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

CONTROLLED COPY

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 department of repute for learning and research with state-of-the-art facilities to enable the students to succeed in globally competitive environment

Mission

The Mission of the Department is to

- To impart knowledge and skill-based education with competent faculty striving for academic excellence
- To instil research centres in the field, that industry needs, by collaborating with organizations of repute
- To provide ethical and value-based education by promoting activities addressing the societal needs and facilitate lifelong learning

III. Program Educational Objectives (PEOs)

PEO1: Graduates will possess an adequate knowledge and have successful technical career in Electronics and Communication Engineering or related fields

PEO2: Graduates will possess leadership qualities and demonstrate professional and ethical values

PEO3: Graduates will continue their life-long professional development through higher education or entrepreneurship

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.

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: Apply engineering knowledge and modern tools to design and implement the projects pertaining to VLSI, communication, signal and image processing.

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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	Introduction to Electrical and Electronics Engineering	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-
	Calculus and Differential Equations	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	-
	English for Technologist	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Engineering Physics	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-
	Engineering Chemistry	✓	✓	-	-	-	-	✓	-	✓	-	-	✓	-	-
	Problem Solving and C Programming	✓	✓	✓	✓	-	✓	-	✓	✓	✓	-	✓	-	-
	Manufacturing Practices	✓	✓	✓	-	✓	-	✓	-	✓	✓	-	✓	-	-
SEM II	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	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	✓
	Analog Communication	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Data Structures	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	-	-
	Linear Integrated Circuits	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	-	✓

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SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM III	Digital Electronics	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	-	✓
	Analog Electronics Laboratory	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
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	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓	-	✓
SEM V	Transmission Lines and Antennas	✓	✓	✓	-	✓	✓	✓	-	-	-	-	✓	-	✓
	Control System Theory	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Computer Communication Networks	✓	✓	✓	-	✓	-	-	✓	✓	✓	-	✓	-	✓
	Soft Skills - II	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-
	RF and Antenna Design Laboratory	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
	Electronic hardware Troubleshooting	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓	-	-
SEM VI	Embedded Systems and IoT	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	VLSI Design	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
	Artificial Intelligence	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	-
	Soft Skills - III	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Embedded Systems and IoT Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-

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SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM VII	Wireless Communication	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
	Optical and Microwave Engineering	✓	✓	✓	-	-	-	-	✓	✓	✓	-	✓	-	✓
	Project Management and Entrepreneurship	✓	✓	-	✓	-	-	✓	✓	✓	✓	✓	✓	-	-
	Project work Phase - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SEM VIII	Project work Phase - II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VERTICAL 1: VLSI DESIGN	Verilog Programming	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	VLSI Verification Methodologies	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	-	✓
	Physical Design Automation	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	-	✓
	Analog IC Design	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-	✓
	System on Chip	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	-	✓
	System Design using FPGA	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Low Power VLSI	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓
	CAD for VLSI Circuits	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
VERTICAL 2: Signal and Image Processing	DSP Processor Architecture	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Statistical signal Processing	✓	✓	✓	-	-	✓	-	-	-	-	-	✓	-	✓
	Speech Processing	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	-	✓
	Bio-Medical Signal Processing	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	-	✓
	DSP Integrated Circuits	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Radar signal Processing	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	-	✓
	VLSI Signal Processing	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Digital Imaging	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓

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SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
VERTICAL 3: Sensor Technologies and IoT	Sensors and Transducers for IoT	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
	IoT Cloud Computing	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	✓	-
	IoT Architecture and Protocols	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	Industrial IoT	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	-
	IoT Security and Privacy	✓	✓	✓	-	✓	-	-	-	✓	-	-	✓	✓	-
	IoT Based Smart Systems	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	Wearable Sensor Devices	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	✓	-
	Automation using IoT	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-
VERTICAL 4: Multiband Communication	Adhoc and Wireless Sensors Networks	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Advanced Communication System	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Communication Networks	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Optical Networks	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	✓
	Network Security for Communication	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	✓
	Software Defined Networks	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Vehicular Communication Network	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Body Area Networks and Sensors	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	✓
VERTICAL 5: RF and Space Technologies	RF ID System Design and Testing	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	Electromagnetic Interference and Compatibility	✓	✓	✓	-	✓	-	✓	✓	-	-	-	✓	-	✓
	Satellite Communication	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	✓
	Radar and Navigational Aids	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	RF MEMS	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓

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SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	Remote Sensing	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	✓
	Cognitive Radio	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓
	Avionics	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
VERTICAL 6: Emerging and Healthcare Electronics	Nano Electronic Devices	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Fabrication Technologies	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
	Advanced Display Technologies	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	✓
	Flexible Electronics	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	✓
	Medical Electronics	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Bio Telemetry	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	MEMS for Healthcare	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Brain Computing	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓

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B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

REGULATIONS – 2021

For the students admitted 2021 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	U21EC101	Introduction to Electrical and Electronics Engineering	BSC	2	0	0	0	2
2	U21MA101	Calculus and Differential Equations	BSC	3	1	0	0	4
	THEORY COURSE WITH LABORATORY COMPONENT							
3	U21EN101	English for Technologists	HSMC	1	0	2	0	2
4	U21PH101	Engineering Physics	BSC	2	0	2	0	3
5	U21CY101	Engineering Chemistry	BSC	2	0	2	0	3
6	U21CSG01	Problem Solving and C Programming	ESC	2	0	2	0	3
	LABORATORY COURSES							
7	U21MEG02	Manufacturing Practices	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
8	U21MYC01	Induction program	MNC	Three Weeks				
			TOTAL	**12**	**1**	**12**	**0**	**19**

SEMESTER II

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EC201	Circuit Analysis	ESC	3	0	0	0	3
2	U21PH201	Materials Science	ESC	2	0	0	0	2
	THEORY COURSE WITH LABORATORY COMPONENT							
3	U21EN201	Personality Enhancement	HSMC	1	0	2	0	2
4	U21MA206	Linear Algebra and Complex Variables	BSC	3	0	2	0	4
5	U21CSG02	Python Programming	ESC	2	0	2	0	3
6	U21EC202	Electronic Devices and Circuits	PCC	2	0	2	0	3
	LABORATORY COURSES							
7	U21MEG01	Engineering Graphics	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
8	U21MYC02	Environmental Science	MNC	1	0	0	0	0
			TOTAL	**14**	**0**	**12**	**0**	**19**

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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
	MANDATORY NON CREDIT COURSES							
9	U21MYC03	Essence of Indian Traditional Knowledge	MNC	1	0	0	0	0
			TOTAL	18	1	8	2	23

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
	MANDATORY NON CREDIT COURSES							
10	U21MYC04	Indian Constitution	MNC	1	0	0	0	0
			TOTAL	17	0	12	2	23

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SEMESTER V

Sl.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	U21EC505	Electronic hardware Troubleshooting	EEC	0	0	2	0	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	8	2	25

SEMESTER VI

Sl.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	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
MANDATORY NON CREDIT COURSES								
9	U21MYC06	Introduction to UN SDGs: An Integrative Approach	MNC	1	0	0	0	0
	OPTIONAL COURSE							
10	U21EC603	(Live-in-Labs – II)	(HSMC)	3	0	0	0	3
			TOTAL	18	0	8	2	22

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SEMESTER VII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EC703	Project Management and Entrepreneurship	HSMC	3	0	0	0	3
2		Professional Elective – V	PEC	3	0	0	0	3
3		Professional Elective - VI	PEC	3	0	0	0	3
4		Open Elective – IV	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
6	U21EC701	Wireless Communication	PCC	3	0	2	0	4
7	U21EC702	Optical and Microwave Engineering	PCC	3	0	2	0	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
8	U21EC704	Project work Phase - I	EEC	0	0	0	4	2
			TOTAL	18	0	4	4	22

SEMESTER VIII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EC801	Project work Phase - II	EEC	0	0	0	20	10
			TOTAL	0	0	0	20	10

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:

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21NCC01	National Cadet Corp - I	-	1	0	2	0	2
2	U21NCC02	National Cadet Corp - II	-	1	0	2	0	2
3	U21NCC03	National Cadet Corp - III	-	1	0	2	0	2
4	U21NCC04	National Cadet Corp - IV	-	2	0	2	0	3
5	U21NCC05	National Cadet Corp - V	-	1	0	2	0	2
6	U21NCC06	National Cadet Corp - 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 (VLSI Design)	Vertical II (Signal and Image Processing)	Vertical III (Sensor Technologies and IoT)	Vertical IV (Multiband Communication)	Vertical V (RF and Space Technologies)	Vertical VI (Emerging and Healthcare Electronics)
Verilog Programming	DSP Processor Architecture	Sensors and Transducers for IoT	Adhoc and Wireless Sensors Networks	RF ID System Design and Testing	Nano Electronic Devices
VLSI Verification Methodologies	Statistical signal Processing	IoT Cloud Computing	Advanced Communication System	Electromagnetic Interference and Compatibility	Fabrication Technologies
Physical Design Automation	Speech Processing	IoT Architecture and Protocols	Communication Networks	Satellite Communication	Advanced Display Technologies
Analog IC Design	Bio-Medical Signal Processing	Industrial IoT	Optical Networks	Radar and Navigational Aids	Flexible Electronics
System on Chip	DSP Integrated Circuits	IoT Security and Privacy	Network Security for Communication	RF MEMS	Medical Electronics
System Design using FPGA	Radar signal Processing	IoT Based Smart Systems	Software Defined Networks	Remote Sensing	Bio Telemetry
Low Power VLSI	VLSI Signal Processing	Wearable Sensor Devices	Vehicular Communication Network	Cognitive Radio	MEMS for Healthcare
CAD for VLSI Circuits	Digital Imaging	Automation using IoT	Body Area Networks and Sensors	Avionics	Brain Computing

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: VLSI DESIGN

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

VERTICAL 2: Signal and Image Processing

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

VERTICAL 3: Sensor Technologies and IoT

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	U21ECP18	IoT Cloud Computing	PEC	3	0	0	0	3
3	U21ECP19	IoT Architecture and Protocols	PEC	3	0	0	0	3
4	U21ECP20	Industrial IoT	PEC	3	0	0	0	3

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5	U21ECP21	IoT Security and Privacy	PEC	3	0	0	0	3
6	U21ECP22	IoT Based Smart Systems	PEC	3	0	0	0	3
7	U21ECP23	Wearable Sensor Devices	PEC	3	0	0	0	3
8	U21ECP24	Automation using IoT	PEC	3	0	0	0	3

VERTICAL 4: Multiband Communication

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECP25	Adhoc and Wireless Sensors Networks	PEC	3	0	0	0	3
2	U21ECP26	Advanced Communication System	PEC	3	0	0	0	3
3	U21ECP27	Communication Networks	PEC	3	0	0	0	3
4	U21ECP28	Optical Networks	PEC	3	0	0	0	3
5	U21ECP29	Network Security for Communication	PEC	3	0	0	0	3
6	U21ECP30	Software Defined Networks	PEC	3	0	0	0	3
7	U21ECP31	Vehicular Communication Network	PEC	3	0	0	0	3
8	U21ECP32	Body Area Networks and Sensors	PEC	3	0	0	0	3

VERTICAL 5: RF and Space Technologies

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECP33	RF ID System Design and Testing	PEC	3	0	0	0	3
2	U21ECP34	Electromagnetic Interference and Compatibility	PEC	3	0	0	0	3
3	U21ECP35	Satellite Communication	PEC	3	0	0	0	3
4	U21ECP36	Radar and Navigational Aids	PEC	3	0	0	0	3
5	U21ECP37	RF MEMS	PEC	3	0	0	0	3
6	U21ECP38	Remote Sensing	PEC	3	0	0	0	3
7	U21ECP39	Cognitive Radio	PEC	3	0	0	0	3
8	U21ECP40	Avionics	PEC	3	0	0	0	3

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VERTICAL 6: Emerging and Healthcare Electronics

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ECP41	Nano Electronic Devices	PEC	3	0	0	0	3
2	U21ECP42	Fabrication Technologies	PEC	3	0	0	0	3
3	U21ECP43	Advanced Display Technologies	PEC	3	0	0	0	3
4	U21ECP44	Flexible Electronics	PEC	3	0	0	0	3
5	U21ECP45	Medical Electronics	PEC	3	0	0	0	3
6	U21ECP46	Bio Telemetry	PEC	3	0	0	0	3
7	U21ECP47	MEMS for Healthcare	PEC	3	0	0	0	3
8	U21ECP48	Brain Computing	PEC	3	0	0	0	3

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	E-Waste Management	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

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OPEN ELECTIVES – IV (SEMESTER: VII)

Sl.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

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)	2	2	-	1	1	1	3	-	10
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	2	2	10	15
8.	Industrial Training/ Internship	-	-	-	-	-	-	-	2	2
9.	Mandatory Non-Credit Course (MNC)	-	-	-	-	-	-	-	-	-
Total		19	19	23	23	25	22	22	12	165

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SEMESTER I

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)	Category: BSC				
		L	T	P	J	C
		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: Utilize DC machines for real time applications (Apply)
CO3: Explain the construction and operation of AC machines (Understand)
CO4: Compare the principles of various measuring instruments (Apply)
CO5: Summarize the 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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-	-	-	-
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 the knowledge of matrices with the concepts of eigenvalues to study their problems in core areas (Apply)

CO2: Apply the basic techniques and theorems of functions of several variables in other areas of mathematics (Apply)

CO3: Analyze the triple integrals techniques over a region in two dimensional and three dimensional geometry (Apply)

CO4: Apply basic concepts of integration to evaluate line, surface and volume integrals (Apply)

CO5: Solve basic application problems described by second and higher order linear differential equations with constant coefficients (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	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

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

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

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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: Comprehend language and learn strategies for error-free communication (Understand)

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

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

CO4: Evaluate different perspectives on a topic (Analyse)

CO5: Develop listening skills to understand complex business communication in a variety of global english accents through 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" 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

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

CO2: Apply the concepts of fibre optics in engineering (Understand)

CO3: Understand the production methods of ultrasonic waves and uses in engineering and medicine (Understand)

CO4: Apply the concepts of thermal conductivity in hybrid vehicles and viscosity of liquids in engineering applications (Understand)

CO5: Explain the basic concepts of crystals and its growth techniques (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	2	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	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 – Piezoelecrtic 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

U21CY101	ENGINEERING CHEMISTRY (Common to all Programmes)	Category: BSC				
		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 the principles of water technology in treatment of industrial and domestic water and estimate the various constituents of industrial water (Apply)

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

CO3: Outline the different types of corrosion processes and preventive methods adopted in industries (Understand)

CO4: Explain the analysis and calorific value of different types of fuels (Understand)

CO5: Classify the polymers and their engineering applications (Understand)

CO-PO MAPPING:

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

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	2	-	-	-	1	2	2	-	3	-	-
CO2	2	1	1	2	-	-	-	1	2	2	-	2	-	-
CO3	3	2	2	2	-	2	-	1	2	2	-	2	-	-
CO4	3	2	2	2	-	-	-	1	2	2	-	2	-	-
CO5	3	2	2	2	-	-	-	1	2	2	-	2	-	-
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

U21MEG02	MANUFACTURING PRACTICES (Common to all Programmes)	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To provide exposure on workshop tools and additive manufacturing processes
- To provide hands on training experiences in sheet metal, carpentry welding and plumbing operations
- To provide hands on experience on soldering and simple electrical circuit wiring

COURSE OUTCOMES:

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

CO1: Identify the various tools and measuring equipment used for assembly and dismantling practice (Apply)

CO2: Develop simple components using 3D printer (Apply)

CO3: Fabricate products using sheet metal and carpentry (Apply)

CO4: Perform operations such as welding and plumbing (Apply)

CO5: Connect and test the electrical and electronics components for the given circuit diagram (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I PRODUCT WORKSHOP **6**

Disassemble the product of sub assembly – Measure various dimensions using measuring instruments. Free hand rough sketch of the assembly and components – Name of the components and indicate the various materials used – Study the functioning of the assembly and parts – Study the assembly and components design for compactness – Processing – Ease of assembly and disassembly – Assemble the product or subassembly

UNIT II ADDITIVE MANUFACTURING WORKSHOP **6**

Study of 3 axis 3D printing machine – Methods of 3D printing – SLA and FDM methods – Pre – processing – Geometry creation – Support generation and slicing – Post Processing – Requirement and Techniques Support Removal – Sanding – Acetone treatment – Polishing

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UNIT III SHEET METAL AND CARPENTRY WORKSHOP 6

Study of tools and equipment – Draw development drawing of simple objects on sheet metal (cone – Cylinder – Pyramid – Prism – Tray etc.) – Fabrication of components using small shearing and bending machines – Riveting practice – Study of carpentry process – Fabrication of wood joints like Lap – Tee – Dovetail and mortise & tenon joint

UNIT IV WELDING AND PLUMBING WORKSHOP 6

Study of tools and equipment – Study of various welding – Arc welding practice – Fitting – Square butt joint and lap joint – Plumbing tools – Make a piping joint to a simple piping layout (should include cutting – Threading and pipe fixing)

UNIT V ELECTRICAL AND ELECTRONICS ENGINEERING WORKSHOP 6

Study of tools and equipment – Study of basic electrical components and symbols – Simple Wiring – Staircase Wiring – fluorescent wiring – Study of soldering tools and methods of soldering

LIST OF EXPERIMENTS

1. Study on measuring instruments used in workshop practices.
2. Dismantling, measuring and reassembling of centrifugal pump.
3. 3D prototyping of simple components using FDM method.
4. 3D Printing of simple geometric shapes using SLA printer
5. Fabrication of sheet metal tray and funnel
6. Fabrication of wood joints
7. Preparation of MS plate for Lap, butt and Tee joints using arc welding
8. Installation of water lines for washbasin and showers faucets
9. Preparation of wiring for tube light, staircase and electric fan
10. Soldering of a simple circuit consists of THC and SMD components

Contact Periods:

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

Total: 60 Periods

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Mechanical Engineering", Media Promoters, 11th edition, 2010
2. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy the Elements of Workshop Technology – Vol I & II, Media Promoters and Publishers, Mumbai, 11th edition 2001

REFERENCES:

1. Workshop manual prepared by Department of Mechanical Engineering

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 II

U21EC201	CIRCUIT ANALYSIS	Category: ESC				
		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 (Apply)
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	-	-	-	-	-	-	-	-	-	2	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	2	-	1
CO3	3	3	2	-	2	-	-	-	-	-	-	2	-	1
CO4	2	-	-	-	-	-	-	-	-	-	-	2	-	1
CO5	2	-	-	-	-	-	-	-	-	-	-	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:

3. William H. Hayt, Jr. Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis", 8th edition, McGraw Hill, 2018
4. 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				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*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: Demonstrate the electrical characteristics of conducting materials (Understand)

CO2: Interpret the properties and types of semiconducting materials (Understand)

CO3: Compare various types of magnetic materials for engineering applications (Understand)

CO4: Explain the fundamental concepts of dielectric and optical materials (Understand)

CO5: Examine new engineering materials for industrial 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	-	-
CO2	3	2	-	-	-	1	-	-	-	-	-	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 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					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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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 in speech and writing (Analyse)

CO4: Negotiate and lead teams towards success (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:

<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>
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<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>
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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 the concepts of the linear system of equations to solve core engineering problems (Apply)

CO2: Compare the linear independence and dependence of vectors and basis of vector space (Understand)

CO3: Analyze the complex functions and their mapping in certain complex planes (Understand)

CO4: Evaluate complex contour integrals directly and use the Cauchy integral theorem in its various versions (Understand)

CO5: Compute the residues of a function at given points or singularities and use the residue theorem to evaluate a contour integral (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	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	-	-
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:

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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 operations of tokens in python (Understand)
CO2: Demonstrate the programs using control statements (Apply)
CO3: Develop programs using python data structures (Apply)
CO4: Implement the exceptions in file-handling concepts (Apply)
CO5: Apply the python libraries in real-world problems (Apply)

CO-PO MAPPING:

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

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

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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:

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</table>

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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 fundamentals of semiconductor materials (Understand)

CO2: Construct electronic circuits using the PN junction diode for various applications (Apply)

CO3: Experiment with BJT and JFET characteristics (Apply)

CO4: Implement the biasing of BJT using suitable methods (Apply)

CO5: Analyze the frequency response of CE amplifier (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	1
CO2	3	2	-	2	2	-	-	2	2	2	-	2	2	1
CO3	3	2	-	2	-	-	-	2	2	2	-	2	2	1
CO4	3	2	-	2	-	-	-	2	2	2	-	2	2	1
CO5	3	3	2	2	2	-	-	2	2	2	-	2	2	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 and FET
5. Frequency response analysis of RC coupled CE amplifier using simulation tool
6. 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	
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40	60	75	25		
25		25		25	25
50				50	
Total: 100					

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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 (Apply)

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

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 (Apply)

CO PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	3	2	2	-	3	-	-	-	-	3	-	1	-	-
CO4	3	2	2	-	3	-	-	-	-	3	-	1	-	-
CO5	3	2	2	-	3	-	-	-	-	3	-	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 and the moments of discrete and continuous random variables to core engineering problems (Apply)

CO2: Use discrete probability distributions including requirements, mean and variance for making decisions (Understand)

CO3: Compare correlation and linear regression with respect to two dimensional random variables (Understand)

CO4: Analyze the simple classes of discrete random processes to model random arrivals (Understand)

CO5: Compare correlation functions and spectral density functions based on the properties (Understand)

CO-PO MAPPING:

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

UNIT II DISTRIBUTION FUNCTIONS **9**

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

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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					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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SEMESTER III

U21EC301	SIGNALS AND SYSTEMS	Category: PCC				
		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 various types of signals and systems with its properties (Understand)

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

CO3: Analyze the continuous time linear time invariant systems using Laplace transform (Analyze)

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

CO5: Examine discrete time linear time invariant systems using Z-transform (Analyze)

CO-PO MAPPING:

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

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

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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					
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 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: Apply the multistage concept to improve gain of 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	-	-	-	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-	2	-	2
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

U21EC303	ANALOG COMMUNICATION	Category: PCC				
		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: Apply suitable amplitude modulation technique for analog communication (Apply)
CO2: Outline the performance of angle modulation techniques (Understand)
CO3: Classify various pulse modulation systems (Understand)
CO4: Examine the performance of different transmitters and receivers (Analyze)
CO5: Explain 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	2	-	-	-	-	-	-	-	-	2	-	3
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO4	3	3	2	-	-	-	-	-	-	-	-	-	-	3
CO5	2	1	-	-	-	-	-	-	-	-	-	-	-	3
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					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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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: Explain the concept of linear and non-linear data structures (Understand)

CO2: Demonstrate stack and queue with suitable applications (Apply)

CO3: Implement various searching, sorting, and hashing techniques (Apply)

CO4: Analyze non-linear data structures – trees (Apply)

CO5: Implement various problems in graph data structures (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	-	-	-	1	2	2	-	3	-	-
CO2	2	2	2	2	-	-	-	1	2	2	-	3	-	-
CO3	3	3	2	2	-	-	-	1	2	2	-	3	-	-
CO4	3	3	2	2	-	-	-	1	2	2	-	3	-	-
CO5	3	3	2	2	-	-	-	1	2	2	-	3	-	-
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>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 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: Model the PLL and 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	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	3	2	-	2	-	-	-	2	2	2	-	2	-	2
CO3	3	2	-	2	-	-	-	2	2	2	-	2	-	2
CO4	3	2	-	2	-	-	-	2	2	2	-	2	-	2
CO5	3	3	2	2	-	-	-	2	2	2	-	2	-	2
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 the inverting and non-inverting amplifiers, integrator and differentiator, active low-pass and high-pass filters using op-amp
2. Design and implement schmitt trigger using op-amp
3. Generate a sinusoidal waveform generator using op-amp
4. Construct a DC power supply using IC regulators
5. Design and construct the multivibrators using op-amp and NE555
6. Construct the D/A converter using op-amp

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					

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SEMESTER III

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)	Category: PCC				
		L	T	P	J	C
		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 gates (Apply)
CO3: Examine the performances of latches and flip-flops (Analyze)
CO4: Construct sequential logic circuits using flip-flops (Apply)
CO5: Design hazard free circuit for asynchronous sequential circuit (Analyze)

CO-PO MAPPING:

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

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:

<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>
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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: Analyze the performance of differential amplifier circuit (Analyze)
CO2: Examine the characteristics of negative feedback amplifier (Analyze)
CO3: Construct LC and RC oscillator circuits (Apply)
CO4: Build tuned amplifier and power amplifier circuits using BJT (Apply)
CO5: Utilize active and passive electronic components 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	3	2	3	-	-	-	2	2	2	-	2	-	2
CO2	3	3	2	3	-	-	-	2	2	2	-	2	-	2
CO3	3	2	2	3	-	-	-	2	2	2	-	2	-	2
CO4	3	2	2	3	-	-	-	2	2	2	-	2	-	2
CO5	3	2	2	3	2	-	-	2	2	2	-	2	-	2
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. Construct voltage shunt feedback amplifier and obtain the frequency response
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
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

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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><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><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>40</td></tr>
<tr><td colspan="5">60</td><td>40</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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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: Illustrate the coordinate systems and basic theorems of static electric field (Understand)
CO2: Summarize the basic laws and theorems of static magnetic field (Understand)
CO3: Explain the boundary conditions of dielectric and magnetic materials (Understand)
CO4: Apply various time varying conditions for electromagnetic wave propagation (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	-	-	-	-	2	2	-	-	-	-	2	-	2
CO2	2	-	-	-	-	2	2	-	-	-	-	2	-	2
CO3	2	-	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	3	2	-	-	2	2	-	-	-	-	2	-	2
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: Summarize the effects of finite word length (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	-	-	2	-	-	-	-	-	-	2	-	2
CO2	3	2	-	-	2	-	-	-	-	-	-	2	-	2
CO3	3	3	2	-	2	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	2	-	-	-	-	-	-	2	-	2
CO5	2	-	-	-	2	-	-	-	-	-	-	2	-	2
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:

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

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 signaling schemes

COURSE OUTCOMES:

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

CO1: Explain the concepts of channel coding schemes (Understand)

CO2: Summarize various waveform coding concepts (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 transmission (Apply)

CO-PO MAPPING:

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

<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

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: Describe the object-oriented programming concepts to develop simple java programs (Understand)

CO2: Develop Java programs using Inheritance principle (Apply)

CO3: Apply exception handling techniques in Java programs (Apply)

CO4: Develop Java programs with Input Output classes and multithreading (Apply)

CO5: Implement Java programs with Collections (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	2	-	-
CO2	3	2	2	2	-	-	-	1	2	2	-	2	-	-
CO3	3	2	2	2	-	-	-	1	2	2	-	2	-	-
CO4	3	2	2	2	-	-	-	1	2	2	-	2	-	-
CO5	3	2	2	2	-	-	-	1	2	2	-	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 ALU operations using 8086 microprocessor (Apply)
CO2: Apply the 8086 interfacing concepts for different applications (Apply)
CO3: Compare different addressing modes of 8051 microcontroller (Analyze)
CO4: Explain the concepts of interrupts and timers in 8051 microcontroller (Understand)
CO5: Develop solutions for real time applications using 8051 microcontrollers (Analyze)

CO-PO MAPPING:

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

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

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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. Interfacing of stepper motor with 8051
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

U21SSG01	SOFT SKILLS – I	Category: HSMC				
		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 (Analyse)

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: Analyze AM and FM schemes in terms of modulation index (Analyze)

CO2: Compute appropriate sampling rate for analog to digital conversion (Apply)

CO3: Experiment with various waveform coding schemes (Apply)

CO4: Examine the SNR and BER of various digital modulation techniques (Analyze)

CO5: Implement digital transmission using error detection and correction technique (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	-	-	-	2	2	2	-	-	-	3
CO2	3	2	-	3	-	-	-	2	2	2	-	-	-	3
CO3	3	2	-	3	-	-	-	2	2	2	-	-	-	3
CO4	3	3	2	3	2	-	-	2	2	2	-	-	-	3
CO5	3	2	-	3	2	-	-	2	2	2	-	-	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

LIST OF EXPERIMENTS

1. AM modulation and demodulation
   i. Analyze the amplitude modulation in terms of modulation index and perform the spectrum analysis.
2. FM modulation and demodulation
   i. Perform frequency modulation and spectrum analysis for the given analog signal
   ii. Calculate the modulation index and identify the type of frequency modulation.
3. Signal sampling and reconstruction
   i. Consider the given analog signal and calculate the required sampling rate.
   ii. Perform sampling with various sampling rate and reconstruct the original signal.
4. Pulse position modulation technique
   i. With the help of sampling pulses, modulate the given message signal using PPM technique.

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5. Pulse Coding for analog sources
    i. Consider the given analog audio signal and convert it into binary sequence using pulse code modulation and reconstruct the original signal.
6. Delta and adaptive delta modulation techniques
    i. Convert the analog input signal into binary sequence using delta modulation.
    ii. Also analyze the impact of step size and sampling period on the staircase reconstructed signal.
7. Line coding
    i. Generate the baseband signal for the given binary sequence with the help of following line coding techniques
        a. Unipolar
        b. Bipolar
        c. Manchester
8. Linear block error control coding scheme
    i. Write a code to generate (n,k) linear block code for the given message vector and perform the error detection and correction using syndrome vector
9. Digital modulation techniques
    i. Write a code to generate ASK and FSK for a given message signal and analyze the performance of SNR and BER
    ii. Write a code to generate BPSK and QPSK for a given message signal and analyze the performance of SNR and BER
    iii. Write a code to generate constellation diagram for BPSK and QPSK

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: Develop MATLAB code to perform convolution and correlation (Analyze)
CO2: Inspect the frequency spectrum using DFT (Analyze)
CO3: Examine the frequency response of FIR and IIR filters (Analyze)
CO4: Analyze ECG and EEG signals using MATLAB (Analyze)
CO5: Implement DFT and FFT computations using DSP processor (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	2	2	2	-	2
CO2	3	3	2	2	2	-	-	2	2	2	2	2	-	2
CO3	3	3	2	2	2	-	-	2	2	2	2	2	-	2
CO4	3	3	2	2	2	-	-	2	2	2	2	2	-	2
CO5	3	2	-	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.
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.

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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. 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

Contact Periods:

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

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EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Practical) (100 Marks)		**Assessment II (Project) (100 Marks)**			**Practical Examinations (Examinations will be conducted for 100 Marks)**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	Review I	Review II	Review III	
75	**25**	**15**	**25**	**60**	
200					**40**
60					**40**
Total: 100					

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SEMESTER V

U21EC501	TRANSMISSION LINES AND ANTENNAS	Category: PCC				
		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 the basic radiation parameters of antennas (Understand)

CO4: Implement the field and phase patterns of aperture and array antennas (Apply)

CO5: Explain the radiation pattern of special and modern antennas (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	2	-	3
CO2	3	3	2	-	-	-	-	-	-	-	-	2	-	3
CO3	2	-	-	-	2	2	2	-	-	-	-	2	-	3
CO4	3	2	2	-	2	2	2	-	-	-	-	2	-	3
CO5	2	-	-	-	-	2	2	-	-	-	-	2	-	3
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 for dynamical 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 the 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	-	-	-	-	-	-	-	-	-	-	2	-	1
CO2	2	-	-	-	2	-	-	-	-	-	-	2	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	2	-	1
CO4	3	2	2	-	2	-	-	-	-	-	-	2	-	1
CO5	3	2	2	-	-	-	-	-	-	-	-	2	-	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: Solve the topology issues in physical layer (Apply)

CO2: Model the error detection and correction mechanism for data-link layer (Apply)

CO3: Implement suitable routing protocols for the networks (Apply)

CO4: Examine the functions of transport layer protocols (Analyze)

CO5: Compare the performance of different application layer protocols (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	2	2	2	-	2	-	1
CO2	3	2	-	-	2	-	-	2	2	2	-	2	-	1
CO3	3	2	-	-	2	-	-	2	2	2	-	2	-	1
CO4	3	3	2	-	2	-	-	2	2	2	-	2	-	1
CO5	3	3	2	-	2	-	-	2	2	2	-	2	-	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. CSMA/CD and CSMA/CA protocols
4. High Level Data Link Control
5. IP address configuration and execution of IP commands
6. Distance vector routing algorithm
7. Link state routing algorithm
8. Stop and wait and sliding window protocols
9. Go-back-N and selective repeat protocols
10. TCP congestion control algorithm

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

		Category: HSMC				
U21SSG02	SOFT SKILLS - II	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: Determine the radiation pattern of horn and parabolic reflector antennas (Apply)
CO2: Design RF low pass and high pass filters for given cut off frequency (Analyze)
CO3: Test the performance of wired and array antennas using simulation tools (Apply)
CO4: Compute the return loss and isolation of RF couplers and isolators (Apply)
CO5: Develop the microstrip antenna for real time application (Analyze)

CO-PO MAPPING:

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

II. SIMULATION EXPERIMENTS

1. Measurement of antenna parameters of dipole antenna
2. Parametric analysis of array antenna using frequency domain solver
3. Design of couplers and isolators for RF systems
4. Design of microstrip antenna for Wi-Fi application

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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><th colspan="2">Assessment I (Practical) (100 Marks)</th><th colspan="3">Assessment II (Project) (100 Marks)</th><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>40</td></tr>
<tr><td colspan="5">60</td><td>40</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER V

U21EC505	ELECTRONIC HARDWARE TROUBLESHOOTING	Category: EEC				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- U21EC305: Analog Electronics Laboratory

COURSE OBJECTIVES:

- To understand the process of identification and testing of various electronic components and instruments
- To introduce the troubleshooting methods of various electronic circuits
- To learn the testing procedure of PCB layout design

COURSE OUTCOMES:

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

CO1: Analyze the faults present in various electronic components and instruments (Analyze)
CO2: Experiment with simple electronic circuits for troubleshooting errors (Apply)
CO3: Examine the PCB interconnections for proper electrical conduction (Analyze)
CO4: Apply the testing methods for fault diagnosis of appliances (Apply)
CO5: Test the working of power inverters and power supplies (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	2	2	-	-
CO2	3	2	2	2	-	-	-	2	2	2	2	2	-	-
CO3	3	3	2	2	-	-	-	2	2	2	2	2	-	-
CO4	3	2	2	2	-	-	-	2	2	2	2	2	-	-
CO5	3	2	2	2	-	-	-	2	2	2	2	2	-	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

LIST OF EXPERIMENTS

1. Trouble shooting and testing of breadboard, diode and transistors.
2. Soldering and de-soldering practices to repair electronic gadgets.
3. Trouble shooting and testing of digital multimeter and function generator.
4. Troubleshooting of power supplies
5. Troubleshooting of power inverters
6. Identification of faulty electronic components in PCB
7. Testing of simple audio amplifiers
8. Testing of functioning of CRO
9. Troubleshooting and testing of display devices

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Contact Periods:

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

Total: 30 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 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 real time embedded system and its components (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 the given application (Analyze)

CO5: Apply knowledge 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	-	-	-	-	-	-	-	-	-	-	2	3	-
CO2	2	-	-	-	-	-	-	-	-	-	-	2	3	-
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	-
CO4	3	3	2	-	2	-	-	-	-	-	-	2	3	-
CO5	3	2	2	-	-	-	-	-	-	-	-	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

		Category: PCC				
U21EC601	VLSI Design	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 diagram of CMOS circuits (Apply)

CO3: Model sequential logic circuits and memories using CMOS (Apply)

CO4: Apply appropriate subsystem for arithmetic circuit design (Apply)

CO5: Develop real time applications 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	3	2	-	-	2	2	2	-	2	-	3
CO2	3	2	2	3	2	-	-	2	2	2	-	2	-	3
CO3	3	2	2	3	2	-	-	2	2	2	-	2	-	3
CO4	3	2	2	3	2	-	-	2	2	2	-	2	-	3
CO5	3	3	2	3	2	-	-	2	2	2	-	2	-	3
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

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

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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 DC transfer characteristics of CMOS inverter
2. Simulation of combinational circuits using CMOS logic
3. Simulation of sequential circuits using CMOS logic
4. Layout design of combinational circuits and sequential circuits
5. Design and Implementation of combinational circuits using FPGA
6. Design and Implementation of sequential circuits using FPGA

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 (For EC)	Category: ESC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21CSG02 : Python Programming

COURSE OBJECTIVES:

- To introduce the fundamentals of artificial intelligence and intelligent agents
- To learn the methods of knowledge representation and knowledge inference
- To understand the concepts of expert systems

COURSE OUTCOMES:

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

CO1: Exemplify the fundamentals of Artificial Intelligence and Intelligent agents. (Understand)
CO2: Identify appropriate methods to solve AI problems. (Understand)
CO3: Differentiate game theory and CSP. (Understand)
CO4: Discuss the concepts of logical agents. (Understand)
CO5: Use different methodologies to represent and infer knowledge. (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	-	3	3	-
CO2	3	3	2	-	2	-	-	-	-	2	-	3	3	-
CO3	3	3	2	-	2	-	-	-	-	2	-	3	3	-
CO4	3	3	2	-	2	-	-	-	-	2	-	3	3	-
CO5	3	3	2	-	2	-	-	-	-	2	-	3	3	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I INTELLIGENT AGENTS 9

Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments – Structure of agents – Problem solving agents – Search algorithms – Uninformed search strategies

UNIT II PROBLEM-SOLVING METHODS 9

Heuristic search strategies – Heuristic functions – Local search and optimization problems – Local search in continuous space – Search with nondeterministic actions – Search in partially observable environments – Online search agents and unknown environments

UNIT III GAME PLAYING AND CSP 9

Game theory – Optimal decisions in games – Alpha-beta search – Monte-carlo tree search – Stochastic games – Partially observable games – Constraint satisfaction problems – Constraint propagation – Backtracking search for CSP – Local search for CSP – Structure of CSP

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UNIT IV LOGICAL AGENTS 9

Knowledge-based agents – Propositional logic – Propositional theorem proving – Propositional model checking – Agents based on propositional logic First-order logic – Syntax and semantics – Knowledge representation and engineering – Inferences in first-order logic – Forward chaining – Backward chaining – Resolution

UNIT V KNOWLEDGE REPRESENTATION AND PLANNING 9

Ontological engineering – Categories and objects – Events – Mental objects and modal logic – Reasoning systems for categories – Reasoning with default information Classical planning – Algorithms for classical planning – Heuristics for planning – Hierarchical planning – Non-deterministic domains – Time, schedule and resources – Analysis

LIST OF EXPERIMENTS

1. Working with default and user defined datasets. (.xls and .csv)
2. Implement basic search strategies for selected AI applications
3. Implement genetic algorithms for AI tasks
4. Implement backtracking algorithms for CSP
5. Implement local search algorithms for CSP
6. Implement propositional logic inferences for AI tasks
5. Implement classical planning algorithms

Contact Periods:

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

TEXT BOOKS:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence", 3rd Edition, Mc Graw Hill, 2019
2. Dennis Rothman, "Artificial Intelligence by Example: Develop Machine Intelligence from Scratch using Real Artificial Intelligence Use Cases", 1st Edition, Packt Publishing, 2018
3. Dan W. Patterson, "Introduction to AI and ES", 1st Edition, Pearson Education,

REFERENCES:

1. Deepak Khemani "Artificial Intelligence", 1st Edition, Tata Mc Graw Hill Education, 2013
2. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007
3. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education, 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)
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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

		Category: HSMC				
U21SSG03	SOFT SKILLS - III	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 (Analyse)

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: Construct an LED based running display with different brightness level (Apply)
CO2: Develop an LCD based system for character display (Analyze)
CO3: Experiment with ARM Processor for speed control of stepper motor (Apply)
CO4: Utilize the IoT platform for data transmission and reception (Apply)
CO5: Implement the concept of IoT for providing solutions to real world applications (Analyze)

CO-PO MAPPING:

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

LIST OF EXPERIMENTS

1. Interfacing LED to toggle at equal time delay using Arduino.
2. Interfacing of LED circuit for various intensity levels with different duty cycles using LPC2148 and MSP430
3. Display a character in a 16x2 LCD using LPC2148.
4. Stepper motor to rotate in clockwise and anti-clockwise direction using LPC2148.
5. Real Time Clock using LPC2148
6. PIR sensor based object detection using LPC2148
7. IoT based Gas monitoring system using MQ5 sensor

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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. Room temperature control using LM35 sensor

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>40</td></tr>
<tr><td colspan="5">60</td><td>40</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER VII

		Category: PCC				
U21EC701	**WIRELESS COMMUNICATION**	**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: Construct various multiple access methods for data transmission (Apply)
CO2: Examine the performance of mobile radio propagation models (Analyze)
CO3: Develop the system to identify the errors in fading channel (Analyze)
CO4: Apply multipath mitigation techniques to determine the error probability (Apply)
CO5: Experiment with MIMO antennas using simulation software (Apply)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	–	–	2	2	2	–	2	–	2
CO2	3	3	2	2	2	–	–	2	2	2	–	2	–	2
CO3	3	3	2	2	2	–	–	2	2	2	–	2	–	2
CO4	3	2	2	2	2	–	–	2	2	2	–	2	–	2
CO5	3	2	2	2	2	–	–	2	2	2	–	2	–	2
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. Analyse the performance of rake receiver using multipath channels with diversity reception using simulation tool

5. Simulation of MIMO system
   i. Channel capacity 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

		Category: PCC				
U21EC702	OPTICAL AND MICROWAVE ENGINEERING	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 basic principles of optical fiber systems (Understand)
CO2: Apply appropriate sources and detectors for optical data transmission (Apply)
CO3: Implement suitable passive and active components for microwave applications (Apply)
CO4: Utilize the microwave sources for generation of microwave signals (Apply)
CO5: Develop a microwave test bench using microwave components for microwave measurements (Analyze)

CO-PO MAPPING:

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

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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

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. DC characteristics of LED
3. VI and PI characteristics of PIN photo diode
4. Characteristics of Reflex klystron and Gunn diode
5. Measurement of VSWR, frequency and wavelength using Reflex klystron
6. 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:

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(100 Marks)</th><th colspan="2">Assessment II
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(100 Marks)</th></tr>
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<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>35</td><td>15</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER VII

		Category: HSMC				
U21EC703	PROJECT MANAGEMENT AND ENTREPRENEURSHIP	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the project, project life cycle, roles, challenges and importance of project management.
- To learn the key aspects of managing risks in project proposals.
- To study the entrepreneurial competencies efficiently and effectively.

COURSE OUTCOMES:

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

CO1: Explain the fundamentals of project management (Understand)

CO2: Illustrate the risk management and mobilizing the project resources (Understand)

CO3: Classify various appraisal and evaluation techniques (Understand)

CO4: Examine the entrepreneurial skills in business (Apply)

CO5: Develop the competencies for effective business management (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I BASICS OF PROJECT MANAGEMENT 9

Project Management – Definition –Goal – Lifecycles – Project environment – Project manager – Roles- Responsibilities and selection

UNIT II PLANNING, BUDGETING AND RISK MANAGEMENT 9

The Planning Process – Work Break down Structure – Cost estimating and budgeting – Process, summaries, schedules and forecasts – Managing risks – Concepts, identification, assessment and response planning

UNIT III PROJECT APPRAISAL AND EVALUATION 9

Introduction – Technical appraisal – Commercial appraisal – Economic appraisal – Financial appraisal – Management appraisal – PERT & CPM Networks – Project durations and floats –Crashing – Capital budgeting – Discounted and non-discounted cash flow techniques

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UNIT IV ENTREPRENEURAL COMPETENCE AND BUSINESS 9

Entrepreneurship concept – Entrepreneurship as a Career – Personality, characteristics, knowledge and skills of a successful entrepreneur – Sources of product for business – Prefeasibility study – Criteria for selection of product project profile preparation

UNIT V BUSINESS PLAN AND LAUNCHING OF SMALL BUSINESS 9

Matching entrepreneur with the project – Feasibility report preparation and evaluation criteria. Finance and human resource mobilization – Operations planning – Market and channel selection - Growth strategies – Product launching – Incubation, venture capital, start-ups

Contact Periods:

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

TEXT BOOKS:

1. Panneerselvam. R, Senthilkumar. P, Project Management, PHI Learning, 1st edition, 2009
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 1st edition, 2016

REFERENCES:

1. John M. Nicholas, Project Management for Business and Technology - Principles and Practice, 2nd edition, Pearson Education, 2006
2. Dr. Vasant Desai, "Small Scale Industries and Entrepreneurship", HPH, 1st edition, 2006
3. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 8th edition, 2017
4. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th edition, Pearson Education, 2004

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 VII

		Category: EEC				
U21EC704	PROJECT WORK PHASE - I	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: Formulate the specific problem statements for real life problems with the fundamental knowledge of Electronics and Communication engineering (Apply)

CO2: Conduct a comprehensive literature review in the appropriate project domain (Understand)

CO3: Identify the methodology and apply the suitable modern tools and techniques to get desired solution through individual and team work (Apply)

CO4: Design and simulate circuits / systems / algorithms with ethical guidelines and considerations related to the project work (Analyze)

CO5: Demonstrate the project through effective presentation and document the technical reports (Apply)

CO–PO MAPPING:

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

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SEMESTER VIII

U21EC801	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: Identify, formulate and analyze the problem statements with appropriate consideration of societal needs (Apply)

CO2: Design and develop solutions based on electronics and communication system using modern tools/equipment /software (Apply)

CO3: Apply ethical principles and professional practices throughout the project (Apply)

CO4: Analyze, synthesize the results to provide the solutions for real life problem (Evaluate)

CO5: Demonstrate the working model as an individual / team and organize the results in form of technical reports (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	3	-	2	-	-	2	3	3
CO2	-	-	3	3	3	2	2	-	2	-	-	2	3	3
CO3	-	-	-	-	-	-	-	3	-	-	-	2	3	3
CO4	-	-	3	3	3	3	3	1	2	-	-	2	3	3
CO5	-	-	-	-	-	-	-	-	3	3	3	2	3	3

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

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VERTICAL 1: VLSI DESIGN

U21ECP01	VERILOG PROGRAMMING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ECG01: Digital Electronics

COURSE OBJECTIVES:

- To learn various types of modeling 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: Compare gate level and dataflow modeling in Verilog HDL (Understand)
CO2: Summarize various statements and blocks in behavioral modelling (Understand)
CO3: Construct combinational and sequential circuits using Verilog HDL (Apply)
CO4: Compare the delay performance of various modelling techniques (Analyze)
CO5: Outline the concept of system Verilog and its functional elements (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I HIERARCHICAL MODELING CONCEPTS **9**

Overview of digital design with verilog HDL – Modules and ports – Gate level modeling – Dataflow modeling – Continuous assignments, delays, operators

UNIT II BEHAVIORAL MODELING **9**

Structured procedures – Procedural assignments – Timing controls – Conditional statements – Multiway branching – Loops – Sequential and parallel blocks – Generate blocks

UNIT III VERILOG HDL MODELS **9**

Verilog HDL Models – Decoders, encoders, multiplexers and de-multiplexers, comparators, adders and subtractors – Latches and flip-flops, counters, shift register – Design examples (using Verilog HDL) - Barrel shifter

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UNIT IV DELAYS AND SWITCH LEVEL MODELING 9

Types of delay models – Path delay modeling – Timing checks – Delay back annotation Switch modeling elements – Implementation of CMOS NAND, NOR, multiplexer, flip-flop

UNIT V SYSTEM VERILOG 9

System verilog variables – Structures – Union – Arrays – Tasks and functions – Design hierarchy – Module prototype, net aliasing – Interfaces

Contact Periods:

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

Total: 45 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 and VHDL" 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

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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U21ECP02	VLSI VERIFICATION METHODOLOGIES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the verification guidelines and various data types.
- To learn procedural statements and interfacing design with test bench.
- To study UVM testing and verification using test bench.

COURSE OUTCOMES:

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

CO1: Explain the fundamentals of verification process (Understand)

CO2: Summarize the various data types in verification methods (Understand)

CO3: Illustrate the procedural statements and routines (Understand)

CO4: Apply interfacing concepts for system Verilog test bench (Apply)

CO5: Model combinational circuits using universal verification methodology (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I VERIFICATION PROCEDURES **9**

Introduction to verification process – Verification methodology – Test bench functionality – Direct testing and methodology basics – Randomization – Functional coverage – Test bench components – Layered test bench – Simulation of verification scenarios – Code reuse and test bench performance

UNIT II DATA TYPES **9**

Build-in data types – Fixed size array – Dynamic arrays – Queues – Associative arrays – Array methods – Storage type – New types with typedef and user defined structures – Packages – Conversion types – Streaming operations – Enumerated types

UNIT III PROCEDURAL STATEMENTS AND ROUTINES **9**

Procedural statements – Tasks, functions and void functions overview – Routine arguments and return – Local data storage – Time values

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UNIT IV DESIGN AND TESTBENCH INTERFACE 9

Testbench and design separation – Construction of interface – Stimulus timing – Driving and sampling interface – Program blocks – Top level scope and program module interactions – System Verilog assertions – Four port ATM router – Ref port direction

UNIT V UNIVERSAL VERIFICATION METHODOLOGY 9

Components – Environments – Tests – Reporting – Transactions – Agents – Sequences – New paradigm – Multiple objects – Analysis reports in a testbench

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Ray Salemi, "The UVM Primer, An Introduction to the Universal Verification Methodology", 1st edition, 2013
2. Chris Spear, Greg Tumbush, "System Verilog for Verification: A Guide to Learning the Testbench Language Features", 3rd edition, 2012

REFERENCES:

1. Ashok B. Mehta, "System Verilog Assertions and Functional Coverage Guide to Language, Methodology and Applications", 2nd edition, Mehta Publisher, 2014
2. Vanessa R. Cooper, "Getting Started with UVM: A Beginner's Guide", 1st edition, Kindle Edition, Verilab Publishing, 2013
3. Sharon Rosenberg, Kathleen Meade, "A Practical Guide to Adopting the Universal Verification Methodology (UVM)" 2nd edition, Cadence Design Systems, 2013
4. Srikanth Vijayaraghavan, Meyyappan Ramanathan "A Practical Guide for System Verilog Assertions", 1st edition, Springer New York Publisher, 2005

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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U21ECP03	PHYSICAL DESIGN AUTOMATION	Category: PEC				
		L	T	P	J	C
		3	0	0	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: Illustrate the algorithms for partitioning, placement and floor planning (Understand)

CO3: Summarize the algorithms for routing and compaction (Understand)

CO4: Apply the optimized gate level representation to combinational circuits (Apply)

CO5: Develop the physical design automation using FPGA (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I VLSI DESIGN FLOW **9**

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 **9**

Circuit representation – Placement algorithms – KL partitioning algorithm – Floor planning – Linear programming algorithm – Representation and optimization – Shape functions and floor plan sizing

UNIT III ROUTING AND COMPACTION **9**

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 9

Simulation – Gate-level modeling – Switch-level modeling – Combinational logic synthesis using simulation tool – Binary decision diagrams – ROBDD – Two level logic synthesis – Scheduling algorithm

UNIT V PHYSICAL DESIGN AUTOMATION OF FPGA AND MCM 9

FPGA and MCM technologies – MCM and FPGA physical design cycle – Partitioning – Placement – Routing – Routing algorithm for the non-segmented and segmented model

Contact Periods:

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

Total: 45 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:

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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U21ECP04	ANALOG IC DESIGN	Category: PEC				
		L	T	P	J	C
		3	0	0	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: Explain the fundamental concepts of MOS transistors (Understand)

CO2: Illustrate the operation of different current mirror circuits (Understand)

CO3: Examine the frequency response and noise effects in MOS amplifiers (Analyze)

CO4: Determine the performance parameters of op-amp (Apply)

CO5: Summarize the principle of various switched capacitor amplifiers (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I MOS DEVICE PHYSICS AND SINGLE STAGE AMPLIFIERS **9**

MOS I/V characteristics – Second-Order effects – MOS device capacitances – MOS small-signal model – long channel versus short channel devices – Common Source stage with resistive load - Diode Connected load – Current Source load – Source follower.

UNIT II DIFFERENTIAL AMPLIFIERS AND CURRENT MIRRORS **9**

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 **9**

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 9

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 9

Temperature independent references – PTAT current generation – Constant GM biasing – sampling switches – Switched capacitor amplifiers – Switched capacitor Common Mode feedback amplifiers– Switched capacitor integrator – Nonlinearity and mismatch – Simulation of switched capacitor filter design.

Contact Periods:

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

Total: 45 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, 2013
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

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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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 understand the importance of co-ware design
- 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	-	-	-	-	-	-	-	2	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	2	-	-	2	-	2
CO3	3	3	2	-	2	-	-	-	2	-	-	2	-	2
CO4	3	2	2	-	-	-	-	-	2	-	-	2	-	2
CO5	2	1	-	-	-	-	-	-	2	-	-	2	-	2
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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21ECP06	SYSTEM DESIGN USING FPGA	Category: PEC				
		L	T	P	J	C
		3	0	0	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: Summarize the inputs and outputs of programming in ASIC (Understand)
CO4: Illustrate the various FPGA architecture and logic synthesis (Understand)
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	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	3	3	2	-	-	-	-	-	-	-	-	2	-	2
CO3	2	1	-	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO5	3	2	2	-	2	-	-	-	-	-	-	2	-	2
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I BASICS OF ASIC **9**

Types of ASICs – Design flow – Economics of ASICs – ASIC cell library – Library cell design – Library architecture - Gate array design – Data path cell design

UNIT II PROGRAMMABLE FPGA **9**

Anti-fuse – Metal-metal anti-fuse –FPGAs in use – Specifications – PREP benchmarks – FPGA economics – FPGA pricing – Pricing examples – Actel ACT – Xilinx LCA – Altera FLEX – Altera MAX

UNIT III PROGRAMMABLE I/O CELLS **9**

DC output – AC output – DC Input – AC input – Clock input – Power input – Xilinx I/O block

UNIT IV PROGRAMMABLE INTERCONNECT **9**

Actel ACT – Xilinx LCA – Xilinx EPLD – Altera MAX 5000 and 7000 – Altera MAX 9000 – Altera flex – Design systems – FPGA logic synthesis – Half gate ASIC

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UNIT V LOW LEVEL DESIGN ENTRY 9

Schematic entry – Hierarchical design – Schematic icons and symbols – Nets – Vectored instances and buses – Netlist screener – Low level design languages – PLA tools – Examples – CFI design representation

Contact Periods:

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

Total: 45 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 (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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U21ECP07	LOW POWER VLSI	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC601: VLSI Design

COURSE OBJECTIVES:

- To learn different sources of power dissipation and power estimation in CMOS
- To study the concept for synthesis of different level low power transforms
- To understand low power static RAM architecture & energy recovery techniques used in low power design

COURSE OUTCOMES:

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

CO1: Interpret the concept of power dissipation in CMOS (Understand)

CO2: Illustrate the different power estimation techniques (Understand)

CO3: Apply the Behavioral level transforms for logical level optimization (Apply)

CO4: Explain the static RAM architecture for reducing power in the circuits (Understand)

CO5: Examine the low energy computation using appropriate energy recovery techniques (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I POWER DISSIPATION IN CMOS **9**

Sources of power dissipation – Physics of power dissipation in MOSFET devices – The MIS structure, long channel MOSFET, submicron MOSFET and gate induced drain leakage – Power dissipation in CMOS – short circuit dissipation, dynamic dissipation and load capacitance

UNIT II POWER ESTIMATION **9**

Modelling of signals – Signal probability calculation – Statistical techniques – Estimation of glitching power sensitivity analysis – Power estimation using input vector compaction, power dissipation in domino logic, circuit reliability, power estimation at the circuit level

UNIT III SYNTHESIS FOR LOW POWER **9**

Behavioral level transforms – Software design algorithms – Parallel implementation – Pipelined implementation – Logic level optimization – Technology dependent and independent circuits

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UNIT IV LOW POWER STATIC RAM ARCHITECTURES 9

Organization of a static RAM– MOS static RAM memory cell– Banked organization of SRAMs – Reducing voltage swings on bit lines – Reducing power in the write diver circuits – Reducing power in sense amplifier circuits

UNIT V LOW ENERGY COMPUTING USING ENERGY RECOVERY TECHNIQUES 9

Energy dissipation in transistor channel using an RC model – Energy recovery circuit design – Designs with partially reversible logic – Supply clock generation

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. K.S. Yeo and K.Roy, "Low Voltage Low Power VLSI Subsystems", 2nd edition, Tata McGraw Hill, 2016
2. K.Roy and S.C. Prasad, "Low Power CMOS VLSI Circuit Design", 3rd edition, Wiley, 2014

REFERENCES:

1. James B. Kuo and Shin Chia Lin, "Low voltage SOI CMOS VLSI Devices and Circuits", 2nd edition, John a Wiley and Sons, 2012
2. Dimitrios Soudris, Chirstian Pignet and Costas Goutis, "Designing CMOS Circuits for Low Power",1st edition, Kluwer, 2009
3. Gary Yeap, "Practical Low Power Digital VLSI Design", 4th edition, Kluwer, 2012
4. J.B Kuo and J.H Lou, "Low voltage CMOS VLSI Circuits", 2nd edition, Wiley, 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	CAD FOR VLSI CIRCUITS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand VLSI design flow and methodologies
- To learn floor planning and routing
- To study simulation and high-level synthesis

COURSE OUTCOMES:

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

CO1: Explain VLSI design automation tools (Understand)
CO2: Choose appropriate algorithm for partitioning and placement (Apply)
CO3: Identify suitable algorithms for placement and floor planning (Apply)
CO4: Examine the optimized gate level representation of combinational circuits (Analyze)
CO5: Summarize hardware model for high level synthesis (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I VLSI DESIGN FLOW 9

Introduction to VLSI design flow and design methodologies – Evolution of CAD tools – Classification of CAD tools – Overview of VLSI design automation tools and algorithms – Tractable and Intractable problems – General purpose methods for combinatorial optimization

UNIT II PARTITIONING AND PLACEMENT 9

Layout compaction – Design rules- Problem formulation – Algorithms for constraint graph compaction – Placement and Partitioning – Circuit representation – Placement algorithms – Partitioning

UNIT III FLOOR PLANNING AND ROUTING 9

Floor planning concepts – Shape functions and floor plan sizing – Types of local routing problems – Area routing – Channel routing – Global routing – Algorithms

UNIT IV SIMULATION AND LOGIC SYNTHESIS 9

Simulation – Gate level modeling and simulation – Switch-level modeling and simulation – Combinational Logic Synthesis – Binary Decision Diagrams (BDD)

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UNIT V MODELLING AND HIGH LEVEL SYNTHESIS 9

High level synthesis – Hardware models – Internal representation – Allocation – Assignment and scheduling – Simple scheduling algorithm – Assignment problem

Contact Periods:

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

Total: 45 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 Kluwer Academic Publishers, 2002

REFERENCES:

1. Stephen Trimberger, "Introduction to CAD for VLSI", 2nd edition, Kluwer Academic publisher, 2002
2. Sadiq M. Sait, Habib Youssef, "VLSI Physical Design automation: Theory and Practice", 2nd edition, World Scientific, 1999
3. Drechsler, R., "Evolutionary Algorithms for VLSI CAD", 5th edition, Kluwer Academic Publishers, 1998

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 2: Signal and Image Processing

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	-	2	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO5	2	-	-	-	-	-	-	-	-	-	-	2	-	2
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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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	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	3	3	2	-	-	2	-	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO4	3	2	2	-	-	2	-	-	-	-	-	2	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-	2	-	2
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

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

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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					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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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	-	-	-	-	-	-	-	2	-	-	2	-	2
CO2	2	1	-	-	-	-	-	-	2	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	2	-	-	2	-	2
CO4	3	3	2	-	2	-	-	-	2	-	-	2	-	2
CO5	3	2	2	-	2	-	-	-	2	-	-	2	-	2
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 – Hidden Markov model – 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	

*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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U21ECP12	BIO-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	-	-	-	-	-	-	-	2	-	-	2	-	2
CO2	3	2	2	-	2	-	-	-	2	-	-	2	-	2
CO3	3	3	2	-	2	-	-	-	2	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	2	-	-	2	-	2
CO5	2	1	-	-	-	-	-	-	2	-	-	2	-	2
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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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	2	-	-	-	-	-	-	-	-	-	2	-	2
CO2	2	2	-	-	2	-	-	-	-	-	-	2	-	2
CO3	2	2	-	-	-	-	-	-	-	-	-	2	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO5	3	3	2	-	2	-	-	-	-	-	-	2	-	2
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					
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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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 using MATLAB (Analyze)

CO-PO MAPPING:

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

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	

*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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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	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO5	2	-	-	-	-	-	-	-	-	-	-	2	-	2
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:

- U21EC402: Digital Signal Processing

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	-	-	-	2	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	2	-	-	-	-	-	-	2	-	2
CO3	2	1	-	-	-	-	-	-	-	-	-	2	-	2
CO4	3	3	2	-	2	-	-	-	-	-	-	2	-	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2	-	2

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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VERTICAL 3: Sensor Technologies and IoT

		Category: PEC				
U21ECP17	SENSORS AND TRANSDUCERS FOR IoT	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 particular field of applications

COURSE OUTCOMES:

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

CO1: Explain the basic concepts of measurement system (Understand)

CO2: Summarize the principles of non-electrical transducers (Understand)

CO3: Classify electrical transducers for various applications (Understand)

CO4: Illustrate the operations of sensors for data acquisition techniques (Understand)

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	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-	2	-
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

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

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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U21ECP18	IoT CLOUD COMPUTING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concept of cloud computing and evolution of cloud from the existing technologies
- To acquaint with various cloud architecture and services
- To learn the emergence of cloud as the next generation computing paradigm

COURSE OUTCOMES:

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

CO1: Explain the principles of distributed and parallel computing for cloud technology (Understand)

CO2: Summarize the key enabling technologies for cloud development (Understand)

CO3: Compare different cloud architectures using storage providers (Analyze)

CO4: Apply the concepts of resource management and security in cloud service (Apply)

CO5: Utilize the appropriate technology for cloud services (Apply)

CO- PO MAPPING:

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

SYLLABUS:

UNIT I OVERVIEW OF CLOUD COMPUTING 9

Introduction to cloud computing – Definition of cloud – Evolution of cloud computing – Underlying principles of parallel and distributed computing – Cloud characteristics – Elasticity in cloud, cloud on demand provisioning

UNIT II CLOUD ENABLING TECHNOLOGIES 9

Service oriented architecture – REST and systems – Web services – Publish subscribe model – Basics of virtualization, types of virtualization, levels of virtualization, virtualization structures, simulation on open source software – Tools and mechanisms – Virtualization of CPU – Memory, I/O devices – Virtualization support and disaster recovery

UNIT III CLOUD ARCHITECTURE, SERVICES AND STORAGE 9

Layered cloud architecture design – NIST cloud computing reference architecture – Public, private and hybrid clouds – IaaS - PaaS - SaaS – Architectural design challenges – Cloud storage, storage as a service, advantages of cloud storage, cloud storage providers – Amazon S3

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UNIT IV RESOURCE MANAGEMENT AND SECURITY IN CLOUD 9

Inter cloud resource management – Resource provisioning and resource provisioning methods – Global exchange of cloud resources – Security overview, cloud security challenges – Software as a service security – Security governance – Virtual machine security – IAM – Security standards

UNIT V CLOUD TECHNOLOGIES AND ADVANCEMENTS 9

Hadoop – Map reduce – Virtual box – Google app engine – Programming environment for google app engine, open stack – Federation in the cloud – Four levels of federation, federated services and applications, future of federation

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. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", 1st edition, Morgan Kaufmann, 2012

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

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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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 and its protocols
- To learn the design methodology and different IoT hardware platforms.
- To understand the basics of IoT Data Analytics and its industrial applications.

COURSE OUTCOMES:

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

CO1: Explain the basics of IoT (Understand)

CO2: Examine the performance of different IoT protocols (Analyze)

CO3: Develop simple programs using IoT platforms (Apply)

CO4: Illustrate the data analytics and supporting system used in IoT (Understand)

CO5: Apply the concept of IoT for industrial applications (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I FUNDAMENTALS OF IoT 9

Evolution of Internet of Things – Enabling technologies – M2M communication – IoT world forum (IoTWF) standardized architecture – Simplified IoT architecture – Core IoT functional stack – Fog, Edge and cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, actuators, smart objects and connecting smart objects

UNIT II IoT PROTOCOLS 9

IoT Access Technologies – Physical and MAC layers, topology and security of IEEE 802.15.4, 802.11ah and Lora WAN – Network Layer – IP versions, constrained nodes and constrained networks, 6LoWPAN – Application transport methods – SCADA – Application layer protocols – CoAP, MQTT

UNIT III DESIGN AND DEVELOPMENT 9

Design Methodology – Embedded computing logic – Microcontroller – System on Chips – IoT system building blocks IoT platform overview – Overview of IoT supported hardware platforms

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UNIT IV DATA ANALYTICS AND SUPPORTING SERVICES 9

Data Analytics – Introduction – Structured versus unstructured data – Data in motion versus Data at Rest – IoT data analytics challenges – Data acquiring – Organizing in IoT/M2M – Supporting Services – Computing using a cloud platform for IoT/M2M applications/services – Everything as a service and cloud service models

UNIT V CASE STUDIES/INDUSTRIAL APPLICATIONS 9

IoT applications – Home, infrastructures, buildings, ssecurity, industries – Home Appliances – Other IoT electronic equipment

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. Rajkamal , "Internet of Things: Architecture, Design Principles And Applications", 2nd edition , McGraw Hill Higher Education, 2017
2. ller, VlaslosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014
3. Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, "The Internet of Things – Key applications and Protocols", 2nd edition, Wiley, 2012
4. Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), "Architecting the Internet of Things",Springer, 2011

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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U21ECP20	INDUSTRIAL IoT	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide an overview of the industrial internet of things and its applications.
- To learn various IIoT WAN technologies and protocols.
- To solve industrial and real-world problems using the IIoT.

COURSE OUTCOMES:

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

CO1: Explain the basics of IoT architecture and introduction to IIoT (Understand)
CO2: Illustrate the different types of communication protocols used in IIoT (Understand)
CO3: Apply artificial intelligence to the Industrial Internet of Things (Apply)
CO4: Compare the performance of various data management methods (Analyze)
CO5: Apply IIoT solutions to various industries and real-time social needs (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I FUNDAMENTALS OF IIOT 9

IoT definition and characteristics – Physical design – Logical design – IoT enabling technologies – Industrial revolutions – Role of Internet of Things (IoT) and Industrial Internet of Things (IIoT) in Industry – Industry 4.0 revolutions – Support System for Industry 4.0 – Smart factories

UNIT II COMMUNICATION PROTOCOLS 9

IIoT device low power WAN optimized technologies for M2M – Sig-Fox – MQTT – HTTP – Zig-Bee – LoRaWAN – Modbus – Li-Fi

UNIT III CYBER PHYSICAL SYSTEMS 9

Next generation sensors – Collaborative platform and product lifecycle management – Augmented reality and virtual reality – Artificial intelligence – Machine learning

UNIT IV IIOT ANALYTICS AND DATA MANAGEMENT 9

Introduction – Data science – Data center networks – Big data and advanced analysis – Cloud computing in IIoT – Fog computing in IIoT

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UNIT V IIOT REAL–WORLD APPLICATIONS 9

Smart metering – e-Health body area networks – City automation – Automotive applications – Home automation – Smart cards – Plant automation – Real life examples of IIOT in manufacturing sector.

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2017
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011

REFERENCES:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014
2. CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493-9357-1
3. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key• applications and Protocols", Wiley, 2012
4. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 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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U21ECP21	IoT SECURITY AND PRIVACY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn about the security issues in IoT and cloud computing
- To understand the cryptography solutions and issues in IoT
- To study the security measures taken in IoT and Cloud systems to improve security

COURSE OUTCOMES:

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

CO1: Explain the concepts of fundamental security issues in Internet of things (Understand)

CO2: Classify the cloud services in cloud computing (Understand)

CO3: Summarize the challenges in cloud architecture and services (Understand)

CO4: Apply the appropriate algorithm for IoT security (Apply)

CO5: Analyze the performance of different measures to overcome security threats (Analyze)

CO–PO MAPPING:

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

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

SYLLABUS:

UNIT I FUNDAMENTALS OF IoT ECOSYSTEM 9

IoT security issues – IoT system design – Hardware, software and network security related to IoT systems – Basics of cryptographic solutions to IoT systems.

UNIT II OVERVIEW OF CLOUD COMPUTING AND ITS SERVICES 9

Cloud computing – Definition, private, public and hybrid cloud – Cloud types – IaaS, PaaS, SaaS

UNIT III CHALLENGES IN CLOUD COMPUTING 9

Benefits and challenges of cloud computing – Public vs. Private clouds – Role of virtualization in enabling the cloud – Architectural design challenges – Cloud storage, storage-as-a-service, advantages of cloud storage

UNIT IV SECURITY CONCEPTS 9

Introduction to security concepts – Confidentiality, privacy, integrity, authentication, non-repudiation, Virtualization – Algorithms – RSA algorithm, blowfish algorithm, data encryption standard algorithm

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UNIT V IoT SECURITY THREATS AND COUNTERMEASURES 9

System-specific attacks – Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure) – VM migration attack, hyper jacking

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Drew Van Duren, Brian Russell, "Practical Internet of Things Security", Packt, 1st Edition, 2016
2. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012

REFERENCES:

1. Madhusanka Liyanage, An Braeken, Pardeep Kumar, Mika Ylianttila, "IoT security: Advances in authentication", Wiley, February 2020
2. Brian Russell, Drew Van Duren, "Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem", 2nd Edition, Packt, 2018
3. Sean Smith, "The Internet of Risky Things", 1st Edition O'Reilly Media, 2017
4. David Etter, " IoT Security: Practical guide book", 1st edition, Create Space,2016

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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U21ECP22	IoT BASED SMART SYSTEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize the IoT network architecture and IoT pillars
- To acquire the knowledge of middleware for IoT and the cloud of things
- To apply the concept of operator 4.0 in various applications.

COURSE OUTCOMES:

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

CO1: Illustrate the network architecture of Internet of things (Understand)
CO2: Explain the process involved in pillars of IoT (Understand)
CO3: Compare the parameters of middle wares used in IoT (Analyze)
CO4: Apply the concepts of cloud computing for smart systems (Apply)
CO5: Implement the various smart systems using operator 4.0 (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I IoT NETWORK ARCHITECTURE AND DESIGN 9

Comparing IoT architectures – M2M IoT standardized architecture – IoT world forum (IoTWF) standardized architecture – Core IoT functional stack - Things – Sensors and actuators layer – Communications network layer – Applications and analytics layer

UNIT II PILLARS OF IoT 9

Four pillars – M2M – Internet of devices – RFID – Internet of objects – WSN – Internet of transducers – SCADA – Internet of controllers – DNA of IoT – DCM – Device, connect and manage

UNIT III MIDDLEWARE FOR IoT 9

Overview of middleware – Communication middleware for IoT – MTC/M2M, SCADA, RFID, WSN – LBS and surveillance middleware

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UNIT IV THE CLOUD OF THINGS 9

Grid/SOA and cloud computing – Cloud middleware – NIST's SPI architecture and cloud standards – The internet of things and cloud computing – Mobile cloud computing – MAI versus XaaS – The cloud of things architecture

UNIT V OPERATOR 4.0 9

Augmented reality for O and M – Intelligent health and safety devices for operators – Smart cap, smart watch, smart connected worker – Collaborative robotics in industry 4.0 – Characteristics, operations, applications

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on Approach)", VPT, 1st edition, 2014
2. Honbo Zhou, "Internet of Things in the cloud:A middleware perspective", CRC press, 2013

REFERENCES:

1. Bhagirathi Nayak, Monika Mangla, Sachi Nandan Mohanty, Suneeta Satpathy, "Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications", Wiley, 2021
2. Diego Galar Pascual, Pasquale Daponte , Uday Kumar, "Handbook of Industry 4.0 and SMART Systems", CRC Press, 2019
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things" Springer-Verlag Berlin Heidelberg, 2011

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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U21ECP23	WEARABLE SENSOR DEVICES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart the importance of various sensors, wearability issues and technical challenges for wearable device
- To identify the need for development of wearable devices and its implications on various sectors.
- To comprehend the design and development of various devices for use in healthcare applications.

COURSE OUTCOMES:

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

CO1: Illustrate the operations of various wearable sensors (Understand)

CO2: Explain the technical challenges for signal processing and energy harvesting of wearable system (Understand)

CO3: Outline the concepts of wireless health monitoring systems (Understand)

CO4: Develop wearable applications using textile sensors (Analyze)

CO5: Apply the principles of wearable devices for healthcare applications (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I WEARABLE SENSORS 9

Need for wearable systems – Sensors for wearable systems – Inertial movement sensors, respiration activity sensor, inductive plethysmography, impedance plethysmography, galvanic skin resistance, pulse oximetry, gas sensors, radiant thermal sensor, motion sensors and biochemical Sensors

UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING 9

Wearability issues – System architecture and signal processing flow – Action coverage for node placement – Principles of energy harvesting – Thermo-Electric Generator (TEG) – Characteristics of wearable TEGs – Human body as a heat source for power generation – TEGs in Wearable Devices – Hybrid thermoelectric-photovoltaic energy harvests

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UNIT III WIRELESS HEALTH SYSTEMS 9

Need for wireless monitoring – Body area network – Wireless Standards – System security and reliability – Wireless technology categories – Signal throughput – Resource allocations – Power optimization – Wireless health monitoring systems

UNIT IV TEXTILE BASED SENSOR 9

Fibres and textiles – Bio-electrodes, sensing, energy harvesting and storage – Smart textiles for actuation – Textile-based communication devices – Textile antennas – Microelectronics for smart textiles – Interconnect technology between textiles and electronics

UNIT V WEARABLE DEVICES FOR HEALTHCARE 9

Wearable devices – ECG, EEG, EMG and surface electrodes – Measurement of wearable EMG/ SEMG Signals, blood pressure and body temperature – Case Study – Google Glass, health monitoring, Smart textile for neurological rehabilitation system (NRS)

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Tilak Dias, "Electronic Textiles Smart Fabrics and Wearable Technology", 1st edition, Woodhead Publications, 2015
2. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", 1st edition, Springer, 2011

REFERENCES:

1. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata subramanian, "Body Area Networks Safety, Security, and Sustainability", 1st edition, Cambridge University Press, 2013 Hang,Yuan-Ting, "Wearable medical sensors and systems", Springer,2013
2. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology", 1st edition Singapore, 2012
3. Guang-Zhong Yang (Ed.), "Body Sensor Networks ", 2nd edition, Springer, 2006
4. Andreas Lymberis, Danilo de Rossi, "Wearable eHealth systems for Personalized Health Management - State of the art and future challenges", 1st edition, IOS press, The Netherlands, 2004

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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U21ECP24	AUTOMATION USING IoT	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the basic concepts of Internet of Things
- To understand the hardware and software IoT design for an application
- To learn different interfacing methods of IoT with real world applications

COURSE OUTCOMES:

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

CO1: Illustrate the basics of Internet of Things and its levels (Understand)
CO2: Infer the communication standards and networking related to IoT (Understand)
CO3: Interpret the logical and physical designs of IoT (Understand)
CO4: Analyze the performance of various Raspberry Pi interfaces for simple applications (Analyze)
CO5: Solve real world problems using the concept of Internet of Things (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO IoT **9**

Definition and characteristics – Physical design – Logical design – IoT enabling technologies – Domain specific IoT – Healthcare, smart cities, industrial applications

UNIT II IoT ARCHITECTURE AND NETWORKS **9**

IoT and M2M – LoRaWAN – Software defined networking – Network function virtualization – System management with NETCONF–YANG – IoT design methodology

UNIT III LOGICAL AND PHYSICAL DESIGNS **9**

Logical Design – Python data types and data structures – Control flow, functions, modules, packages, file handling, date and time operation, classes, python packages of IoT – IoT physical devices – Basic building blocks, Raspberry Pi, Linux on Raspberry Pi

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UNIT IV IoT PROJECT DEVELOPMENT 9

Raspberry Pi Interfaces – Serial, SPI, I2C – Programming Raspberry Pi with python – Project development – Home temperature monitoring system, Webcam interfacing with Raspberry Pi– Industrial visit to automation industry

UNIT V CASE STUDIES AND REAL–WORLD APPLICATIONS 9

Real world design constraints – Applications – industrial automation, smart grid, commercial building automation, smart cities – Participatory sensing – Data analytics for IoT software, management tools for IoT cloud storage models, communication APIs – Cloud for IoT

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", 1st edition, Universities Press, 2019
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, 2018

REFERENCES:

1. Santanu Pattanayakl, "Intelligent Projects Using Python", 1st edition, Packt Publishing, 2019
2. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things",1st edition, Wiley Publishers, 2017
3. Ovidiu Vermesan, Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", 1st edition, River Publishers, 2013
4. Anthony Townsend., "Smart cities: big data, civic hackers, and the quest for a new utopia", 1st edition, WW Norton & Company, 2013

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*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: Multiband Communication

U21ECP25	ADHOC AND WIRELESS SENSORS NETWORKS	Category: PEC				
		L	T	P	J	C
		3	0	0	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: Classify the MAC protocols based on the time synchronization and reservation approaches (Understand)

CO2: Explain the routing protocols for Ad-hoc wireless networks (Understand)

CO3: Summarize the transport layer protocols and security attacks (Understand)

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	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	2	1	-	-	-	-	-	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO4	3	3	2	-	-	-	-	-	-	-	-	2	-	2
CO5	3	2	2	-	2	-	-	-	-	-	-	2	-	2
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I MAC PROTOCOLS FOR ADHOC WIRELESS NETWORKS 9

Introduction and issues in ad-hoc wireless networks – Design goals – Classification of MAC protocols – Contention based protocols with reservation mechanisms – 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, on-demand routing protocols, ad-hoc on-demand distance vector routing – Tree based multicast routing protocols

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UNIT III TRANSPORT LAYER AND SECURITY PROTOCOLS 9

Issues – Design goals – Classification of transport layer – TCP over ad-hoc wireless networks – TCP bus, ad-hoc TCP, split TCP – Network security attacks – Key management – Symmetric, asymmetric – Secure routing – QoS routing protocol

UNIT IV WIRLESS SENSOR NETWORK 9

Comparison with ad-hoc wireless networks – Sensor network architecture – Layered architecture, clustered architecture – Data dissemination – Data gathering – CSMA based MAC protocol

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor node hardware – Berkeley motes – Programming challenges – Node level software platforms – TinyOS, nesC, CONTIKIOS – Node level simulators – NS2, COOJA, TOSSIM – State centric programming.

Contact Periods:

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

Total: 45 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

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	-	-	-	-	-	-	-	-	-	-	2	-	3
CO2	3	3	2	-	-	-	-	-	-	-	-	2	-	3
CO3	2	-	-	-	-	-	-	-	-	-	-	2	-	3
CO4	2	-	-	-	-	-	-	-	-	-	-	2	-	3
CO5	3	2	2	-	2	-	-	-	-	-	-	2	-	3

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:

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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U21ECP27	COMMUNICATION NETWORKS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

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: Illustrate various architectures of 5G communication (Understand)

CO2: Summarize the technologies involved in millimeter wave (mmW) communication (Understand)

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	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO3	3	3	2	-	2	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO5	3	2	2	-	2	-	-	-	-	-	-	2	-	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

SYLLABUS:

UNIT I 5G ARCHITECTURE **9**

Introduction – Network function virtualization (NFV) and software defined network (SDN) – Basics of radio access network (RAN) architecture – High level requirements for 5G architecture – Functional architecture and 5G flexibility – Split criteria – Split alternatives – Optimization for specific applications – Integration of LTE and new air interface – Enhanced Multi-RAT coordination features – Physical architecture and 5G deployment

UNIT II MILLIMETER WAVE COMMUNICATION **9**

Spectrum and regulations – Channel propagation – Hardware technologies for mmW systems – Deployment scenarios – Architecture and mobility – Beamforming – Physical layer techniques

UNIT III 5G MASSIVE MIMO SYSTEMS **9**

MIMO in LTE – Single user MIMO – Multi-user MIMO – Massive MIMO Pilot design – Resource allocation and transceiver algorithms – Baseband and RF implementations

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UNIT IV INTERFERENCE AND MOBILITY MANAGEMENT IN 5G 9

Network deployment types – Interference management –Ultra dense network (UDN) , moving relay nodes – Interference cancelation – Mobility management in heterogeneous 5G networks – Dynamic network reconfiguration in 5G

UNIT V 5G SPECTRUM 9

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

Contact Periods:

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

Total: 45 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

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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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	-	-	-	-	-	-	-	2	-	-	2	-	2
CO2	2	1	-	-	-	-	-	-	2	-	-	2	-	2
CO3	3	2	2	-	-	-	-	-	2	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	2	-	-	2	-	2
CO5	3	3	2	-	-	-	-	-	2	-	-	2	-	2
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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U21ECP29	NETWORK SECURITY FOR COMMUNICATION	Category: PEC				
		L	T	P	J	C
		3	0	0	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: Summarize various cryptographic techniques for OSI security architecture (Understand)

CO2: Explain the operations of data encryption standard and advancedencryption standard (Understand)

CO3: Illustrate the principles of public key cryptosystems (Understand)

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	2	1	-	-	-	-	-	-	-	-	-	-	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	-	-	1
CO3	2	1	-	-	-	-	-	-	-	-	-	-	-	1
CO4	3	2	1	-	-	-	-	-	-	-	-	-	-	1
CO5	3	3	1	-	-	-	-	-	-	-	-	-	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I BASIC CIPHERS **9**

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 **9**

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 **9**

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 9

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function – MD5 – SHA– HMAC – CMAC – Digital signature and authentication protocols – DSS – El Gamal – Authentication applications – Kerberos– X.509 Authentication services

UNIT V INTERNET AND MOBILE SECURITY 9

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 – Establishing keys privacy authentication of the source – Message Integrity – Non-repudiation

Contact Periods:

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

Total: 45 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

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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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	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2	-	2

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 – Why SDN – Evolution of SDN – How SDN Works – 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 Center 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					
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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U21ECP31	VEHICULAR COMMUNICATION NETWORK	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

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: Summarize the standards of vehicular networks (Understand)

CO2: Examine transportation inefficiencies problem in smart cities (Analyze)

CO3: Apply the principles of DAS in real time applications (Apply)

CO4: Illustrate the operation of information dissemination in vehicular networks (Understand)

CO5: Explain safety and privacy issues in vehicular communication (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I VEHICULAR COMMUNICATIONS STANDARDS **9**

Introduction to transportation – Intelligent transport systems – Wireless access for vehicular environments – IEEE 1609 – SAE J2735 – LED Enabled visible light communications – ETSI and CEN standards for V2X communications

UNIT II SUSTAINABLE MOBILITY IN SMART CITIES **9**

Goals of traffic assessment – Forecasting and management – Urban transportation inefficiencies – Smart cities and smart city operations – Sustainable mobility – Mobility as a service – Case studies – Car pooling, intelligent parking management

UNIT III ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS) **9**

Introduction – Cooperative mobility and cooperative driving – Green (eco) driving – 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 9

Dissemination concepts – Broadcast based dissemination – Multi-hop dissemination and store carry forward – Intelligent flooding and geocasting – Dissemination via cellular networks – Peer-to-peer traffic information system – Cellular multicast

UNIT V SECURITY AND PRIVACY 9

Introduction and security requirements – Identity management – Performance – Computational and communication overhead – Privacy protection – Identity based cryptography – Symmetric cryptography schemes

Contact Periods:

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

Total: 45 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

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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U21ECP32	BODY AREA NETWORKS AND SENSORS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

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: Explain the basic principles of BAN (Understand)

CO2: Illustrate the hardware components used for BAN (Understand)

CO3: Design body area networks using WPAN technologies (Analyze)

CO4: Summarize the regulatory and security issues of BAN (Understand)

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	2	-	-	-	-	-	-	-	2	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	2	-	-	2	-	2
CO3	3	3	2	-	-	-	-	-	2	-	-	2	-	2
CO4	2	1	-	-	-	-	-	-	2	-	-	2	-	2
CO5	3	2	2	-	-	-	-	-	2	-	-	2	-	2
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I FUNDAMENTALS OF BAN **9**

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 **9**

Processor – Low Power MCUs – Mobile Computing MCUs – Integrated processor with radio transceiver, Memory – Antenna – PCB antenna, wire antenna, ceramic antenna, external antenna, sensor interface, power sources – Batteries and fuel cells for sensor nodes

UNIT III WIRELESS COMMUNICATION AND NETWORK **9**

RF communication in body – Antenna design and testing – Propagation – Base station – Network topology – Stand-alone BAN – Wireless personal area network technologies – IEEE 802.15.1, IEEE P802.15.13, IEEE 802.15.14, Zig-bee

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UNIT IV COEXISTENCE ISSUES WITH BAN 9

Interferences – Effect on transmission, counter measures – Physical layer and data link layer – Security and self-protection – Bacterial attacks, virus infection, secured protocols, self-protection

UNIT V APPLICATIONS OF BAN 9

Monitoring patients with chronic disease – Elderly patients – Cardiac arrhythmias monitoring – Multi patient monitoring systems – Multichannel neural recording – Gait analysis – Sports medicine – Electronic pill

Contact Periods:

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

Total: 45 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

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*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 5: RF and Space Technologies

		Category: PEC				
U21ECP33	RF ID SYSTEM DESIGN AND TESTING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the basic functions and principles of RFID components and systems
- To understand the communication fundamentals of RFID system
- To design a sensor-based RFID system

COURSE OUTCOMES:

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

CO1: Explain the functions of RFID components and systems (Understand)

CO2: Illustrate the communication fundamentals of RFID system (Understand)

CO3: Summarize the performance characteristics of different types of RFID sensors (Understand)

CO4: Examine the efficiency of various RFID enabled system (Analyze)

CO5: Apply the principles of RFID 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	-	-	-	-	-	-	-	-	-	-	2	2	-
CO2	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO3	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO4	3	3	2	-	2	-	-	-	-	-	-	2	2	-
CO5	3	2	2	-	2	-	-	-	-	-	-	2	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I FUNDAMENTALS AND OPERATING PRINCIPLES OF RFID **9**

Introduction to barcode systems – Magnetic strip card, smart cards, RFID systems – History of RFID, RFID tag components – Tag antenna, integrated circuits, substrate – RFID tag types – Passive tags, active tags, 1-bit transponder and chip less tags

UNIT II COMMUNICATION FUNDAMENTALS IN RFID SYSTEMS **9**

Communication principles – Coding, modulation and demodulation – Data integrity – Multiple access procedures – Anti-collision procedure – Security issues and solutions – Hardware architecture of tags and readers – Transponder design – Reader RF interface, control unit, middleware – Near field communications

UNIT III RFID SENSORS AND TESTING **9**

Types of sensors – Use of sensors – Basic considerations of sensor design – Requirements for accuracy – Requirements for resolution – Environment of the sensor – Calibration

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UNIT IV DESIGN OF RFID-ENABLED SYSTEM 9

RFID antenna design challenges – Antenna basics and the dipole – Passive RFID antenna using serial stubs – Bowtie T-match RFID antenna – Voltage multiplier for RFID Integrated Circuits – Microcontroller for active RFID-enabled sensor

UNIT V RFID APPLICATIONS 9

Short range RFID applications – Access control transportation ticketing, personnel identification, vehicle identification, production line monitoring – Long range RFID applications – Supply chain management, mail and shipping, clothing tags, food production control

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. V. Daniel Hunt, Alber Puglia, Mike Puglia, "RFID: A guide for radio frequency identification", Wiley & Sons, Inc., Publication, 2011
2. Amin Rida, LiYang, Manos Tentzeris, "RFID-Enabled Sensor Design and Applications", 2nd edition, Artech House, 2010

REFERENCES:

1. Steven Shepard, "Radio Frequency Identification", 1st edition, McGraw Hill, 2011
2. Klaus Finkenzeller, "RFID Handbook: Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication", 3rd edition, John Wiley, 2010
3. Syed Ahson, Mohammad Ilyas, Kyongjin Jo, "RFID Handbook: Applications, Technology, Security, and Privacy", 1st edition, CRC Press, 2008
4. Claus Heinrich, "RFID and Beyond", 1st edition, John Wiley & Sons, 2005

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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U21ECP34	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	Category: PEC				
		L	T	P	J	C
		3	0	0	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: Explain the basic theory of electromagnetic interference and compatibility (Understand)
CO2: Analyze the electromagnetic emissions from various apparatus and circuits (Analyze)
CO3: Summarize mitigation techniques available for EMI suppression (Understand)
CO4: Classify standards and regulations of electromagnetic compatibility (Understand)
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	2	-	-	-	-	-	2	-	-	-	-	2	-	2
CO2	3	3	2	-	-	-	2	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	2	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	2	2	-	-	-	2	-	2
CO5	3	2	-	-	2	-	2	-	-	-	-	2	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I BASICS OF EMI AND EMC 9

Concepts of EMI and EMC – Practical experiences and concerns – Sources of EMI – EMI emission and susceptibility – Conducted, radiated – Radiation hazards

UNIT II EMI SOURCES 9

Noise from relays and switches – Circuit non-linearities – Intermodulation, cross modulation – Cross-talk in transmission lines – Transients in power supplies – Calculation of induced voltage and current

UNIT III MITIGATION TECHNIQUES 9

Principle of EM shielding – Shielding materials, cable shielding, shielding effectiveness, low frequency magnetic shielding – EMI suppression cables – Gasketting types – Principle of grounding – Measurement of ground resistance, cable shield grounding

UNIT IV EMI/EMC STANDARDS 9

Standards for EMI/EMC – Standardizing organizations – IEEE/ANSI and CISPR/IEC – Test and evaluation methods – FCC regulations – MIL-STD 461/462 standards

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UNIT V TEST METHODS AND MEASUREMENTS 9

Open field test – Radiated interference measurement – Shielded anechoic chamber, transverse electromagnetic cell – Conducted interference measurement – Power supply noise, equipment interference

Contact Periods:

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

Total: 45 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

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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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:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	2	-	-	2	-	3
CO2	2	-	-	-	-	-	-	-	2	-	-	2	-	3
CO3	3	3	2	-	-	-	-	-	2	-	-	2	-	3
CO4	2	-	-	-	-	-	-	-	2	-	-	2	-	3
CO5	2	1	-	-	-	-	-	-	2	-	-	2	-	3
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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U21ECP36	RADAR AND NAVIGATIONAL AIDS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC501: Transmission Lines and Antennas

COURSE OBJECTIVES:

- To study the radar principles, types and tracking.
- To learn radar detections and navigation techniques.
- To understand concepts of satellite navigation systems.

COURSE OUTCOMES:

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

CO1: Explain the fundamental principles of RADAR (Understand)

CO2: Apply the radar concepts in tracking of targets (Apply)

CO3: Illustrate the detection of signals for navigation systems (Understand)

CO4: Compare the efficiency of various direction finding techniques (Analyze)

CO5: Summarize the different satellite navigation systems (Understand)

CO–PO MAPPING:

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

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

SYLLABUS:

UNIT I BASICS OF RADAR **9**

Radar block diagram – Radar frequencies – Radar equation – Applications of radar – Probabilities of detection and false alarm – Integration of radar pulses – Radar cross section of targets – Radar cross section fluctuations – Transmitter power – Pulse repetition frequency – Antenna parameters – System losses

UNIT II RADAR TYPES AND TRACKING **9**

Introduction to doppler effect – CW radar – FMCW radar – MTI radar – Doppler filter banks – Digital MTI processing – Moving target detector – MTI from a moving platform – Pulse doppler radar – Tracking with radar – Monopulse tracking – Low angle tracking – Comparison of trackers

UNIT III DETECTION OF SIGNAL **9**

Introduction – Automatic detector – Constant false alarm rate receivers – Radar operator – Propagation radar waves – Atmospheric refraction – Standard propagation – Nonstandard propagation – Radar antenna – Reflector antennas – Electronically steered phased array antennas – Phase shifters – Frequency scan arrays

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UNIT IV METHODS OF NAVIGATION 9

Radio direction finding – Loop antenna – Aural null direction finder – Goniometer – Errors in direction finding – Adcock direction finders – Direction finding at very high frequencies – Direction finders – Automatic, commutated aerial – LF/MF four course radio range – VHF omni directional range (VOR) – VOR receiving equipment – Range and accuracy of VOR

UNIT V SATELLITE NAVIGATION SYSTEM 9

Distance measuring equipment (DME) – Operation of DME – Instrument landing system – Ground controlled approach system – Microwave landing system – Components of the doppler navigation System – Doppler range equation – Accuracy of doppler navigation systems – Inertial navigation– Global Positioning System

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. N.S.Nagaraja, "Elements of Electronic Navigation Systems" , 2nd edition, TMH, 2017
2. Merrill I. Skolnik," Introduction to Radar Systems", 3rd edition, Tata Mc Graw–Hill 2003

REFERENCES:

1. J.C Toomay, " Principles of Radar", 2nd edition PHI, 2012
2. Albert Helfrick.D, "Principles of Avionics", 7th edition, Avionics communications Inc, 2012
3. Myron Kyton and W.R.Fried, "Avionics Navigation systems", 2nd edition, John Wiley & Sons Inc, 1997
4. Peyton Z. Peebles: "Radar Principles", John Wiley, 2004

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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U21ECP37	RF MEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the micro fabrication process, MEMS materials and various system issues
- To acquire basic knowledge on MEMS based filters, phase shifters and switches
- To learn the concepts of transmission lines and MEMS based antenna design

COURSE OUTCOMES:

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

CO1: Explain the basic concepts of MEMS (Understand)

CO2: Summarize various types of switches and passive components (Understand)

CO3: Illustrate MEMS based RF filters and phase shifters (Understand)

CO4: Utilize the characteristics of micro machined transmission lines for MEMS systems (Apply)

CO5: Analyze the performance of antenna using micromachining technique (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I MICROELECTROMECHANICAL SYSTEMS 9

Introduction to micro fabrication for MEMS – Tranducers – Electromechanical, electrostrictive, magnetostrictive, electrodynamic – Electrothermal actuators – Micro sensing for MEMS – MEMS materials and fabrication – Micro stereo lithography for polymer MEMS

UNIT II RF MEMS SWITCHES 9

Switching parameters – Switches for RF and microwave applications – Switching – Electrostatic, magnetic, thermal switching – MEMS switch design considerations – Inductors – MEMS micromachined, folded, polymer based inductors – MEMS capacitors – MEMS sensors and actuators

UNIT III RF FILTERS AND PHASE SHIFTERS 9

Modeling of mechanical filters – Micromechanical filters – Types of phase shifters and their limitations – MEMS phase shifters, ferroelectric phase shifters

UNIT IV MEMS BASED TRANSMISSION LINES 9

Introduction to micromachined transmission lines and components – Microshield circuit components, micromachined waveguide components, micromachined mixer

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UNIT V MICROMACHINED ANTENNA 9

Overview of microstrip antenna – Micromachining techniques to improve antenna performance – Micromachining as a fabrication process for small antenna – Micromachined reconfigurable antenna

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Vijay K Varadan, Vinoy K J and Jose K A, "RF MEMS and Their Applications ", 1st edition, John Wiley & Sons Ltd, 2011
2. Gabriel M Rebeiz, "RF MEMS Theory, Design and Technology ", 1st edition, John Wiley & Sons Ltd, 2010

REFERENCES:

1. Tai Ran Hsu,"MEMS & Micro systems Design and Manufacture", 1st edition, Tata McGraw Hill, 2017
2. Chang Liu, "Foundations of MEMS", 2nd edition, Pearson Education Inc., 2012
3. James J.Allen, "Micro Electro Mechanical System Design", 1st edition, CRC Press Publisher, 2010
4. Mohamed Gad-el-Hak" The MEMS Handbook", 2nd edition, CRC press, 2002

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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U21ECP38	REMOTE SENSING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn about the basic principles of remote sensing and its platform
- To understand about various types of sensors used for remote sensing
- To learn about data analysis and data reception in GIS

COURSE OUTCOMES:

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

CO1: Explain the characteristics and components of maps and GIS (Understand)
CO2: Summarize the different Spatial and Non-spatial data in GIS (Understand)
CO3: Classify the spatial relationship between elements using GIS tools (Understand)
CO4: Choose the appropriate network and surface data for decision making in data reception (Apply)
CO5: Compare various approaches for earth data analytics in geographical information system (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I PHYSICS OF REMOTE SENSING **9**

Remote sensing – Definition – Components – Electromagnetic spectrum – Basic wave theory – Particle theory – Stefan Boltzman law – Wiens-displacement Law – Radiometric quantities – Effects of atmosphere – Scattering – Different types – Absorption – Atmospheric window – Energy interaction with surface features – Spectral reflectance of vegetation, soil and water – Atmospheric influence on spectral response patterns

UNIT II PLATFORMS **9**

Orbit elements – Types of orbits – Motions of planets and satellites – Launch of space vehicle – Orbit perturbations and maneuvers – Escape velocity – Types and characteristics of different remote sensing platforms – Sun synchronous and Geo-synchronous satellites

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UNIT III SENSORS 9

Classification of remote sensors – Selection of sensor parameters – Resolution concept – Spectral, radiometric and temporal resolution – Quality of images – Imaging mode – Photographic camera – Opto-mechanical scanners – Push broom and whiskbroom cameras – Panchromatic, multi spectral , thermal, hyperspectral scanners and microwave sensors – Geometric characteristics of scanner imagery

UNIT IV DATA RECEPTION AND DATA PRODUCTS 9

Ground segment organization – Data product generation – Sources of errors in received data – referencing scheme – data product output medium – Digital products – Super structure, fast, Geo TIFF, Hierarchical and HDF formats – Indian and International Satellite data products – Ordering of data

UNIT V DATA ANALYSIS 9

Introduction – Field studies of earth sciences, earth science data analytics, tools, and techniques, various approaches for earth data analytics, categories of analytics, tools for analytics in earth sciences – Geographical information system

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. John R. Jensen, "Introductory Digital Image Processing": A Remote Sensing Perspective, 4th Edition, Pearson Publication, 2017
2. Lillesand T.M., and Kiefer,R.W. "Remote Sensing and Image interpretation", 6th edition , John Wiley & Sons, 2015

REFERENCES:

1. Nilanjan Dey, Chintan Bhatt, Amira S.Ashour, "Big Data for Remote Sensing: Visualization, Analysis and Interpretation", Springer International Publishing AG, 1st edition, part of Springer Nature, 2019
2. George Joseph, "Fundamentals of Remote Sensing", 3rd edition, Universities Press (India) Pvt Ltd, Hyderabad, 2018
3. John A.Richards, Verlag, "Remate Sensing Digital Image Analysis", 5th edition, Springer, 2013
4. Paul Curran P.J. "Principles of Remote Sensing", International Journal of Remote Sensing, Vol. 6, No. 7, Taylor and Francis, 1985

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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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	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO3	3	3	2	-	2	-	-	-	-	-	-	2	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO5	3	2	2	-	2	-	-	-	-	-	-	2	-	2
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:

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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U21ECP40	AVIONICS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the fundamentals avionics.
- To familiarize the digital principles and avionics architecture
- To study about the control, displays and avionics systems.

COURSE OUTCOMES:

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

CO1: Explain the basic concepts of avionics (Understand)
CO2: Apply the principles of digital systems to avionics (Apply)
CO3: Compare various digital avionics architectures (Understand)
CO4: Illustrate the concept of Control and display technologies (Understand)
CO5: Implement the navigation systems using suitable communication technology (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO AVIONICS 9

Need for Avionics in civil and military aircraft and space systems – Integrated Avionics system – Typical avionics sub systems – Design approaches and recent advances – Application Technologies

UNIT II PRINCIPLES OF DIGITAL SYSTEMS 9

Digital Computers – Digital number system- number systems and codes – Fundamentals of logic and combinational logic circuits – Digital arithmetic – Interfacing with analogue systems – Microprocessors – Memories

UNIT III DIGITAL AVIONICS ARCHITECTURE 9

Avionics system architecture – Salient features and applications of Data buses MIL – STD 1553 B – ARINC 429 – ARINC 629

UNIT IV FLIGHT DECK AND COCKPITS 9

Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil cockpit and military cockpit – MFDS, HUD, MFK, HOTAS 63

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UNIT V AVIONICS SYSTEMS 9

Communication Systems – Navigation systems – Flight control systems – Radar electronic warfare – Utility systems Reliability and maintainability – Certification

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Gaonkar, R.S., "Microprocessors Architecture – Programming and Application", Wiley and Sons Ltd., New Delhi, 1990
2. Spitzer, C.R., "Digital Avionic Systems", Prentice Hall, Englewood Cliffs, N.J., USA., 1987

REFERENCES:

1. Brain Kendal, "Manual of Avionics", The English Book House, 3rd edition, New Delhi, 1993
2. Malcrno A.P. and Leach, D.P., "Digital Principles and Application", Tata McGraw-Hill, 1990
3. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989

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 6: Emerging and Healthcare Electronics

U21ECP41	NANO ELECTRONIC DEVICES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC202: Electronic Devices and Circuits

COURSE OBJECTIVES:

- To understand the basics of Nano electronics and Nano devices
- To learn the principles and operation of Nano electronic devices
- To analyze the potential applications of Nano electronics

COURSE OUTCOMES:

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

CO1: Explain the concepts of Nano electronics, and electron transport in a lattice (Understand)

CO2: Illustrate the physics of single electron devices (Understand)

CO3: Apply the tunneling phenomenon for enhanced transient response (Apply)

CO4: Summarize the working principles of Nano transistors (Understand)

CO5: Compare the flexible electronic devices based on different semiconductor materials (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION **9**

Basics of Nano electronics – Band diagram of semiconductor structures (quantum well, quantum barrier, super lattice) – Types of transistor integration – Photons interacting with electrons in solids – electron transport

UNIT II SINGLE ELECTRON DEVICES **9**

Single electron Box – Single electron transistor (SET) – Single electron trap – Coulomb blockade – performance of single electron transistor – Single electron transistor technology – Single electron transistor circuit design – Electrostatic data storage

UNIT III TUNNELING DEVICES **9**

Quantum mechanical tunnel devices – Tunneling diode – Tunnel resistance – Resonant tunneling diode (RTD) – Resonant tunneling bipolar transistor – Tunneling element technology – RTD-Circuit design based resonant tunneling diode

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UNIT IV TRANSISTOR 9

Introduction – Electrons in mesoscopic structures – Short channel MOS transistor – Split gate transistor – Electron wave transistor – Electron spin transistor – Quantum cellular automate – Quantum dot array – Molecular tweezer – Molecular processor – Molecular switches – Molecular shuttle

UNIT V FLEXIBLE ELECTRONICS 9

Polymer electronics – Self assembling circuits – Optical molecular memories – Switches based on fullerenes and CNTs, Quantum well infrared photo detector.

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Hanson, G. W, "Fundamentals of nanoelectronics", Upper Saddle River, N.J: Pearson/Prentice Hall, 2008
2. Wolf, E. L,"Nanophysics and nanotechnology: An introduction to modern concepts in Nanoscience" Weinheim: Wiley-VCH, 2004

REFERENCES:

1. Arun Kumar Singh, Balwinder Raj, "Nanoelectronic Devices for Hardware and Software Security", CRC Press, 2021
2. Lim, T.C, "Nanosensors: Theory and applications in industry, healthcare, and defense. Boca Raton", CRC Press, 2011
3. Balandin, A. A., and Wang, K. L, "Handbook of semiconductor nanostructures and Nano devices", Stevenson Ranch, Calif: American Scientific Publishers, 2006
4. Cao, G, "Nanostructures & nanomaterials: Synthesis, properties & applications", London: Imperial College Press, 2004

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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U21ECP42	FABRICATION TECHNOLOGIES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC601: VLSI Design

COURSE OBJECTIVES:

- To understand the various design process involved in the device fabrication
- To learn the detailed fabrication process used in their manufacture of device
- To analyze the different analytical techniques used and its process in the various device fabrication

COURSE OUTCOMES:

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

CO1: Explain the substrate cleaning and additive process (Understand)
CO2: Illustrate the various material deposition processes (Understand)
CO3: Apply the principles and process of lithography methods for device fabrication (Apply)
CO4: Summarize the etching properties and practices in the fabrication (Understand)
CO5: Examine the performance of different mechanical polishing processes for CMOS integration (Analyze)

CO- PO MAPPING:

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

SYLLABUS:

UNIT I SUBSTRATE AND ADDITIVE PROCESSING **9**

Substrate – Introduction to cleanroom – Additive Processing – Defects and diffusion – Contamination and surface cleaning – Ion Implantation – Native films – Chemical vapour deposition – Precursor transport – Types – Nucleation and growth

UNIT II MATERIAL DEPOSITION **9**

Atomic layer deposition – Physical vapour deposition – Evaporation and Sputtering – Contact resistance – Electro migration and Epilogue – Pattern transfer basics

UNIT III LITHOGRAPHY **9**

Optical Lithography – Resist process – Contact and Proximity printing – Stepper and Scanner – Surface Reflection – Mask Technology – Resolution enhancement – Projection Lithography – Image formation – Electron beam lithography – Emerging lithography techniques.

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UNIT IV ETCHING 9

Wet Etching – Etching figures of merit – Basics and recipes – Dry etch – Plasma – Plasma etching – Plasma tool configuration – Etch mechanism – Etch chemistry

UNIT V CHEMICAL MECHANICAL POLISHING AND PROCESS INTEGRATION 9

Chemical mechanical polishing –Tools and Process – Manufacturability – Process Integration – PV integration – CMOS integration.

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Kumar Shubham, Ankaj Gupta, "Integrated Circuit Fabrication", CRC Press, 2021
2. Sami Franssila, "Introduction to Microfabrication", 2nd edition, Wiley, 2010

REFERENCES:

1. Gouranga Bose, "IC Fabrication Technology", McGraw Hill Education, 2017
2. Jeorge S. Hurtarte, Evert A. Wolsheimer, Lisa M. Tafoya, "Understanding Fabless IC Technology", Newnes, 2011
3. Peter Shepherd, "Integrated Circuit Design, Fabrication and Test", Palgrave Macmillan, 2002
4. https://onlinecourses.nptel.ac.in/noc19_bt29/preview

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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U21ECP43	ADVANCED DISPLAY TECHNOLOGIES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study display glasses, inorganic semiconductor TFT technology
- To compare inorganic phosphors, cathode ray tubes, vacuum florescent displays
- To differentiate between paper like and low power displays

COURSE OUTCOMES:

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

CO1: Explain the fundaments of light components and its properties (Understand)

CO2: Apply photolithography techniques for fabrication of thin film and flexible displays (Apply)

CO3: Summarise the principles of different display devices (Understand)

CO4: Illustrate the 3D technologies involved in the display device (Understand)

CO5: Classify the micro display technologies based on characteristics (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
CO2	3	2	2	-	-	-	-	-	2	-	-	2	-	1
CO3	2	-	-	-	-	-	-	-	2	-	-	2	-	1
CO4	2	-	-	-	-	-	-	-	2	-	-	2	-	1
CO5	3	3	2	-	-	-	-	-	2	-	-	2	-	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)					

SYLLABUS:

UNIT I PROPERTIES OF LIGHT **9**

Properties of light, geometric optics, optical modulation – Vision and perception – Anatomy of eye, light detection and sensitivity, spatial vision and pattern perception, binocular vision and depth perception – Driving displays – Direct drive, multiplex and passive matrix, active matrix driving, panel interfaces, graphic controllers, signal processing mechanism – Power supply – Fundamentals, power supply sequencing

UNIT II TFT & LCD DISPLAYS **9**

Display glasses, inorganic semiconductor TFT technology, organic TFT technology – Transparent conductors, patterning processes – Photolithography for thin film LCD, wet etching, dry etching – Flexible displays – Attributes, technologies compatible with flexible substrate and applications, TFT signal processing techniques – Touch screen technologies – Introduction, coatings, adhesive

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UNIT III DISPLAY MATERIALS 9

Inorganic Phosphors, cathode ray tubes, vacuum florescent displays, filed emission displays; plasma display panels, LED display panels – Inorganic Electroluminescent Displays – Thin film electroluminescent displays, organic electroluminescent displays – OLEDs, active matrix for OLED displays; liquid crystal displays – Fundamentals and materials, properties of liquid crystals, optics and modeling of liquid crystals – LCD device technology – Twisted numeric and super twisted numeric displays, Smectic LCD modes, in-plane switching technology, vertical aligned Nematic LCD technology, bi-stable LCDS.

UNIT IV PAPER LIKE AND LOW POWER DISPLAYS 9

Colorant transposition displays, mems based displays, 3-D displays, 3-D cinema technology, auto-stereoscopic 3-D technology, volumetric and 3-D volumetric display technology, holographic 3-D technology – Mobile displays – Trans-reflective displays for mobile devices, liquid crystal optics for mobile displays, energy aspects of mobile display technology.

UNIT V MICRO DISPLAY TECHNOLOGIES 9

Liquid crystals on silicon reflective micro- display, trans missive liquid crystal micro-display, MEMs Micro-display, DLP Projection Technology – Micro-display Applications – Projection systems, head worn displays; electronic view finders, multi- focus displays, occlusion displays, cognitive engineering and information displays – Display metrology, standard measurement procedures, advanced measurement procedures – Spatial effects, temporal effects, viewing angle, ambient light.

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. In Byeong Kang, Chang Wook Han, Jae Kyeong Jeong, "Advanced Display Technology: Next Generation Self-Emitting Displays", Springer, 2021
2. Janglin Chen, Wayne Cranton, Mark Fihn, "Handbook of Visual Display Technology", Springer Publication, 2017

REFERENCES:

1. Achintya K. Bhowmik, Zili Li, Philip J. Bos, "Mobile Displays: Technology and Applications", John Wiley & Sons, 2008
2. Jiun-Haw Lee, David N. Liu, Shin-Tson Wu, "Introduction to Flat Panel Displays", John Wiley & Sons, 2008
3. Victor V. Belyaev, Igor N. Kompanets, "Advanced Display Technologies: Basic Studies of Problems in Information Display", SPIE Publication, 2001
4. Joseph Castellano, "Handbook of Display Technology", Elsevier, 1992

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*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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U21ECP44	FLEXIBLE ELECTRONICS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EC202: Electronic Devices and Circuits

COURSE OBJECTIVES:

- To understand the basics of flexible electronics
- To learn the specific design rules and the process of fabrication of flexible electronic devices
- To identify the potential applications of flexible electronics

COURSE OUTCOMES:

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

CO1: Summarize the principles of flexible electronic devices (Understand)

CO2: Explain the different fabrication techniques of flexible electronic devices (Understand)

CO3: Summarize the mechanical properties of nanomaterials (Understand)

CO4: Model the structure and characteristics of thin film transistors (Apply)

CO5: Analyze the methods of fabricating the economic flexible devices (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
CO2	2	-	-	-	-	-	-	-	2	-	-	2	-	1
CO3	2	-	-	-	-	-	-	-	2	-	-	2	-	1
CO4	3	2	2	-	-	-	-	-	2	-	-	2	-	1
CO5	3	3	2	-	-	-	-	-	2	-	-	2	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I FLEXIBLE ELECTRONICS BASICS 9

Introduction to flexible and printed electronics and their materials systems – Background and history – Emerging technologies – General applications – Review of semiconductors and circuit elements, carrier transport, doping, band structure, thin-film electronic devices

UNIT II FLEXIBLE DEVICES FABRICATION AND MATERIALS 9

Thin-film deposition and processing methods for flexible devices – CVD, ECVD, PVD – Etching – Photolithography – Low process integration – Materials for flexible and printed electronics – Nanowire and nanoparticle synthesis – Transition metal oxides – Amorphous thin films, polymeric semiconductors, paper electronics, textile substrates, barrier materials

UNIT III PATTERNING PROCESS, INTERFACES 9

Solution-based Patterning Processes – Ink-jet printing, gravure, imprint lithography, spray pyrolysis, surface energy effects, multilayer patterning Contacts and Interfaces to Organic and Inorganic

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Electronic Devices – Schottky contacts, defects, carrier recombination, effect of applied mechanical strain.

UNIT IV THIN FILM TRANSISTORS **9**

Thin Film Transistors device structure characteristics – Mechanics of thin transistors – Thin-film mechanics models, neutral plane – Conformal electronics – Mechanical modeling

UNIT V APPLICATIONS AND ECONOMICS **9**

Flexible Electronics Applications – Displays, sensor arrays, memory devices, MEMS, lab-on-a-chip and photo-voltaics – Introduction to cost models and economics of printed flexible electronics – Overview of display industry cost models – Cost advantages and disadvantages for printed electronics – Scaling of large-area flexible systems – Cost of goods sold for display applications

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", World Scientific, 2016
2. Wong, William S., Salleo, Alberto, "Flexible Electronics: Materials and Application", Springer, 2009

REFERENCES:

1. Aftab M. Hussain, "Introduction to Flexible Electronics", CRC Press, 2021
2. Takao Someya, "Stretchable electronics: functional materials, fabrication strategies and applications", Taylor & Francis, 2019
3. Vinod Kumar Khanna, "Flexible Electronics", IOP Publishing, 2019
4. Stergios Logothetidis, "Handbook of Flexible Organic Electronics", Elsevier, 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 / 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	-	-	-	-	-	-	-	-	-	-	2	2	-
CO2	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO3	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO4	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO5	3	2	2	-	-	-	-	-	-	-	-	2	2	-
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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U21ECP46	BIO TELEMETRY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the technologies and standards in telemetry.
- To learn protocols behind communication technologies for secure transmission of data.
- To study the applications of telemetry in healthcare.

COURSE OUTCOMES:

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

CO1: Explain the fundamentals of telemetry system (Understand)
CO2: Classify various types of biosensors based on application (Understand)
CO3: Summarize different communication technologies and standards (Understand)
CO4: Analyze the challenges in telemetry and telemedicine (Analyze)
CO5: Apply the principles of telemetry in 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	-	-	-	-	-	-	-	-	-	-	2	2	-
CO2	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO3	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO4	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO5	3	2	2	-	-	-	-	-	-	-	-	2	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO BIOMEDICAL TELEMETRY **9**

Definition – Significance – Typical telemetry systems – Challenges – Commercial medical telemetry Devices – Design consideration – Architecture, transmission methods

UNIT II BIOSENSORS **9**

Structure of Bio sensors – Types – Electrochemical, optical, thermal and piezoelectric – Other types – Magnetic, Pyro electric and Ion Channel – Invasive and implantable sensors – Non-Invasive sensors

UNIT III COMMUNICATION TECHNOLOGIES, STANDARDS AND ISSUES **9**

Numerical and physical modelling – Safety issues – Inductive Coupling – On-body, Implantable and Ingestible antennas – Clinical safety

UNIT IV TELEMETRY AND TELEMEDICINE **9**

Instrumentation – Integration – Implementation and standards – Health care – Future research Directions – Challenges

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UNIT V APPLICATIONS 9

Wearable health care systems - Inner layer tissue monitoring – Implantable health care systems - Ingestible health care systems - Simulators – mHealth

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Konstantina S Nikitha, "Handbook of Biomedical Telemetry", Reprint, John Wiley & Sons, Ltd, 2014
2. Bernard Fong, A.C.M. Fong, C.K. Li, "Telemedicine Technologies: Information Technologies in Medicine and Telehealth", Wiley, 2011

REFERENCES:

1. Johnna Fisher, "Biomedical Ethics: A Canadian Focus", Oxford University Press Canada, 1st edition 1, 2009
2. Gary E Wnek, Gary L Browlin, "Encyclopaedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc New York, 2nd edition, 2008
3. Joseph D.Bronzino, "The Biomedical Engineering Handbook", 3rd edition: Three Volume Set, CRC Press,2006
4. Wootton, R., Craig, J., Patterson, V, "Introduction to Telemedicine", Royal Society of Medicine Press Ltd, 2nd Edition, 2006

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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U21ECP47	MEMS FOR HEATHCARE	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn various MEMS fabrication techniques.
- To understand different types of sensors and actuators and their principles of operation at the micro scale level.
- To know the applications of MEMS in different fields of medicine

COURSE OUTCOMES:

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

CO1: Summarize various MEMS fabrication techniques (Understand)

CO2: Illustrate the operation of different types of mechanical and thermal sensors and actuators (Understand)

CO3: Explain the functions of various types of electrostatic and piezoelectric sensors and actuators (Understand)

CO4: Analyze the characteristics of fluid flow under various circumstances (Analyze)

CO5: Apply the principles of MEMS devices for different medical applications (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I MEMS MATERIALS AND FABRICATION 9

Typical MEMs and Microsystems – Materials for MEMS – Active substrate materials – Silicon and its compounds, silicon piezo-resistors, gallium arsenide, quartz, polymers – Micromachining – Photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding – LIGA

UNIT II MECHANICAL, THERMAL SENSORS AND ACTUATORS 9

Mechanical sensors and actuators – Beam and cantilever – Microplates, strain, pressure and flow measurements – Thermal sensors and actuators – Thermal couples, thermal resistor, shape memory alloys, inertia sensor, flow sensor

UNIT III ELECTROSTATIC, PIEZOELECTRIC SENSORS AND ACTUATORS 9

Parallel plate capacitor – Pull-in-effect – Electrostatic sensors and actuators – Inertia sensor, pressure sensor, flow sensor, tactile sensor, comb drive – Properties of piezoelectric material – Piezoelectric sensor and actuator – Inchworm motor, inertia sensor, flow sensor

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UNIT IV MICROFLUIDIC SYSTEMS 9

Fluid dynamics – Llaminar flow in circular conduits – Fluid flow in microconduits, submicrometer and nanoscale – Fluid actuation methods – Electro wetting, thermocapillary effect, electro osmosis, dielectrophoresis – Micro fluid dispenser – Microneedle, micro pumps continuous flow system, micromixers

UNIT V APPLICATIONS OF BIOMEMS 9

Drug delivery – Micrototal analysis systems detection and measurement methods – Microsystem approaches to polymerase chain reaction – DNA sensor – MEMS based drug delivery – Electronic nose – Introduction to 3D printing

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Tai Ran Hsu , "MEMS and Microsystems design and manufacture", 1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 2002
2. Chang Liu, " Foundations of MEMS", 2nd Edition, Pearson Education International, New Jersey, USA, 2011

REFERENCES:

1. Marc J. Madou, "Fundamentals of Microfabrication: the science of miniaturization", CRC Press, 2017
2. Wanjun Wang, Stephen A.Soper, "BioMEMS: Technologies and applications", 1st Edition, CRC Press, New York, 2007
3. Mohamed Gad-el-Hak, "The MEMS Handbook", 2nd edition, CRC press, 2006
4. Nadim Maluf, Kirt Williams, "An Introduction to Microelectro mechanical Systems Engineering", 2nd Edition, Artech House Inc, MA, 2004

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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U21ECP48	BRAIN COMPUTING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basic concepts of brain computer interface.
- To study the different signal processing methods and machine learning methods of brain computer interface.
- To learn the various applications of brain computer interface.

COURSE OUTCOMES:

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

CO1: Explain the fundamentals of brain computer interface (Understand)

CO2: Illustrate the concept of brain activation patterns (Understand)

CO3: Analyze various feature extraction algorithms (Analyze)

CO4: Summarize various machine learning algorithms for classification (Understand)

CO5: Develop different brain computer interface applications (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I BASICS OF BRAIN COMPUTER INTERFACE **9**

Introduction – Brain structure and function – Fundamentals of brain computer interface (BCI) – Structure of BCI system – Classification of BCI – Invasive, non-invasive and partially invasive BCI – BCI monitoring hardware, EEG, ECoG, MEG, fMR – EEG signal acquisition – Signal Preprocessing

UNIT II BRAIN ACTIVATION **9**

Brain activation patterns – Spikes, oscillatory potential and ERD, slow cortical potentials, movement related potentials – Mu rhythms, motor imagery, stimulus related potentials – Visual evoked potentials – P300 and auditory evoked potentials, potentials related to cognitive tasks

UNIT III FEATURE EXTRACTION METHODS **9**

Data Processing – Spike sorting, frequency domain analysis, wavelet analysis, time domain analysis, spatial filtering – Principal component analysis (PCA), independent component analysis (ICA), Artefacts reduction, feature extraction – Phase synchronization and coherence

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UNIT IV MACHINE LEARNING METHODS FOR BCI 9

Classification techniques – Binary classification, ensemble classification, multiclass Classification, evaluation of classification performance, regression – Linear, polynomial, RBF's, perceptron's, multilayer neural networks, support vector machine, graph theoretical functional connectivity analysis

UNIT V APPLICATIONS OF BCI 9

Invasive BCIs – decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, cursor and robotic control using multi electrode array implant, cortical control of muscles via functional electrical stimulation – Noninvasive BCIs – P300 Mind Speller, visual cognitive BCI, emotion detection – Ethics of Brain Computer Interfacing

Contact Periods:

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

Total: 45 Periods

TEXT BOOKS:

1. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, 1st edition, January 2012
2. Reza Fazel-Rezai, "Recent Advances in Brain-Computer Interface Systems",Intech Publications, 1st edition, 2011

REFERENCES:

1. Ella Hassianien, A and Azar.A.T, "Brain-Computer Interfaces Current Trends and Applications", 1st edition, Springer, 2015
2. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, 1st edition, 2013
3. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 1st edition, 2010
4. Theodre Berger W and John k Chapin , "Brain computer interfaces, An International assessment of research and developmental trends", Springer, 1st edition, 2008

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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