOUD 9

Technology and services for future communication platforms – Mobile cloud – Mobile cloud enablers – Network coding – Potential 5G communication system architecture – Challenges in 5G communication systems

UNIT V SYSTEM ON NETWORKS 9

SON evolution for 5G mobile networks – SON in UMTS and LTE – Need for SON in 5G – Evolution towards small cell dominant HetNets – SON architecture for 5G – Vision for 5G mobile – Design drivers for next generation networks

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Fredric J. Harris and Bernard Sklar, "Digital Communications: Fundamentals and Applications", 3rd edition, Pearson Education, 2020.
2. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", 1st edition, Wiley,2015.

REFERENCES:

1. B. P. Lathi, "Modern Digital and Analog Communication Systems", 3rd edition, Oxford University Press, 2017
2. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", 1st edition, Cambridge University Press, 2016
3. John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems", 2nd edition, Pearson Education, 2014
4. Simon Haykin, Michael Moher and David Koilpillai, "Modern Wireless communications", 1st edition, Pearson Education, 2011

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="3">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</th><th>Written Test</th><th>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</th><th>Written Test</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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U21ECP39	COGNITIVE RADIO	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basic architecture of software defined radio and cognitive radio
- To learn different spectrum sensing techniques and mobility management in cognitive networks
- To acquaint with applications and advanced features of cognitive radio

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the design principles of software defined radio (Understand)

CO2: Illustrate the architecture and standards of cognitive radio (Understand)

CO3: Compare various spectrum sensing and sharing techniques (Analyze)

CO4: Implement cognitive networks with suitable mobility management algorithm (Apply)

CO5: Apply the concept of cognitive radio for real world applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I CONCEPTS OF SOFTWARE DEFINED RADIO **9**

Evolution of software defined radio – Interoperability – Dynamic spectrum access – Radio frequency regulatory challenges and actions – Regulatory issues of cognitive access – SDR and cognitive radio relationship – SDR architectures – Software tunable analog radio components

UNIT II COGNITIVE RADIO ARCHITECTURE **9**

Cognition cycle – Cognitive radio network architectures – IEEE 802.22 physical layer – IEEE 802.22 MAC layer

UNIT III SPECTRUM SENSING AND SHARING **9**

Primary signal detection – Energy detector, cyclostationary feature detector, matched filter, cooperative sensing – Implications of spectrum opportunity and detection – Spectrum access and sharing – Unlicensed spectrum sharing – Licensed spectrum sharing

UNIT IV COGNITIVE WIRELESS NETWORKS **9**

Cognitive wireless network model – Location estimation and sensing – Mobility management – OFDM based cognitive radio – Challenges of cognitive OFDM systems – Multi band OFDM – MIMO CR

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UNIT V APPLICATIONS OF COGNITIVE RADIO 9

On demand spectrum auctions – Economically robust spectrum auctions – Cognitive radio for wireless communications in a hospital environment – GNU radio for cognitive radio experimentation – GNU radio software architecture

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou "Cognitive Radio Communications and Networks", Academic Press, 1st edition, Elsevier, 2010
2. Huseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", 1st edition, Springer, 2007

REFERENCES:

1. Geetam Tomar, Ashish Bagwari, Jyotshana Kanti, "Introduction to Cognitive Radio Networks and Applications", 1st edition, CRC press, 2016
2. Ezio Biglieri, Professor Andrea J. Goldsmith, Dr Larry J. Greenstein, Narayan B. Mandayam, H. Vincent Poor, "Principles of Cognitive Radio", 1st edition, Cambridge University Press, 2012
3. Kwang Cheng Chen, Ramjee Prasad, "Cognitive Radio Networks", John Wiley and Sons, 1st edition, 2009
4. Bruce Fette, "Cognitive Radio Technology", 2nd edition, Academic press, 2006

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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