BIRLA INSTITUTE OF TECHNOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS) CURRICULUM

(Effective from Academic Session: Monsoon 2018)

NAME OF THE PROGRAMME

B.TECH. Electronics and Communication Engineering

NAME OF THE DEPARTMENT

Department of Electronics and Communication Engineering

Institute Vision

To become a Globally Recognised Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research, and technological service to the National needs.

Institute Mission

- To educate students at Under Graduate, Post Graduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education, and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision:

To become a centre of excellence in teaching and research for creating technical manpower to meet the technological, societal and environmental needs of the country in the field of Electronics and Communication Engineering.

Department Mission

- To offer state of the art education of global standards through innovative methods of teaching and learning with practical orientation aiming to prepare the students for successful career and to provide required technological services.

- To prepare the students to think independently, take initiative, lead a team in an organization, take responsibility and solve the problems related to industry, society, environmental, health, safety, legal and cultural issues maintaining the professional ethics.

- To pursue high quality contemporary research through continued interaction with research organizations and industries.

Graduate Attributes

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

2. **Problem Analysis**: Identify, formulate, research literature and analyze complex engineering problems
reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

4. **Conduct investigations of complex problems** using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

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

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

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

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

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

Programme Educational Objectives (PEOs)

1. To develop an ability to apply the knowledge acquired in basic sciences and engineering for solving Electronics and Communication Engineering problems with regards to technical, economic, environmental and social contexts.
2. To build confident and competent graduates capable of designing and testing electronic devices and communication systems for the given specifications.
3. To inculcate an attitude to work in a team using technical knowhow, software tools and interdisciplinary working environments to achieve project goals.
4. To nurture effective communication and interpersonal skills to demonstrate leadership qualities, and exhibit professional ethics.
5. To develop an ability, enthusiasm and understanding for life-long learning development and motivation towards higher studies and research.

(A) Programme Outcomes (POs)

Engineering Graduates will be able to:

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

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

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

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

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

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

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

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

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

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

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

(B) Programme Specific Outcomes (PSOs)

1. Apply the knowledge acquired in basic sciences and engineering for solving electronics and communication engineering problems.
2. Build competence in design and analysis of electronics and communication systems.
3. Develop skills to carry out research in electronic instrumentation, signal processing, VLSI systems, microwave engineering, wireless communication and networking.

PROGRAMME COURSE STRUCTURE (ALL SEMESTERS)

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018-19
Based on CBCS & OBE model
Recommended scheme of study
(B.Tech. in Electronics & Communications Engineering, Computer Science & Engineering, Electrical & Electronics Engineering, Information Technology)

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Course	L (Periods/ week)	T (Periods/ week)	P (Periods/ week)	C
				THEORY				
FIRST Monsoon	**FIRST**	FS *Foundation Sciences*	MA 103	Mathematics - I	3	1	0	4
			CH101	Chemistry	3	1	0	4
		GE *General Engineering*	EC101	Basics of Electronics & Communication Engineering	3	1	0	4
			ME101	Basics of Mechanical Engineering	3	1	0	4
				LABORATORIES				
	FIRST	FS	CH102	Chemistry Lab	0	0	3	1.5
		GE	EC102	Electronics & Communication Lab	0	0	3	1.5
		GE	ME102	Engineering Graphics	0	0	4	2
		MC *Mandatory Course*	MC101/102/103/104	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
TOTAL								**22**
				THEORY				
SECOND Spring	**FIRST**	FS	MA107	Mathematics - II	3	1	0	4
			PH113	Physics	3	1	0	4
		GE	CS101	Programming for problem Solving	3	1	0	4
			EE101	Basics of Electrical Engineering	3	1	0	4
				LABORATORIES				
	FIRST	FS	PH114	Physics Lab	0	0	3	1.5
		GE	CS102	Programming for problem Solving lab	0	0	3	1.5
			PE101	Workshop Practice	0	0	3	1.5
		MC	MC105/106/107/108	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
TOTAL								**21.5**
GRAND TOTAL FOR FIRST YEAR								**43.5**

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study
B.Tech. in Electronics & Communications Engineering

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practicals*			Total Credits *C- Credits*
					L (*Periods/ week*)	**T** (*Periods/ week*)	**P** (*Periods/ week*)	**C**
THIRD Monsoon				**THEORY**				
	FIRST	FS	BE101	Biological Science for Engineers	2	0	0	2
	SECOND	GE	IT 201	Basics of Intelligent Computing	3	0	0	3
		PC	EE205	Circuit Theory	3	1	0	4
			EC201	Electronic Devices	3	0	0	3
			EC203	Digital System Design	3	0	0	3
			EC205	Signals and Systems	3	0	0	3
				LABORATORIES				
	FIRST	GE	EE102	Electrical Engineering lab	0	0	3	1.5
	SECOND	MC	MC201/202/203/204	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
		PC	EC202	Electronic Devices Lab	0	0	3	1.5
			EC204	Digital System Design Lab	0	0	3	1.5
			EC208	Electronic Measurements Lab	0	0	4	2
TOTAL								**25.5**
FOURTH Spring				**THEORY**				
	SECOND	FS	MA203	Numerical Methods	2	0	0	2
	FIRST	FS	CE101	Environmental Science	2	0	0	2
	SECOND	PC	EC251	Probability and Random Processes	3	0	0	3
			EC253	Analog Circuits	3	0	0	3
			EC255	Analog Communication	3	0	0	3
			EC257	Electromagnetic Fields and Waves	3	0	0	3
				LABORATORIES				
	SECOND	FS	MA204	Numerical Methods Lab	0	0	2	1
		GE	IT202	Basic IT Workshop (Common Subject)	0	0	2	1
		MC	MC205/206/207/208	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
		PC	EC254	Analog Circuits Lab	0	0	3	1.5
			EC258	Electromagnetic Waves Lab	0	0	3	1.5
TOTAL								**22**

			EC301	Digital Communication	3	0	0	3
			EC303	Microprocessors and Microcontrollers	3	0	0	3
		PC	EC305	Signal Processing Techniques	3	0	0	3
	THIRD		EC307	Fundamentals of Data Communication	3	0	0	3
FIFTH Monsoon		PE		Program Elective-I	3	0	0	3
		OE		Open Elective-I	3	0	0	3
			LABORATORIES					
			EC302	Communication System Lab	0	0	4	2
	THIRD	PC	EC304	Microprocessors and Microcontrollers Lab	0	0	3	1.5
			EC306	Signal Processing Lab	0	0	3	1.5
			TOTAL					**23**
Student may choose subjects of minor/specialization from 5th semester and onwards.								
			EC351	Fiber Optic Communication	3	0	0	3
		PC	EC353	Pulse, Digital and Switching System	3	0	0	3
	THIRD		EC379	Control Systems	3	0	0	3
		PE		Program Elective-II	3	0	0	3
		OE		Open Elective-II	3	0	0	3
SIXTH Spring	FIRST	HSS	MT123	Business Communications	3	0	0	3
	THIRD	MC	MC300	Summer training - Mandatory				3
	SECOND	HSS	MT204	Constitution of India	2	0	0	0 Non-credit
			LABORATORIES					
	THIRD	PC	EC352	Fiber Optic Communication Lab	0	0	3	1.5
		PC	EC354	Pulse, Digital and Switching System Lab	0	0	3	1.5
			TOTAL					**24**
		PC	EC401	Industrial Electronics	3	0	0	3
			EC403	Professional Practice Law & Ethics	2	0	0	2
SEVENTH Monsoon	FOURTH	PE		Program Elective-III	3	0	0	3
				Program Elective-IV	3	0	0	3
		OE		Open Elective-III	3	0	0	3
				Open Elective-IV	3	0	0	3
			TOTAL					**17**
EIGTH Spring	FOURTH	PC	EC400	Research project / Industry Internship	*NOT APPLICABLE*			12
GRAND TOTAL *Minimum requirement for Degree award*								**167**

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
PROGRAMME ELECTIVES (PE)*
OFFERED FOR LEVEL 1-4

PE / LEVEL	Code no.	Name of the PE courses	Prerequisite/Corequisite courses with code	L	T	P	C
		PE-I					
PE/Level-3 (MO) SEM-V	EC309	Adaptive Signal Processing	EC305 Signal Processing Techniques	3	0	0	3
	EC311	Digital Signal Processor	EC305 Signal Processing Techniques	3	0	0	3
	EC313	Electronic Measurements	EC208 Electronic Measurement Lab	3	0	0	3
	EC315	Introduction to Industrial Instrumentation	EC208 Electronic Measurement Lab	3	0	0	3
	EC319	VLSI Systems	EC101Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC321	Microelectronic Devices and Circuits	EC101Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC323	Microwave Theory and Techniques	EC257 Electromagnetic Fields and Waves	3	0	0	3
	EC325	Antenna and Wave Propagation	EC257 Electromagnetic Fields and Waves	3	0	0	3
	EC327	Mobile & Cellular Communication	EC255 Analog Communication, EC301 Digital Communication	3	0	0	3
	EC329	Information Theory and Coding	EC251 Probability and Random Process, EC255 Analog Communication	3	0	0	3
	EC331	Issues in Nanoscale CMOS Design	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3

* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS

PE / LEVEL	Code no.	Name of the PE courses	Prerequisite/Corequisite courses with code	L	T	P	C
		PE-II					
PE/Level-3 (SP) SEM-VI	EC355	Time Frequency and Wavelet Transform	EC205 Signals and Systems, EC305 Signal Processing Techniques EC251Probability and Random Processes	3	0	0	3
	EC357	Speech and Audio Processing	EC205 Signals and Systems, EC305 Signal Processing Techniques EC251Probability and Random Processes	3	0	0	3
	EC359	Microcontrollers and Interfacing	EC303 Microprocessors and Microcontrollers	3	0	0	3
	EC361	Digital Systems Design with FPGAs	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices EC203 digital System Design	3	0	0	3
	EC363	Nanoelectronics	EC101Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC365	Radar and Navigation System	EC257 Electromagnetic Fields and Waves	3	0	0	3
	EC367	Computer Networking	EC307 Fundamentals of Data Communication	3	0	0	3
	EC369	Wireless Networks	EC307 Fundamentals of Data Communication	3	0	0	3
	EC371	Introduction to Electromagnetic Compatibility	EC257 Electromagnetic Fields and Waves	3	0	0	3
	EC373	Introduction to Sensors and Transducers	EC208 Electronic Measurement Lab	3	0	0	3
	EC375	High Speed Electronics	EC101 Basics of Electronics and Communication Engineering,	3	0	0	3
	EC381	Error correcting Codes	EC329 Information Theory and Coding	3	0	0	3
	EC383	DSP Architecture for VLSI	EC331 VLSI Systems EC305 Signal Processing Techniques	3	0	0	3
	EC385	Physical Design Automation	EC331 VLSI Systems	3	0	0	3
	EC387	Wireless Communication	EC255 Analog Communication, EC301 Digital Communication	3	0	0	3
	EC389	Radar Signal Analysis	EC323 Microwave Theory and Techniques	3	0	0	3
* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS							

PE / LEVEL	Code no.	Name of the PE courses	Prerequisite/Corequisite courses with code	L	T	P	C
			PE-III				
PE/Level-4(MO) SEM-VII	EC405	Digital Image & Video Processing	EC305 Signal Processing Techniques	3	0	0	3
	EC407	Multichannel Signal Processing	EC305 Signal Processing Techniques	3	0	0	3
	EC409	Fiber Optic Sensors	EC351 Fiber Optic Communication	3	0	0	3
	EC411	Mixed Signal Design	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC413	Real Time Embedded System	EC203 Digital System Design EC303 Microprocessors and Microcontrollers	3	0	0	3
	EC415	Semicustom IC Design	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC419	Satellite Communication	EC255 Analog Communication, EC301 Digital Communication	3	0	0	3
	EC421	Bio-Medical Electronics & Signal Processing	EC205 Signals and Systems, EC305 Signal Processing Techniques EC207 Probability and Random Processes	3	0	0	3
* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS							

PE / LEVEL	Code no.	Name of the PE courses	Prerequisite/Corequisite courses with code	L	T	P	C
			PE-IV				
PE/Level-4(MO) VII SEM	EC423	Radar Engineering	EC257 Electromagnetic Fields and Waves				
	EC425	Optoelectronic devices	EC351 Fiber Optic Communication	3	0	0	3
	EC427	Neural Networks and Fuzzy System	EC205 Signals and Systems, EC305 Signal Processing Techniques	3	0	0	3
	EC429	Device Modeling & Simulation	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC431	Multimedia Communication	EC255 Analog Communication, EC301 Digital Communication	3	0	0	3
	EC433	Low Power VLSI Circuits	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC435	ASIC Design	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices EC331 VLSI Systems	3	0	0	3
	EC437	VLSI System Testing	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC439	Integrated Circuit Technology	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices	3	0	0	3
	EC447	Electronic Packaging	EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices EC331 VLSI Systems	3	0	0	3
	EC449	Wireless Sensors networks	EC307 Fundamentals of Data Communication	3	0	0	3
* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS							

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING OPEN ELECTIVES (OE)*
OFFERED FOR LEVEL 1-4

OE / LEVEL	Code No.	Name of the OE courses	Prerequisites courses with code	L	T	P	C
		OE-I					
OE/Level-3 (MO)	EC333	Sensors and Transducers	N/A	3	0	0	3
	EC335	Consumer Electronics	N/A	3	0	0	3
		OE-II					
OE/Level-3 (SP)	EC377	Introduction to Communication System	N/A	3	0	0	3
		OE-III					
OE/Level-4 (MO)	EC441	Introduction to MEMS	N/A	3	0	0	3
	EC443	Introduction to Human- Machine Interface	N/A	3	0	0	3
		OE-IV					
	EC445	Introduction to Signal Processing	N/A	3	0	0	3

* OPEN ELECTIVES TO BE OPTED ONLY BY OTHER DEPARTMENT STUDENTS

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for
In-depth Specialisation in Signal Processing

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial;P-Practicals*			Total Credits *C- Credits*
					L	**T**	**P**	**C**
				THEORY				
FIFTH Monsoon	THIRD	PE	EC309	Adaptive Signal Processing	3	0	0	3
	THIRD	PE	EC311	Digital Signal Processor	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC312	Digital Signal Processor Lab	0	0	3	1.5
TOTAL								**7.5**
SIXTH Spring	THIRD	PE	EC355	Time Frequency and Wavelet Transform	3	0	0	3
			EC357	Speech and Audio Processing	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC356	Time Frequency and Wavelet Transform Lab	0	0	3	1.5
TOTAL								**7.5**
SEVENTH Monsoon	FOURTH	PE	EC405	Digital & Video Image Processing	3	0	0	3
				LABORATORIES				
	FOURTH	PC	EC406	Image Processing Lab	0	0	4	2
TOTAL								**5**
GRAND TOTAL *Minimum requirement for In-depth Specialisation award*								**20**

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for
In-depth Specialisation in Electronic Instrumentation

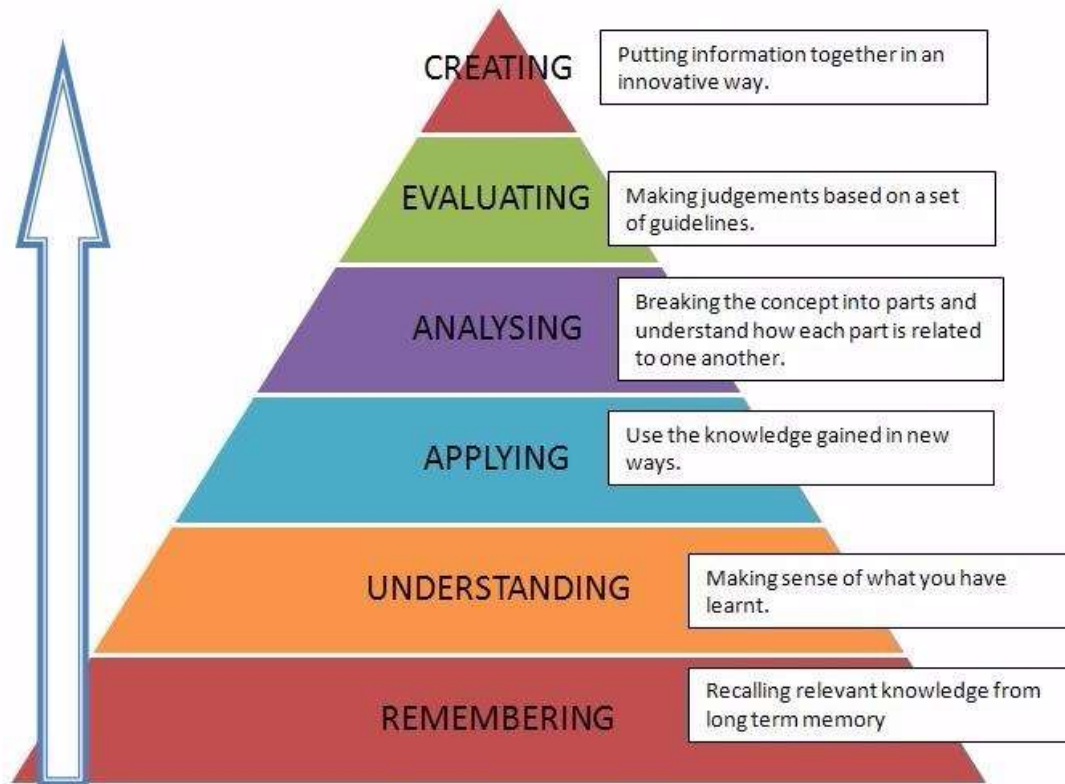| Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial;P-Practicals*			Total Credits *C- Credits*
					L	**T**	**P**	**C**
				THEORY				
FIFTH Monsoon	THIRD	PE	EC313	Electronic Measurements	3	0	0	3
			EC315	Introduction to Industrial Instrumentation	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC316	Industrial Instrumentation Lab	0	0	4	2
TOTAL								**8**
SIXTH Spring	THIRD	PE	EC359	Microcontrollers and Interfacing	3	0	0	3
			EC373	Introduction to Sensors and Transducers	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC360	Microcontroller Lab	0	0	3	1.5
TOTAL								**7.5**
SEVENTH Monsoon	FOURTH	PE	EC421	Bio-Medical Electronics & Signal Processing	3	0	0	3
				LABORATORIES				
	FOURTH	PC	EC422	Bio-Medical Signal Processing Lab	0	0	3	1.5
TOTAL								**4.5**
GRAND TOTAL *Minimum requirement for In-depth Specialisation award*								**20**

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19

Based on CBCS & OBE model

Recommended scheme of study for

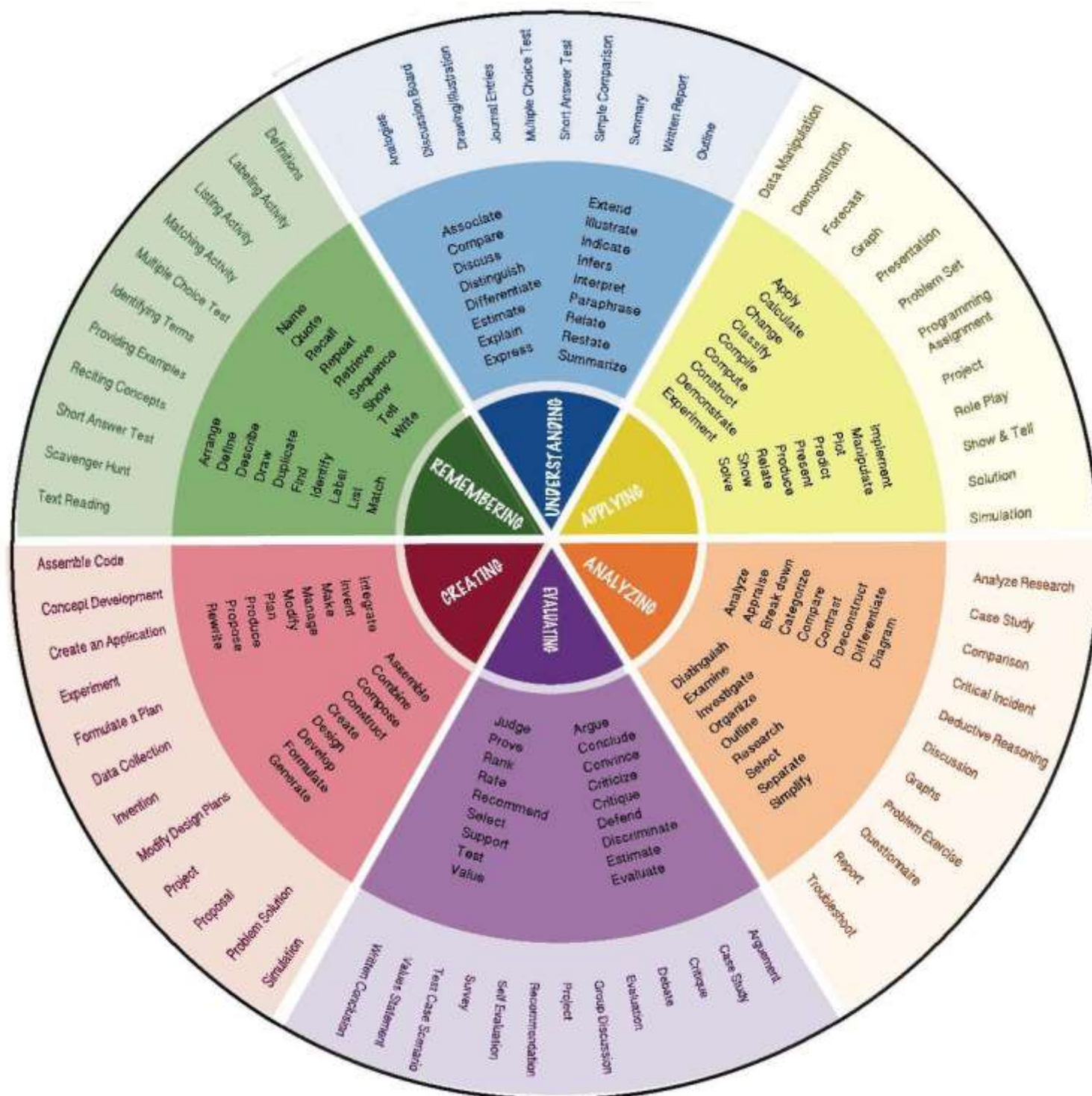*In-depth Specialisation in Microwave Engineering*

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial;P-Practicals*			Total Credits *C- Credits*
					L	**T**	**P**	**C**
				THEORY				
FIFTH Monsoon	THIRD	PE	EC323	Microwave Theory and Techniques	3	0	0	3
	THIRD	PE	EC325	Antenna and Wave Propagation	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC324	Microwave Engineering Lab	0	0	3	1.5
TOTAL								**7.5**
SIXTH Spring	THIRD	PE	EC365	Radar and Navigation System	3	0	0	3
	THIRD	PE	EC371	Introduction to Electromagnetic Compatibility	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC366	Advanced Microwave Engineering Lab	0	0	3	1.5
TOTAL								**7.5**
SEVENTH Monsoon	FOURTH	PE	EC419	Satellite Communication	3	0	0	3
				LABORATORIES				
	FOURTH	PC	EC420	Advanced Communication Lab	0	0	4	2
TOTAL								**5**
GRAND TOTAL *Minimum requirement for In-depth Specialisation award*								**20**

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for
In-depth Specialisation in Wireless Communication and Networking

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial;P-Practicals*			Total Credits *C- Credits*
					L	**T**	**P**	**C**
				THEORY				
FIFTH Monsoon	THIRD	PE	EC327	Mobile and Cellular Communication	3	0	0	3
	THIRD	PE	EC329	Information Theory and Coding	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC328	Mobile and Cellular Communication Lab	0	0	3	1.5
TOTAL								**7.5**
SIXTH Spring	THIRD	PE	EC367	Computer Networking	3	0	0	3
	THIRD	PE	EC369	Wireless Networks	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC370	Wireless Networks Lab	0	0	3	1.5
TOTAL								**7.5**
SEVENTH Monsoon	FOURTH	PE	EC419	Satellite Communication	3	0	0	3
				LABORATORIES				
	FOURTH	PC	EC420	Advanced Communication Lab	0	0	4	2
TOTAL								**5**
GRAND TOTAL *Minimum requirement for In-depth Specialisation award*								**20**

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for
In-depth Specialisation in VLSI Systems

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practicals*			Total Credits *C- Credits*
					L	T	P	C
				THEORY				
FIFTH Monsoon	THIRD	PE	EC319	VLSI Systems	3	0	0	3
	THIRD	PE	EC321	Microelectronic Devices and Circuits	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC320	VLSI Systems Lab	0	0	3	1.5
TOTAL								**7.5**
SIXTH Spring	THIRD	PE	EC361	Digital Systems Design with FPGAs	3	0	0	3
	THIRD	PE	EC363	Nanoelectronics	3	0	0	3
				LABORATORIES				
	THIRD	PC	EC362	Digital Systems Design with FPGAs Lab	0	0	4	2
TOTAL								**8**
SEVENTH Monsoon	FOURTH	PE	EC413	Real Time Embedded System	3	0	0	3
				LABORATORIES				
	FOURTH	PC	EC414	Real Time Embedded System Lab	0	0	3	1.5
TOTAL								**4.5**
		GRAND TOTAL *Minimum requirement for In-depth Specialisation award*						**20**

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for
Minor in Electronics & Communications Engineering

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Course	Mode of delivery & credits *L-Lecture; T-Tutorial;P-Practicals*			Total Credits *C- Credits*
					L	T	P	C
THEORY								
FIFTH Monsoon	SECOND	PC	EC201/ EC203	Electronic Devices/ Digital System Design	3	0	0	3
			EC205	Signals and Systems	3	0	0	3
	LABORATORIES							
	SECOND	PC	EC202/ EC204	Electronic Devices Lab/ Digital System Design Lab	0	0	3	1.5
TOTAL								**7.5**
SIXTH Spring	SECOND	PC	EC253	Analog Circuits	3	0	0	3
			EC255	Analog Communication	3	0	0	3
	LABORATORIES							
	SECOND	PC	EC254	Analog Circuits Lab	0	0	3	1.5
TOTAL								**7.5**
SEVENTH Monsoon	THIRD	PC	EC301	Digital Communication	3	0	0	3
	LABORATORIES							
	FOURTH	PC	EC402	Communication Lab	0	0	3	2
TOTAL								**5**
GRAND TOTAL *Minimum requirement for Minor degree award*								**20**

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.

Bloom's Taxonomy Wheel

REMEMBERING
Definitions, Labeling Activity, Listing Activity, Matching Activity, Multiple Choice Test, Identifying Terms, Providing Examples, Reciting Concepts, Short Answer Test, Scavenger Hunt, Text Reading
Name, Quote, Recall, Repeat, Retrieve, Sequence, Show, Tell, Write, Arrange, Define, Describe, Draw, Duplicate, Find, Identify, Label, List, Match

UNDERSTANDING
Analogies, Discussion Board, Drawing/Illustration, Journal Entries, Multiple Choice Test, Short Answer Test, Simple Comparison, Summary, Written Report, Outline
Associate, Compare, Discuss, Distinguish, Differentiate, Estimate, Explain, Express, Extend, Illustrate, Indicate, Infers, Interpret, Paraphrase, Relate, Restate, Summarize

APPLYING
Data Manipulation, Demonstration, Forecast, Graph, Presentation, Problem Set, Programming Assignment, Project, Role Play, Show & Tell, Solution, Simulation
Apply, Calculate, Change, Classify, Compile, Compute, Construct, Demonstrate, Experiment, Implement, Manipulate, Plot, Predict, Present, Produce, Relate, Show, Solve

ANALYZING
Analyze Research, Case Study, Comparison, Critical Incident, Deductive Reasoning, Discussion, Graphs, Problem Exercise, Questionnaire, Report, Troubleshoot
Analyze, Appraise, Break down, Categorize, Compare, Contrast, Deconstruct, Differentiate, Diagram, Distinguish, Examine, Investigate, Organize, Outline, Research, Select, Separate, Simplify

EVALUATING
Argument, Case Study, Critique, Debate, Evaluation, Group Discussion, Project, Recommendation, Self Evaluation, Survey, Test Case Scenario, Values Statement, Written Conclusion
Judge, Prove, Rank, Rate, Recommend, Select, Support, Test, Value, Argue, Conclude, Convince, Criticize, Critique, Defend, Discriminate, Estimate, Evaluate

CREATING
Assemble Code, Concept Development, Create an Application, Experiment, Formulate a Plan, Data Collection, Invention, Modify Design Plans, Project, Proposal, Problem Solution, Simulation
Integrate, Invent, Make, Manage, Modify, Plan, Produce, Propose, Rewrite, Assemble, Combine, Compose, Construct, Create, Design, Develop, Formulate, Generate

COURSE INFORMATION SHEET

Course code: EC101
Course title: Basics of Electronics & Communication Engineering
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L: 3   T: 1   P: 0   C: 4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: 01/01
Branch: ALL B. Tech.
Name of Teacher: All

Course Objectives:

This course enables the students:

1.	To understand PN Junction, diodes and their applications.
2.	To comprehend BJT, FET and their bias configurations.
3.	To grasp importance of feedback in amplifier circuits, op amp and its applications.
4.	To understand number system, Logic Gates and Boolean algebra.
5.	To apprehend fundamentals of communication technology.

Course Outcomes:

After the completion of this course, students will be able to:

CO1	Explain PN Junction, diodes and their applications.
CO2	Appraise the BJT, FET and their biasing techniques.
CO3	Comprehend feedback in amplifier circuits, op amp and its applications.
CO4	Translate one number system into another, build circuits with Logic Gates, electronic components and OPAMP IC 741 and analyze the measurement results using CRO.
CO5	Appraise the fundamentals of communication technology.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-1 Diodes and Applications: Introduction to PN junction diodes; Characteristics of semiconductor diodes: V-I characteristics, diode-resistance, temperature-dependence, diode-capacitance; DC & AC load lines; Breakdown Mechanisms; Zener Diode – Operation and Applications; Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.	**12**
Module-2 **Bipolar Junction Transistors (BJT):** PNP and NPN Transistors, Basic Transistor Action, Input and Output Characteristics of CB, CE and CC Configurations, dc and ac load line analysis, operating point, Transistor biasing: Fixed bias, emitter bias/self-bias, Low-frequency response of CE amplifier. **Field Effect Transistors:** JFET, Idea of Channel Formation, Pinch-Off and saturation Voltage, Current-Voltage Output Characteristics; MOSFET: Basic structure, operation and characteristics.	**12**
Module-3 **Sinusoidal Oscillators**: Concept of positive and negative feedback, Barkhausen criterion for sustained oscillations, Determination of Frequency and Condition of oscillation, Hartley and Colpitt's oscillator	**8**

Operational Amplifiers: Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Inverting and non-inverting amplifiers, Offset error voltages and currents; Power supply rejection ratio, Slew Rate and concept of Virtual Ground, Summing and Difference Amplifiers, Differentiator and Integrator, RC phase shift oscillator.	
Module-4 **Logic Gates and Boolean algebra:** Introduction to Boolean Algebra and Boolean operators, Symbolic representation, Boolean algebraic function and Truth table of different Digital logic Gates (AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR); Realization of Basic logic gates using universal gates, Adder, Subtractor, adder/subtractor.	8
Module-5 **Electronic communication:** Introduction to electronic communication system, Electromagnetic Communication spectrum band and applications, Elements of Electronic Communication System; Merits and demerits of analog and digital communication, Modes of communication; Signal radiation and propagation; Need for modulation; Introduction to Amplitude modulation and Angle modulation.	10

Text Books:
1. Millman J., Halkias C.C., Parikh Chetan, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill, 2/e.
2. Mano M.M., "Digital Logic and Computer Design", Pearson Education, Inc, Thirteenth Impression, 2011.
3. Singal T. L., "Analog and Digital Communications", Tata McGraw-Hill, 2/e.
4. Haykin S., Moher M., "Introduction to Analog & Digital Communications", Wiley India Pvt. Ltd., 2/e.

Reference Book:

1. Boylstead R.L., Nashelsky L., "Electronic Devices and Circuit Theory", Pearson Education, Inc, 10/e.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: 3, 11, 12

Topics beyond syllabus/Advanced topics/Design: NA

POs met through Topics beyond syllabus/Advanced topics/Design: 2, 3, 11, 12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes:

Mapping of Course Outcomes onto Program Outcomes:

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	1	2	3	1	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	1	1	2	2	3	2	2	3	3	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD3, CD8
CD2	Quizzes	CO2	CD1, CD2, CD3, CD8
CD3	Assignments/Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

Course code: EC102
Course title: Electronics & Communication Lab
Pre-requisite(s):
Co- requisite(s):
Credits: L: 0   T: 0   P: 3   C: 1.5
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 01/01
Branch: ALL B. Tech.
Name of Teacher: ALL

Course Objectives:
This course enables the students:

1.	To demonstrate the measurement of voltage, frequency using CRO
2.	To explain PN junction characteristics and its applications.
3.	To understand the frequency response of BJT amplifier and OPAMP.
4.	To Realize logic gates and implement simple Boolean expression.
5.	To explain the Amplitude Modulation and Frequency Modulation

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Make use of CRO for measuring different parameters
CO2	Appraise PN junction characteristics and its applications.
CO3	Experiment with Diodes, BJT and OPAMP
CO4	Design specified circuit using given electronic components/ICs/logic gates.
CO5	Demonstrate the working of Amplitude Modulation and Frequency Modulation

Syllabus
List of Compulsory experiments:
1. **Name of the Experiment: MEASURMENTS USING CRO**
    AIM-1: To understand the Measurement of voltage, time period and frequency of
          different signals on CRO.

    AIM-2: To measure the frequency and phase of two different signals using Lissajous

          pattern.
2. **Name of the Experiment: PN JUNCTION CHARACTERISTICS**
    AIM-1: To determine the forward bias V-I characteristics of PN junction diode and
          finding its forward cut-in voltage.

    AIM-2: To determine the reverse bias V-I characteristics of PN junction diode and finding its

          reverse breakdown voltage.

3. **Name of the Experiment: ZENER DIODE**
    AIM-1: To design a basic voltage regulator circuit using Zener diode.

AIM-2: To determine the reverse bias V-I characteristics of Zener diode and finding its reverse

    breakdown voltage.

4. **Name of the Experiment: RECTIFIERS WITH FILTERS**.
   AIM-1: To understand the basic operation principle of Half-wave rectifier circuit and

    measurement of rectification efficiency and ripple factor with and without C-

    Filter.

    AIM-2: To understand the basic operation principle of Full-wave rectifier circuit and

    measurement of rectification efficiency and ripple factor with and without C-

    Filter.

    AIM-3: Simulate Half wave, Full wave and Bridge rectifier circuits and determine the

    following in each case

        i)   ripple factor
        ii)   ratio of rectification
        iii)   TUF.

AIM-4: Simulate Half wave rectifier circuit and observe the effect on rectification at high

    frequency.

5. **Name of the Experiment: CE TRANSISTOR AMPLIFIER**
   AIM-1: To understand the basic operation principle of CE transistor amplifier circuit and

    finding its frequency response..

    AIM-2: To determine the gain bandwidth product of CE transistor amplifier from its

    frequency response.

    AIM-3: To determine the minimum input voltage for which the CE transistor amplifier

    saturates for given gain.

6. **Name of the Experiment: FIELD EFFECT TRANSISTOR**
   AIM-1: To determine the output and transfer characteristics of JFET.

    AIM-2: To measure the voltage gain of JFET.

7. **Name of the Experiment: RC OSCILLATOR**.
   AIM-1: To design a RC phase shift oscillator using IC-741 Op-Amp.

AIM-2: To measure its frequency of oscillation and finding the percentage of error in

Comparison with the ideal one.

8. **Name of the Experiment: OPERATIONAL AMPLIFIERS**
AIM-1: To design the Inverting and Non-inverting amplifier using IC 741 OP-AMP.

AIM-2: To find its frequency response and calculate the gain bandwidth product.

AIM-3: To determine the minimum input voltage for which the inverting and non-inverting

amplifier saturates for the gains 100 and 101 respectively.

9. **Name of the Experiment: LOGIC GATES**
AIM-1: To understand basic Boolean logic functions (NOT, AND, OR).

AIM-2: To realize the basic logic gates (AND, OR, NOT) using NAND Gate (IC-7400).

10. **Name of the Experiment: BOOLEAN FUNCTION**
AIM-1: To understand AND Gate IC (IC 7408) and OR Gate IC (IC 7432)

AIM-2: To implement of the Boolean expression F = (A.B.C + D.E) using AND Gate(IC 7408)

and OR Gate (IC 7432).

11. **Name of the Experiment: AMPLITUDE MODULATION**
AIM-1: To analyze the Amplitude modulation for three different cases (under modulation,

critical modulation and over modulation) using standard setup.

. AIM-2: To determine the percentage of error between the ideal and actual observations.

12. **Name of the Experiment: FREQUENCY MODULATION**
AIM-1: To analyze the Frequency modulation using standard setup.

AIM-2: To determine the value of frequency deviation from the observation.

Text Books:
1. Millman J., Halkias C.C., Parikh Chetan, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill, 2/e.
2. Mano M.M., "Digital Logic and Computer Design", Pearson Education, Inc, Thirteenth Impression, 2011.
3. Singal T. L., "Analog and Digital Communications", Tata McGraw-Hill, 2/e.
4. Haykin S., Moher M., "Introduction to Analog & Digital Communications", Wiley India Pvt. Ltd., 2/e.

Reference Book:

1. Boylstead R.L., Nashelsky L., "Electronic Devices and Circuit Theory", Pearson Education, Inc, 10/e.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –
1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	1	2	2	2	2	2	2	1
CO2	3	3	1	2	3	1	2	1	2	2	2	2	2	2	1
CO3	3	2	1	2	3	1	2	1	2	2	2	2	2	2	1
CO4	3	3	1	2	3	1	2	1	2	2	2	2	2	2	1
CO5	3	2	1	2	3	1	2	1	2	2	2	2	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

<div align="center">**COURSE INFORMATION SHEET**</div>

Course code: EC201
Course title: Electronic Devices
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: III/02
Branch: ECE
Name of Teacher:

Course Objectives

This course envisions to impact to students to:

1.	Understand Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors.
2.	Grasp the impact of Excess Carriers in Semiconductors, Optical Absorption, Carrier Lifetime, Photoconductivity and Diffusion of Carriers and apply the obtained knowledge.
3.	Appraise and analyse the characteristics of PN Junction and Junction Diodes.
4.	Evaluate the characteristics of Bipolar Junction Transistor (BJT).
5.	Comprehend the characteristics of Field-Effect Transistors and create their structures.

Course Outcomes

After the completion of this course, a student will be able to:

CO1	Describe and illustrate the Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors.
CO2	Sketch and explain the Carrier Transport Phenomena in semiconductor.
CO3	Illustrate with the sketch of the structure of PN Junction and Junction Diodes diagram their characteristics and analyse them.
CO4	Appraise the principle of operation BJTs, schematize their characteristics, assess and summarize their features.
CO5	Schematize the structure and design Field Effect Transistors. Schematize their characteristics and prepare an inference.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors:** Quantum Mechanics, Bonding Forces and Energy Bands in Solids, Direct and Indirect Semiconductors, **LED**, Variation of Energy Bands with Alloy Composition, Effective Mass, Electrons and Holes in Quantum Wells, **Gunn Diode,** Temperature Dependence of Carrier Concentrations, Conductivity and Mobility, High-Field Effects, The Hall Effect.	**8**
Module – II **Excess Carriers in Semiconductors:** Optical Absorption, Luminescence, Carrier Lifetime and Photoconductivity, Solar Cells; Diffusion of Carriers: Diffusion Processes, Diffusion and Drift of Carriers; Built-in Fields, Diffusion and Recombination; The Continuity Equation, Steady State Carrier Injection; Diffusion Length, The Haynes–Shockley Experiment.	**8**
Module – III **PN Junction and Junction Diodes:** Charge at Junction, Contact Potential, Capacitance of p-n Junctions, Reverse-Bias Breakdown, **Zener diode, Varactor Diode,** Effects of Contact Potential on Carrier Injection, Recombination and Generation in Transition Region, Metal–Semiconductor Junctions, PIN diodes, Step Recovery Diodes, IMPATT diodes, Tunnel Diode.	**8**
Module – IV **Bipolar Junction Transistor (BJT):** Fundamentals of BJT Operation, Amplification with BJTs, Minority Carrier Distributions and Terminal Currents, Drift in the Base Region, Base Narrowing,	

Avalanche Breakdown, Gummel–Poon Model, Kirk Effect; Frequency Limitations of Transistors, High-Frequency Transistors, Heterojunction Bipolar Transistors.	**8**
Module – V **Field-Effect Transistors:** Junction FET, GaAs MESFET, High Electron Mobility Transistor (HEMT); Metal–Insulator–Semiconductor FET, MOSFET: Output Characteristics, Transfer Characteristics, Mobility Models, Short Channel MOSFET I–V Characteristics, Threshold Voltage Expression, Substrate Bias Effects, Subthreshold Characteristics, Equivalent Circuit for the MOSFET, CMOS processes.	**8**

Textbooks:
1. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014.
2. J. P. Colinge, C. A. Colinge, "Physics of Semiconductor Devices", Springer Science & Business Media, 2007.

Reference books:
1. SM Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3/e, Wiley-Interscience, 2006.
2. Donald A. Neamen, Dhrubes Biswas "Semiconductor Physics and Devices", 4/e, McGraw-Hill Education, 2012.

Gaps in the syllabus (to meet Industry/Profession requirements):
1. Hands-on-practical for Device fabrication.

POs met through Gaps in the Syllabus:
   10

Topics beyond syllabus/Advanced topics/Design:
1. **N/A**

POs met through Topics beyond syllabus/Advanced topics/Design:
   10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment
1. Students' Feedback on Course Outcome.

Mapping between Course Outcomes and Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	3	3	1	1			3		3	3	2	1
CO2	3	3	2	3	3	2	1			3		3	3	2	1
CO3	3	3	2	3	3	2	1			3		3	3	2	1
CO4	3	3	2	3	3	3	1			3		3	3	2	1
CO5	3	3	2	3	3	3	1			3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC202
Course title: Electronics Device Lab
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering,
Co- requisite(s): EC201 Electronic Devices
Credits: L: 0   T: 0   P: 3   C: 1.5
Class periods per week: 03
Class: B. Tech.
Semester / Level: III/02
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	understand the material and electrical parameters of intrinsic and extrinsic semiconductor materials.
2.	understand the basic characteristics of MOS transistor, Tunnel diode and solar cell
3.	apply their understanding to use advance design TCAD tool to obtain the material and electrical parameters of intrinsic and extrinsic semiconductor materials.
4.	apply their understanding to use advance design TCAD tool to describe basic characteristics of BJT and MOS transistors and inverter.
5.	apply their understanding to use advance design TCAD tool to analyze characteristics of inverter.

Course Outcomes

After the completion of this course, students will be able to:

CO1	analyse the material and electrical parameters of intrinsic and extrinsic semiconductor materials.
CO2	measure the basic characteristics of Tunnel diode and solar cell
CO3	measure the basic characteristics of MOS transistors
CO4	use the advance design tool TCAD to evaluate the material and electrical parameters of intrinsic and extrinsic semiconductor materials.
CO5	use the advance design tool TCAD to construct BJT, MOS transistors and inverter and evaluate their characteristics.

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC201 Electronic Devices** is the syllabus for the **EC202 Electronic Devices Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of Compulsory experiments:
1. Identify the type of semiconductor material and calculate the mobility, conductivity and carrier concentration of majority carriers using Hall Effect experiment.

2. Calculate the bandgap of semiconductor materials.

3. Measure the I-V characteristics of an NPN transistor in Common Emitter (CE) mode.

4. Measure the Id-Vd and Id-Vg characteristics of an enhancement mode nMOSFET and a depletion mode nMOSFET.

5. Measure the I-V characteristics of a tunnel diode.

6. Evaluate the I-V characteristics of an illuminated pn junction (solar cell).

7. Evaluate the parameters (sheet resistance, mobility, saturation velocity, etc.) of the intrinsic and the extrinsic semiconductor materials using TCAD tool.

8. Construct a silicon pn junction diode and evaluate I-V characteristics curve using TCAD tool.

9. Develop an NPN Transistor and measure the I-V characteristics curves in Common Emitter (CE) mode using TCAD tool.

10. Develop an enhancement mode nMOSFET and measure Id-Vd and Id-Vg characteristics using TCAD tool.

11. Construct an enhancement mode pMOSFET and measure Id-Vd and Id-Vg characteristics using TCAD tool.

12. Design a CMOS inverter and asses the DC/transient characteristcs using TCAD tool.

List of Optional experiments:

1. Calculate the mobility and the diffusion coefficient of minority carriers using Haynes Shockley experiment.

2. Evaluate the I-V characteristics of an NPN transistor in Common Collector (CC) mode.

3. Measure the I-V characteristics of an NPN transistor in Common Base (CB) mode.

4. Evaluate the I-V characteristics of a PNP transistor in Common Emitter (CE) mode.

5. Measure the I-V characteristics of a PNP transistor in Common Collector (CC) mode.

6. Evaluate the I-V characteristics of a PNP transistor in Common Base (CB) mode.

7. <mark>Demonstrate</mark> the I-V characteristics of forward and reverse biased Silicon and Germanium pn-junction diode.

8. <mark>Demonstrate</mark> the I-V characteristics of forward and reverse biased Zener diode. Study the breakdown characteristics of the Zener diode.

9. <mark>Construct</mark> a PNP Transistor and evaluate the I-V characteristics curves in Common Emitter (CE) mode using TCAD tool.

10. <mark>Demonstrate</mark> diode application as a rectifier using TCAD tool

11. <mark>Construct</mark> a depletion mode nMOSFET and <mark>evaluate</mark> Id-Vd and Id-Vg characteristics using TCAD tool.

12. <mark>Construct</mark> a depletion mode pMOSFET and <mark>evaluate</mark> Id-Vd and Id-Vg characteristics using TCAD tool.

Books recommended:
Textbooks:
3. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014.
4. J. P. Colinge, C. A. Colinge, "Physics of Semiconductor Devices", Springer Science & Business Media, 2007.
5. J. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd ed., Prentice Hall, 2003.

Reference books:
3. SM Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3/e, Wiley-Interscience, 2006.
4. Donald A. Neamen, Dhrubes Biswas "Semiconductor Physics and Devices", 4/e, McGraw-Hill Education, 2012.
5. Cogenda Visual TCAD tool user manual.

Gaps in the syllabus (to meet Industry/Profession requirements):

1. Hands-on-practical for Device fabrication.

POs met through Gaps in the Syllabus:
    10

Topics beyond syllabus/Advanced topics/Design:
    N/A

POs met through Topics beyond syllabus/Advanced topics/Design:
    10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz(zes)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	3	3	3	3	3
Semester End Examination	3	3	3	3	3

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	1	1	1		3		3	3	2	2
CO2	3	3	3	3	3	1	1	1		3		3	3	2	2
CO3	3	3	3	3	3	1	1	1		3		3	3	2	1
CO4	3	3	3	3	3	1	1	1		3		3	3	2	1
CO5	3	3	3	3	3	1	1	1		3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6, CD7
CO2	CD1, CD3, CD6, CD7
CO3	CD1, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC203
Course title: Digital System Design
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering
Co- requisite(s):
Credits:　　　**L: 3**　　**T:0**　　**P:0**　　**C:3**
Class schedule per week: 3x1
Class: B. Tech
Semester / Level: III/02
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the basics of digital electronics.
2.	Apply the knowledge of digital electronics to construct various digital circuits.
3.	Analyze the characteristics and explain the outputs of digital circuits.
4.	Evaluate and asses the application of the digital circuits.
5.	Design digital machine for simple computing and control.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Explain the concept of digital electronics.
CO2	Apply the knowledge to produce digital electronics circuits.
CO3	Analyse and categorize digital circuits.
CO4	Justify the uses of different digital circuits.
CO5	Schematize and demonstrate simple computing machines.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Basics of Digital Electronics: Number representation, Binary number system, Number base conversion, Octal, Hexadecimal and BCD codes, Binary Arithmetic, Logic gates, Introduction to VHDL and Verilog, VHDL Models, Logic Families: TTL, ECL, and CMOS Logic Circuits, Logic levels, voltages and currents, fan-in, fan-out, speed, power dissipation. Comparison of logic families.	**8**
Module – II Simplification of Boolean functions: Boolean Algebra, Basic theorems and Properties, De Morgan's theorem, Canonical & Standard forms, Simplification of a Boolean function using Karnaugh map, POS & SOP simplification, Prime implicant, NAND and NOR implementation.	**8**
Module – III **Design of Combinational Circuits:** Analysis and design procedure, Parity Generators and Checkers, Adders, Subtractors, Look ahead carry, Adder, 4-bit BCD adder/subtractor, Magnitude comparator, Decoders, Encoders, Multiplexers, De-multiplexers, Design of 1 bit ALU for basic logic and arithmetic operations.	**8**
Module – IV **Design of Sequential Circuits and Memories:** Basic Latch, Flip-Flops (SR, D, JK, T and Master-Slave), Triggering of Flip Flops, Synchronous and asynchronous counters, Registers, Shift Registers, Memories and Programmable Logic design, Types of memories, Memory Expansion and its decoding, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL)	**8**
Module – V **Design of simple computing machines:** SAP-I concepts with stress on timing diagrams, Microinstructions, Fetch and Execution cycle variable machine cycle, Hardware control Matrix, Macroinstructions, Microprogramming, Bus concepts, Multiplexed Minimum system. Pipelining concepts.	**8**

Books recommended:
Textbooks:
1. "Digital Design", Morris Mano and Michael D. Ciletti ,5th edition PHI
2. "Digital System Design using VHDL", Charles H Roth, Thomson Learning

Reference books:

1. Digital computer Electronics AP Malvino, 3rd Edition Mc Graw Hill

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design: Computer System Architecture

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			3		3	3	3	2
CO2	3	3	2	3	3	3	2			3		3	3	3	2
CO3	3	3	2	3	3	3	2			3		3	3	3	2
CO4	3	3	2	3	3	2	2			3		3	3	3	2
CO5	3	3	2	3	3	2	2			3		3	3	3	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD 8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD 8
CD3	Seminars	CO3	CD1, CD2, CD5, CD 8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD5, CD 8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD5, CD 8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC204
Course title: Digital System design Lab
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering
Co- requisite(s):
Credits: L:0   T:0   P:3   C:1.5
Class schedule per week: 03
Class: B. Tech
Semester / Level: III/ 02
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the basics of logic gates, input, output, power supply, and gates IC's.
2.	Apply the knowledge of digital electronics to construct combinational and sequential circuits.
3.	Analyze controlled digital circuits with different Boolean function.
4.	Evaluate combinational/sequential circuits and memories.
5.	Translate real-world problems into digital logic formulations using VHDL.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Describe the knowledge of basic logic gates and their design using universal gates.
CO2	Demonstrate the working of combinational and sequential circuits.
CO3	Integrate and experiment with controlled digital circuits.
CO4	Appraise combinational/sequential circuits and memories.
CO5	Schematize, simulate and implement combinational and sequential circuits to solve real-world problems using VHDL systems.

SYLLABUS

List of experiments:

1. **Name of the Experiment: CMOS INVERTER**
   AIM1: Design and implement AND OR and NOT gate using CMOS Inverter.
2. **Name of the Experiment: EX-OR GATE**
   AIM1:To study and verify the truth table of NAND and EX-OR gate using IC 7400.
3. **Name of the Experiment: SEVEN SEGMENT DISPLAY**
   AIM1: Design and implement SEVEN segment display unit.
4. **Name of the Experiment: ADDER CIRCUITS**
   AIM1: Design and verify half adder and full Adder circuits using gates and IC 7483.
5. **Name of the Experiment: DECODER CIRCUITS**
   AIM1: Design and implement a 3:8 Decoder.
6. **Name of the Experiment: ENCODER CIRCUITS**
   AIM1: Design and implement 8:3 priority encoder.
7. **Name of the Experiment: MAGNITUDE COMPARATOR**
   AIM1: Design a 4 bit magnitude comparator using combinational circuits.
8. **Name of the Experiment: MUX & DEMUX**
   AIM1:Design and implement 8:1 multiplexer and 1:4 demultiplexer.
9. **Name of the Experiment: ARITHMETIC AND LOGICAL UNIT**
   AIM1: Design ALU with functions of ADD, SUB, INVERT, OR, AND. XOR, INC, DEC, and CMP.
10. **Name of the Experiment: DECADE COUNTER**
    AIM1: Design and verify the Decade Counter.
11. **Name of the Experiment: DIODE ROM**
    AIM1: Design a ROM (8X4) using a decoder, gates, and diodes.
12. **Name of the Experiment: UP/DOWN COUNTER**
    AIM1: Design of pre settable up/down counter.
    ## Implement all the above experiments using VHDL platform and verify.

Books recommended:

Textbooks:

1. "Digital Design", Morris Mano and Michael D. Ciletti ,5th edition PHI
2. "Digital System Design using VHDL", Charles H Roth, Thomson Learning

Reference books:

2. Digital computer Electronics AP Malvino, 3rd Edition Mc Graw Hill

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –
1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	3	1	1	1		3		3	2	2	1
CO2	3	3	3	3	3	1	1	1		3		3	2	2	1
CO3	3	3	3	3	3	1	1	1		3		3	2	2	1
CO4	3	3	3	3	3	1	1	1		3		3	2	2	1
CO5	3	3	3	3	3	1	1	1		3		3	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC205
Course title: Signals and Systems
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: III/02
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

1.	To understand the fundamental characteristics of signals and systems.
2.	To understand the concepts of different transforms for signal and system.
3.	To understand signals and systems in terms of both the time and transform domains.
4.	To develop the mathematical skills to solve problems involving convolution, filtering, modulation, and sampling.
5.	To understand the response of LTI systems using Transform theory.

Course Outcomes:
After the completion of this course, a student will be able to

CO1	define signal, systems and its importance in life.
CO2	represent the signal in the time domain as well as in Frequency domain and find the response of the system.
CO3	explain the transform theory and its importance to analyze signal and system.
CO4	identify system properties based on impulse response and Fourier analysis.
CO5	explain Sampling theorem and its importance in discrete time systems representation.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **INTRODUCTION TO SIGNALS AND SYSTEMS:** Signals and systems as seen in everyday life and in various branches of engineering and science, Signal properties: periodicity, absolute integrability, determinism, and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.	9
Module – II **BEHAVIOR OF CONTINUOUS AND DISCRETE-TIME LTI SYSTEMS:** Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of frequency response and its relation to the impulse response.	9
Module – III **FOURIER** AND **LAPLACE TRANSFORMS:** Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality, Laplace Transform for continuous-time signals and systems, Transfer/system functions, poles and zeros of system functions and signals, Laplace domain analysis, the solution to differential equations and system behavior.	8
Module – IV Z-**TRANSFORM**, **DTFT, AND DFT:** Z-transform, Region of convergence and its properties, Inverse Z transform, properties of ZT, The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT), Parseval's Theorem., Properties of DTFT and DFT, convolution property, multiplication property, Duality, Systems Characterized by Linear Constant Coefficient Difference Equation, The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.	7
Module – V	

SAMPLING AND RECONSTRUCTION:	7
The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. The relation between continuous and discrete time systems. Applications of signal and system theory: modulation for communication, filtering, feedback control systems.	

Books recommended:

Textbooks:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.

Reference books:

1. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications.
2. Robert A. Gable, Richard A. Roberts, Signals & Linear Systems
3. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
4. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
5. Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.
6. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.

Gaps in the Syllabus (to meet Industry/Profession requirements)

Signals and Systems is an advance course; hence it only lays down the foundation of pattern recognition and classification problem.

POs met through Gaps in the Syllabus
May be met through laboratory simulations, experiments, and design problems.

Topics beyond syllabus/Advanced topics/Design

1. Application of **Signals and Systems** in the analysis of time varying signal.
2. Extraction of Pattern vector from time varying signal for the development of decision support system for various applications.

POs met through Topics beyond syllabus/Advanced topics/Design
Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	2	3	3	2	3	1	2	3	3	3	3	3	3	2
CO2	2	2	3	3	2	3	1	2	3	3	3	3	3	3	2
CO3	2	2	3	3	2	3	1	3	3	3	3	3	3	3	2
CO4	2	2	3	3	2	3	1	2	3	3	3	3	3	3	2
CO5	1	1	1	1	1	1	1	1	1	1		1	3	3	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC208**
Course title: **Electronic Measurement Lab**
Pre-requisite(s): **EC101 Basics of Electronics & Communication Engineering**
Co- requisite(s):
Credits:　　　L:　　　T: 0　　P: 4　　C: 2
Class schedule per week: 04 Class: B. Tech.
Semester / Level: III/02 Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the concepts of calibration and measurement.
2.	Apply the concepts of AC bridges for the measurements of the different electrical parameters.
3.	Explain the basic principles of transducers and their uses for the measurements of different physical parameters.
4.	Demonstrate the signal analysis using digital storage oscilloscope.
5.	Design the signal conditioners and converters for different applications.

Course Outcomes
After the completion of this course, students will be able to:

CO1	To list the functions of various components of a measurement system.
CO2	Describe the balancing of different AC bridges and calculate unknown resistance, inductance, quality of a coil, and capacitance at balance condition.
CO3	Calibrate and measure different physical parameters using measurement systems.
CO4	Find and investigate the errors in measuring a parameter.
CO5	Schematize electronic measurement systems for the measurement of different physical parameters.

SYLLABUS
List of experiments:

1. Name of the Experiment
AC BRIDGES

Aim1. Balancing Maxwell's Bridge and measurements of Inductance, DC Resistance, and quality factor of a medium Q coil.

Aim2. Balancing Schering's Bridge and measurements of Capacitance, leakage Resistance, and quality factor of a capacitor.

2. Name of the Experiment
WIEN'S Bridge Measurements

Aim1. Balancing Wien's Bridge and measurements of frequency of unknown sinusoidal signal.

Aim2. Balancing Wien's Bridge and measurements of total harmonic distortion of a 1Khz non-sinusoidal signal.

3. Name of the Experiment
STRAIN GAUGES

Aim1. Calibration and measurement of pressure (in Kg/cm^2) using diaphragm and strain gauge.

4. Name of the Experiment
Temperature Transducers

Aim1. Calibration and measurement of temperature (in ^{o}C) using RTD.

Aim2. Calibration and measurement of temperature (in ^{o}C) Thermocouple, and Thermistor.

5. Name of the Experiment
SPEED MEASUREMENT

Aim1. Measurement of rotating speed in (RPM) using Photo-reflective and Magnetic pickup sensor.

Name of the Experiment
6. LVDT

Aim1. Calibration and measurement of displacement (in mm) using LVDT.

7. Name of the Experiment
LEVEL MEASUREMENT

Aim1. Calibration and measurement of the level (in cm) using Load Cell

8. Name of the Experiment
TORQUE MEASUREMENT

Aim1. Torque Measurement (in kgm) using reaction torque sensor.

9. Name of the Experiment
DAC

Aim1. Design of bipolar DAC using the R-2R Ladder network.

10. Name of the Experiment
INSTRUMENTATION AMPLIFIER

Aim1. Design and implementation of an instrumentation amplifier for a variable gain of 50, 100 and 200.

11. Name of the Experiment
ADC

Aim1. Design Analog to Digital convertor using voltage to frequency converter technique.

12. Name of the Experiment

RISE TIME MEASUREMENT

Aim1. Measurement of the rise time of the RC circuit using Digital Storage Oscilloscope.

Books recommended:

Textbooks:

1. "Electrical and Electronic Measurements and Instrumentation" by A. K. Sawhney.
2. "Modern Electronic Instrumentation & Measurement Techniques" by Helfrick& Cooper.

Reference books:

1. "Electronic Instrumentation", by H. S. Kalsi.

Gaps in the syllabus (to meet Industry/Profession requirements): Visit CIF lab at BIT Mesra.

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: Smart Sensors and Transmitters

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz(zes)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Indirect Assessment
1. Students' Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	3	3	1	1	1		3		3	2	2	1
CO2	3	3	3	3	3	1	1	1		3		3	2	2	1
CO3	3	3	3	3	3	1	1	1		3		3	2	2	1
CO4	3	3	3	3	3	1	1	1		3		3	2	2	1
CO5	3	3	3	3	3	1	1	1		3		3	2	2	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5, CD8, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD5, CD8, CD9
CD3	Seminars	CO3	CD1, CD5, CD8, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5, CD8, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD8, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC251
Course title: **Probability and Random Processes**
Pre-requisite(s): EC205 Signals and Systems
Co- requisite(s):NA
Credits:　　　　L: 3　　T: 0　　P: 0　　C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: IV/02
Branch: ECE
Name of Teacher:
Course Objectives:
This course enables the students:

1.	To explain the random phenomena and impart knowledge on the mathematical modelling of the random experiment.
2.	To develop an ability to describe random vectors and their characterization.
3.	To develop an ability to understand the concept of random processes or stochastic processes.
4.	To develop an ability to analyze the stochastic processes with the help of probability models and its characterization
5.	To develop an ability to evaluate different emerging techniques to improve real-time estimation and detection of random parameters.

Course Outcomes:

After the completion of this course, students will be able to:

CO1	Demonstrate an understanding of the mathematical modelling of the random experiment or random phenomena.
CO2	Describe random vectors and their characterization.
CO3	Demonstrate an understanding of the concept of random processes or stochastic processes.
CO4	Analyze the stochastic processes with the help of probability models and their characterization.
CO5	Evaluate the different emerging techniques to improve real-time estimation and detection of random parameters.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Randomness, Uncertainty and its Description** Random experiments/phenomenon, outcomes of the random experiment, Sample Space, Events, Probability of an event, Concepts of sets and probability theory to explain Random experiments, Probability space; Conditional probability, Independence and Bayes theorem; Combinatorial probability and sampling models.	8
Module – II **Random Variable and its characterization:** Continuous random variables: distribution function, probability density function, Conditional Densities and Distributions, an example of distributions, Gaussian, Rayleigh, and Rician; exponential, chi-squared; gamma. Discrete random variables: distribution function, probability mass function, Example of random variables and distributions (Bernoulli, binomial, Poisson, geometric, negative binomial, etc.), Expectations, Variance, MGF and Characteristics Function of Random Variable, moments of Random Variable.	9
Module – III **Random vector and its characterization:** Joint Events, Joint CDF and PDF, Properties of Joint CDF and PDF, Bivariate Gaussian Distributions, Joint Moments, Random Vectors, Vector Gaussian Random Variables, Moments of Random Vectors, Independence of two random vectors,	9
Module – IV **Inequalities, Convergences, and Limit Theorems**: Random sequences Markov, Chebyshev and Chernoff bounds; modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Stochastic convergence, the law of large numbers, central limit theorem, Limit theorems; Strong and weak laws of large numbers.	8
Module – V **Random Processes and Linear Systems:**	6

Random Data/Signals, stationarity; mean, correlation, and covariance functions, WSS random process; autocorrelation and cross-correlation functions; transmission of a random process through a linear System; power spectral density; white random process; Gaussian process; Poisson process, Application of Probability and Random Processes to understand important domain like digital communication, estimation and information theory.

Text Books:

1. Papoulis. A.," Probability, Random variables, and Stochastic Processes", McGraw Hill, 2002.

2. H.Stark & J.W.Woods, "Probability, Random Processes and Estimations Theory for Engineers", (2/e), Prentice Hall, 1994

Reference Book:

1. E.Wong, "Introduction to Random Processes", Springer Verlag, 1983.

2. W.A.Gardner, "Introduction to Random Processes", (2/e), McGraw Hill, 1990.

3. Davenport," Probability and Random Processes for Scientist and Engineers", McGraw-Hill, 1970.

Gaps in the Syllabus (to meet Industry/Profession requirements)

Probability and Random Processes is an advance course; hence it only lays down the foundation of pattern recognition and classification problem.

POs met through Gaps in the Syllabus
　　　　May be met through laboratory simulations, experiments, and design problems.

Topics beyond syllabus/Advanced topics/Design

1. Application of **Probability and Random Processes** in the analysis of time varying signal.
2. Extraction of Pattern vector from time varying signal for the development of decision support system for various applications.

POs met through Topics beyond syllabus/Advanced topics/Design
　　　　Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

    1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	2	2	3	3	2	3	1	2	3	3	3	3	3	3	1
CO2	2	2	3	3	2	3	1	2	3	3	3	3	3	3	1
CO3	2	2	3	3	2	3	1	3	3	3	3	3	3	3	1
CO4	2	2	3	3	2	3	1	2	3	3	3	3	3	3	1
CO5	1	1	1	1	1	1	1	1	1	1		1	3	3	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8

CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC253**
Course title: **Analog Circuits**
Pre-requisite(s): **EC101 Basics of Electronics & Communication Engineering**
Co-requisite(s): None
Credits: L: 3   T: 0   P: 0   C: 3.0
Class schedule per week: 03

Class: B. Tech
Semester / Level: 04
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students:

1.	To help them understand the operation of Transistors for low frequency applications and power amplifiers
2.	To know the operation of multistage amplifiers and transistors for high frequency applications and tuned amplifiers
3.	To help them understand the operation of feedback amplifiers and oscillators
4.	To help them realize the non-linear applications of op-amp and filters
5.	To help them design the analog-to-digital and digital-to-analog converters

Course Outcomes
After the completion of this course, students will be able to:

CO1	Understand the concept of amplifiers, oscillators and active filter circuits.
CO2	Demonstrate the working of amplifiers, oscillators and active filter circuits.
CO3	Analyze amplifiers, filters at low and high frequency.
CO4	Evaluate amplifiers, filters and converter circuits.
CO5	Schematize amplifiers, oscillators and filter circuits for practical applications.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Review of hybrid models of BJT, simplified hybrid models of CE, CB, CC configurations, CE amplifier with emitter resistance, Emitter follower, High-	**10**

input-resistance transistor circuits: Darlington Circuit, Cascode Amplifier. **Transistor Power Amplifiers:** Circuits and Operations of Class A, Class B, Class C and Push-Pull Configurations.	
Module – II Multistage amplifiers: Frequency response of an amplifier, Bandpass of cascaded stages, Low frequency response of RC coupled amplifier. Transistors at High Frequencies: Hybrid π model and parameters; high frequency response of CE transistor amplifier, Gain-Bandwidth product, Emitter follower at high frequencies, FET (CS & CD) at high frequencies. Tuned amplifiers: single-tuned amplifier, synchronously tuned amplifier, Gain-Bandwidth product.	**10**
Module – III **Feedback Amplifiers:** Classification of amplifiers, feedback concept, transfer gain with feedback, characteristics of negative-feedback amplifier, method of analysis of feedback amplifiers, voltage-series feedback, current-series feedback, current-shunt feedback, voltage-shunt feedback. Concept of stability, gain margin and phase margin. **Oscillators:** RC phase shift oscillator, Wien bridge oscillator, crystal oscillator. Current mirror circuits.	**7**
Module – IV Emitter-coupled differential amplifier, transfer characteristics of differential amplifier, IC of operational amplifier: gain stages and output stages, Electronic analog computation using op-amp, Non-linear applications of OP-AMP: zero-crossing detector, precision rectifier, peak detector, logarithmic amplifier, Schmitt trigger. **Active filters:** Low pass, high pass, band pass and band stop, design guidelines.	**8**
Module – V Sample-and-hold circuit, **D/A converters:** Weighted-resistor D/A Converter, R-2R Ladder type D/A converter, Specifications for D/A Converters. **A/D Converters:** Parallel-comparator type A/D converter, Successive approximation type A/D converter, Counter type A/D converter, Dual slope converter, Comparison of converter types.	**5**

Text books:
1. "Integrated Electronics", Millman & Halkias, TMH
2. "Electronics Circuits: Discrete and Integrated", D. Schilling and C. Belove, McGraw-Hill

3. "Operational Amplifiers and Linear Integrated Circuits" by R. A. Gayakwad, PHI
4. "Digital Integrated Electronics". Taub & Schilling, TMH.

Reference books:
1. "Electronic Devices and Circuit", Millman , Halkias, S Jit, TMH
2. "Micro Electronic Circuits", A. S. Sedra and K. C. Smith, Oxford press

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
Mid semester examination	25
Two quizzes	20 (2×10)

Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment
1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			3		3	3	3	3
CO2	3	3	2	3	3	2	1			3		3	3	3	3
CO3	3	3	2	3	3	2	1			3		3	3	3	3
CO4	3	3	2	3	3	3	1			3		3	3	3	3
CO5	3	3	2	3	3	3	1			3		3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6, CD7
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: **EC254**
Course title: **Analog Circuits Lab.**
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering
Co- requisite(s): Analog Circuits
Credits:　　　L: 0　　T: 0　　P: 3　　C: 1.5
Class periods per week: 03
Class: B. Tech.
Semester / Level: IV
Branch: ECE
Name of Teacher:
Course Objectives
This course enables the students to:

1.	Realize the two-stage amplifier and simple tuned amplifier circuits.
2.	Implement the Feedback amplifier circuits.
3.	Realize the differential amplifier and oscillator.

4.	Realize the active band pass, band stop filter circuits.
5.	Know the operation of analog-to-digital and digital-to-analog converter circuits.

Course Outcomes
After the completion of this course, students will be able to:

CO1	Design two-stage amplifier and simple tuned amplifier circuits.
CO2	Analyze and analyze the feedback amplifier circuits.
CO3	Characterize and Characterize the differential amplifier and oscillator.
CO4	Characterize the active band pass, band stop filter circuits.
CO5	Design the analog-to-digital and digital-to-analog converter circuits.

SYLLABUS

List of Compulsory experiments:

Experiment No.	Name of the Experiments
1.	Determine the h-parameters: hie and hfe of a transistor. AIM1: Design a CE transistor circuit to evaluate the hie. AIM2: Design a CE transistor circuit to evaluate the hfe.
2.	Design and obtain the frequency response characteristics of Darlington pair amplifier. AIM1: Design the circuit of a Darlington pair amplifier in emitter follower configuration and find the current gain of Darlington pair. AIM2: Find the frequency response of the Darlington pair amplifier.
3.	Determine the frequency response of Cascode Amplifier and find the input resistance and output resistance of the amplifier. AIM1: Design the BJT based cascode amplifier and find the frequency response. AIM2: Find the input and output resistance of the amplifier.

4.	Find the frequency response of (a) single stage and (b) multistage amplifiers. Determine the mid-band gain and bandwidth of the amplifiers. AIM1: Find the frequency response of single stage CE amplifier and determine the mid-band gain and bandwidth. AIM2: Find the frequency response of multistage CE amplifiers and determine the mid-band gain and bandwidth.
5.	Design a BJT based tuned amplifier. Find its frequency response. AIM1: Design a BJT based tuned amplifier and Find its frequency response. AIM2: Compare the theoretical resonant frequency with the experimental result.
6.	Design (a) current-series, and (b) voltage-shunt feedback amplifier. Find the frequency response of both amplifiers with and without feedback. AIM1: Design current-series feedback amplifier and Find the frequency response. AIM2: Design voltage-shunt feedback amplifier and Find the frequency response.
7.	Design a Wein bridge oscillator. AIM1: Design the Wein bridge oscillator using BJT / op-amp and calculate the theoretical gain of the main amplifier. AIM2: Observe and plot the output waveform.
8.	Design a differential amplifier using BJT and determine the CMRR. AIM1: Design a differential amplifier using BJT and determine the differential mode gain at different frequencies. AIM2: Design a differential amplifier using BJT and determine the common mode gain at different frequencies. Find the CMRR at those frequencies.
9.	Design and determine the characteristics of logarithmic and antilogarithmic amplifiers using op-amp. AIM1: Design a logarithmic amplifiers using op-amp and plot the output. AIM2: Design an antilogarithmic amplifiers using op-amp and plot the output.
10.	Design and determine the characteristics of Active filters: band pass, band stop. AIM1: Design a band pass filter and find frequency response. AIM2: Design a band stop filter and find frequency response.
11.	Construction of R-2R Ladder type 4-bit D/A converter. AIM1: Design an R-2R Ladder type 4-bit D/A converter using op-amp and find the analog output voltage for all the digital inputs. AIM2: Find the resolution of the converter.
12.	Construction of counter type A/D Converter. AIM1: Design a counter type A/D converter and find the digital output bits for different analog inputs. AIM2: Find the resolution of the converter.

Text books:
 1. "Integrated Electronics", Millman & Halkias, McGraw Hill.

Reference books:
1. "Electronic Devices and Circuit Theory", Nashelesky & Boylestead, PHI/Low price edition.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

POs met through Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	**60**

Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz(zes)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment
1. **Student Feedback on Faculty**
2. **Student Feedback on Course**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			3		3	3	3	3
CO2	3	3	2	3	3	2	1			3		3	3	3	3
CO3	3	3	2	3	3	2	1			3		3	3	3	3
CO4	3	3	2	3	3	3	1			3		3	3	3	3
CO5	3	3	2	3	3	3	1			3		3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3, CD7
CO2	CD3, CD7
CO3	CD3, CD7
CO4	CD3, CD7
CO5	CD3, CD7

COURSE INFORMATION SHEET

Course Code: EC255
Course Title: Analog Communication
Pre-requisite(s):): Good understanding of mathematical tools like integration, differentiation etc.
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Fourth/Second
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	Explain analog communication system and representation of signals.
2.	Explain different methods of amplitude modulation and demodulation schemes, their design, operation and applications.
3.	Explain different methods of angle modulation and demodulation schemes, their design, operation and applications.

4.	Explain different methods of pulse modulation, their design, operation and applications.
5.	Evaluate the performance of analog communication system in the presence of noise.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate an understanding on analog communication system and representation of signals.
CO2	Demonstrate an understanding on different methods of amplitude modulation and demodulation schemes, their design, operation and applications.
CO3	Demonstrate an understanding on different methods of angle modulation and demodulation schemes, their design, operation and applications.
CO4	Demonstrate an understanding on different methods of pulse modulation, their design, operation and applications.
CO5	Evaluate the performance of analog communication system in the presence of noise.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Signal analysis** Time domain and frequency domain representation of a signal, fourier series, complex fourier spectrum (discrete spectrum or line spectrum), fourier transform, properties of fourier transform, energy and power spectral density spectrum, distortion less transmission, causality and physical realizability, pre-envelope and canonical representation of band pass signals.	10
Module – II **Amplitude modulation- demodulation communication systems** Amplitude modulation, square law modulator, switching modulator, square law demodulator, envelope detector, double side band suppressed carrier modulation, balanced and ring modulators, single side band modulation, frequency discrimination and phase discrimination modulators, coherent detection of SSB, frequency division multiplexing and time division multiplexing, super heterodyne AM receiver and its characteristics.	7
Module – III **Angle modulation - demodulation communication systems** Basics of frequency and phase modulation, single tone frequency modulation, NBFM, WBFM, Transmission bandwidth of FM wave, indirect and direct methods of FM generation, frequency discriminator, phase locked loop demodulator, super heterodyne FM receiver.	7

Module – IV	**10**
Pulse modulation demodulation communication systems Sampling process, pulse amplitude modulation, pulse duration modulation, pulse position modulation	
Module – V **Noise in communication systems** Noise, shot noise, thermal noise, white noise, noise equivalent bandwidth, signal to noise ratio for coherent detection of DSBSC, SNR for coherent reception with SSB modulation, SNR for AM receiver using envelope detection, Noise in FM reception, FM Threshold effect, pre emphasis and de-emphasis.	**6**

Text Books:
1. Simon Haykin, "Communication Systems", Wiley Eastern Limited, New Delhi, 2016, 4/e.
2. B. P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press, 2011, 4/e, (Indian Edition)

Reference Books:

1. John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems"Pearson Education, Inc., New Delhi, 2013.
2. Bruce Carlson and Paul B. Crilly, "Communication Systems: An Introduction to signals and Noise in Electrical Communication", Tata McGraw Hills Education Pvt. Ltd., New Delhi, 2011, 5/e.

Gaps in the Syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO2

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	1	-	-	-	-	-	-	-	2	3	2	1
CO2	3	3	3	3	2	-	-	-	-	-	-	1	3	2	2
CO3	3	3	3	3	2	-	-	-	-	-	-	1	3	2	1
CO4	3	3	3	3	2	-	-	-	-	-	-	1	3	2	3
CO5	3	3	3	3	3	-	-	-	-	-	-	1	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD8
CD2	Tutorials/Assignments	CO2	CD1 ,CD8
CD3	Seminars	CO3	CD1, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD8

CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 257
Course Title: Electromagnetic Field and Waves
Pre-requisite(s): Engineering Mathematics
Co- requisite(s):
Credits: L: 3   T: 0   P: 3
Class schedule per week: 03

Class: B. Tech.
Semester / Level: Four
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives
This course envisions to impart to students to:

1.	To apply the basic skills of mathematics, physics and science to understand, design and develop various engineering problems involving electromagnetic fields.
2.	To lay the foundations of electromagnetic engineering and its applications in modern communications involving both wireless and guided wave medium.
3.	To analyse the electromagnetic wave propagation in guided and unguided medium having different medium properties and different boundary conditions.
4.	To develop an ability to identify, formulate, and solve electromagnetic engineering problems.
5.	To review and present the literature ethically and also develop the skill to work individually or in a team.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Explain the basic concepts of time varying electric and magnetic fields in different electromagnetic media.
CO2	Analyze Maxwell's equation in differential and integral forms and apply them to diverse engineering problems.
CO3	Examine and understand the phenomena of wave propagation in different media and its interfaces as well as in guided medium and its applications in microwave engineering.
CO4	Identify, formulate and solve electromagnetic engineering problems.
CO5	Work in a small team and communicate electromagnetic concepts both orally and in writing following ethical rules.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Maxwell's Equations**: Faraday's Law, Transformer & Motional EMF, Displacement Current, Maxwell's Equations (Generalized form). **Boundary Conditions and Wave Equation:** Electromagnetic Boundary Conditions **Time varying Potentials & Fields:** Time varying Potentials, Time harmonic fields, Time harmonics Maxwell's Equations.	8
Module – II **EM Wave propagation:** Wave Equation & Plane Waves in unbounded homogeneous, plane waves in free space and lossy media, Skin depth, Poynting vector and Power considerations, Polarization of Electromagnetic waves, Reflection of a plane wave at Normal incidence and Oblique incidence. Parallel & Perpendicular Polarization at perfect conducting & dielectric boundaries, Brewster's Angle.	9
Module – III **Transmission lines:** Transmission line parameters & Equations, Input Impedance, SWR and Power , The Smith Chart, Quarter Wave Transformer Matching, Single Stub Tuner(Matching), Slotted line (Impedance Measurement, Transients on transmission lines, Microstrip Transmission lines, strip lines, Slot lines and Co-planar lines.	9
Module – IV **Waveguides:** Transverse Electric and Transverse Magnetic wave propagation in Rectangular Waveguide, Rectangular Cavity Resonator, Circular Cavity Resonator, Quality factor of the rectangular Cavity Resonator.	8
Module – V **Antennas:** Radiation from the Hertz dipole, Power radiated by Hertzian dipole, Radiation Parameters of antenna, Monopole and Dipole antenna.	6

Text Books:
1. Principle of Electromagnetics, Matthew N.O. *Sadiku* & S.V. Kulkarni, Oxford University Press, Sixth Edition.

Reference Books:

1. Electromagnetics field Theory and Transmission Line G.S.N Raju, Pearson Education
2. Electromagnetic Waves and Radiating Systems, 2/e, E. C. Jordan and K. G. Balmain, PHI.
3. Electromagnetics, David Cheng, Prentice Hall

Gaps in the Syllabus (to meet Industry/Profession requirements)
      EM field and Waves is a basic course, hence it only lays down the foundation of Advanced Courses.

POs met through Gaps in the Syllabus
      May be met through laboratory simulations, experiments, and design problems.

Topics beyond syllabus/Advanced topics/Design
      3. Application of EM fields and Waves in the analysis of EM interference
      4. Design of Omni directional Antennas for various applications.

POs met through Topics beyond syllabus/Advanced topics/Design
      Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

      1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	1	1	1	2				1	1		2	3	1	2
CO2	2	1		1	2				1	1		2	2	2	2
CO3	3	1		1	2				1	1		2	2	2	2
CO4	1	2	1	2	2	1	1	1	1	1	1	2	3	3	3
CO5	1	1	1	1	2	1	1	2	1	1		2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 258
Course Title: Electromagnetic Waves Lab.

Pre-requisite(s): MATLAB
Co- requisite(s):
Credits: L: 0   T: 0   P: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Four
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	Analyze the Maxwell's equation in explaining the phenomenon of wave propagation.
2.	Apply Maxwell's equation in solving the time varying electromagnetic field problems.
3.	Apply appropriate boundary conditions to solve the time varying Electromagnetic phenomena.
4.	Characterize the wave propagation in guided and unguided media under different media characteristics.
5.	Develop an insight to visualize and solve practical electromagnetic engineering problems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Formulate the electromagnetic problem and solve them using MATLAB simulation tool.
CO2	Visualize the wave propagation in different media and its implication on transmission, reflection and propagation phenomena.
CO3	Visualize the concept of wave propagation in guided media such as transmission lines and waveguides.
CO4	Visualize the concept of wave polarization.
CO5	Visualize and solve practical Electromagnetic engineering problems.

SYLLABUS

LIST OF EXPERIMENTS:

1. Using MATLAB, simulate and plot the phenomenon of Skin effect in current carrying conductors as a function of the conductivity of the conductor and the frequency of operation.
   AIM
   Study the effect of frequency and conductivity on skin depth.

2. Using MATLAB, simulate and plot the variation of the time varying field as a function of distance. Also plot the waveforms to depict linear, circular and elliptical polarization of the wave.
   AIM
   Study the polarization phenomena and understand its significance in communication.

3. A parallel-plate capacitor with plate area 5 cm^2 and plate separation of 3 mm has a voltage 50 sin 10^3 t V applied to its plates. Using MATLAB, Compute the displacement current assuming (i) $\varepsilon = \epsilon_0$ (ii) $\varepsilon = 2\epsilon_0$
   AIM
   Study the effect of dielectric material on displacement current.

4. An electric field in free space is given by E = 50 cos (10^8t + β x) a_y V/m. Using MATLAB, Compute (i) k, λ and T (ii) the time it takes to travel a distance of λ/2. (iii) Plot the wave at t = 0, T/4, and T/2.
   AIM
   Study the characteristics of the EM wave.

5. Using MATLAB Compute the following problems

   (a) In free space, E = 20 cos (ωt – 50 x) a_y V/m. Compute (i) J_d (ii) H (iii) ω

   (b) In a medium characterized by σ = 0, μ = $μ_0$, ε = $4\epsilon_0$, and E = 20 sin (10^8t – βz) a_y V/m
   AIM
   Examine the characteristics of the EM wave in free space and in a specified medium.

6. A plane wave propagating through a medium with ϵ_r = 8, $μ_r$ = 2 and E = 0.5 $e^{-z/3}$ sin(10^8t – βz) a_x V/m. Using MATLAB, compute (i) β (ii) the loss tangent (c) Intrinsic impedance (iv) Wave velocity (v) H field.
   AIM

Examine the characteristics of the EM wave in the specified dielectric medium.

7. In free space ($z \leq 0$), a plane wave with $H_i = 10 \cos(10^8 t - \beta z) a_x$ mA/m is incident normally on a lossless medium ($\mu = 8\mu_0$, $\varepsilon = 2\epsilon_0$) in region $z \geq 0$. Using MATLAB, compute and plot the reflected wave H_r, E_r and the transmitted wave H_t and E_t.
    AIM
    Study the reflected and transmitted phenomena of Plane wave at normal incidence on a lossless dielectric medium.

8. Given a uniform plane wave in air as $E_i = 40 \cos(\omega t - \beta z) a_x + 30 \sin(\omega t - \beta z) a_y$ V/m. Using MATLAB compute and plot
    (i) H_i
    (ii)   If the wave encounters a perfectly conducting plate normal to the z-axis at $z = 0$, find the reflected wave E_r and H_r.
    (iii)   The total E and H fields for $z \leq 0$.
    (iv)   The time-average Poynting vectors for $z \leq 0$ and $z \geq 0$.

    AIM
    Study the phenomenon of plane wave propagation and power calculation.

9.

z =-l   z =0
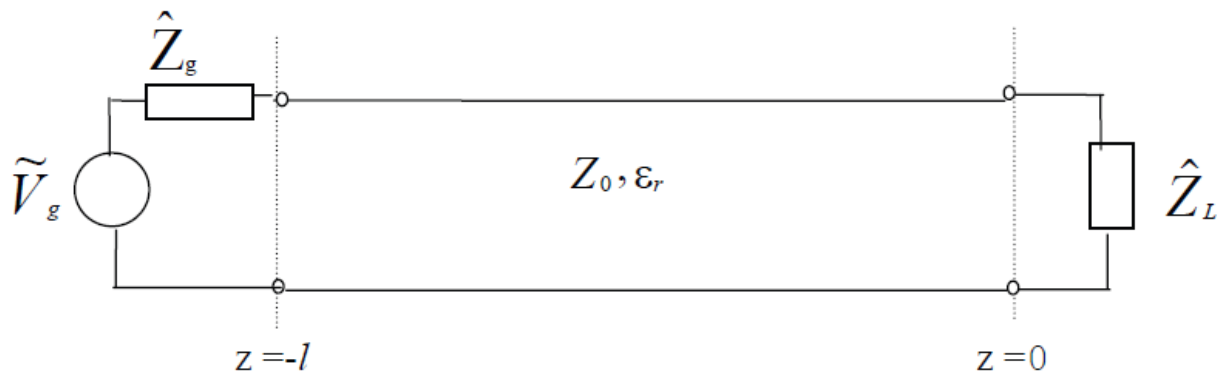
For the transmission line system shown,
f = 600 MHz, Zg = 50 Ω, Z0 = 50 Ω, l = 0.75 λ0, εr = 1.0. The values of the load is given as
(i) ZL = 0 Ω
(ii) ZL = open
(iii) ZL = 100 Ω
(iv) ZL = (25 + j 25) Ω
(v) ZL = (25 − j 25) Ω
Using MATLAB, obtain the following for each of the loads given above.
• The Standing Wave pattern
• Calculate SWR for each load. And plot the normalized SWR pattern.

AIM
Study the propagation of EM wave in two wire transmission line and stud the effect of load on propagation characteristics.

10. A right-hand circularly polarized wave at 1.5 GHz is propagating through a material with $\varepsilon_r = 6.2$ and $\mu_r = 2.0$ and arrives at an interface with air. It is incident at an elevation angle of 15° and an azimuthal angle of 45°. The wave has an amplitude of 12 V/m. The interface lies in the x-y plane. Using MATLAB, Compute
    (i) The angle of incidence θ_1.
    (ii) The critical angle and the Brewster's angles for this configuration for both polarizations.
    (iii) The reflection and transmission coefficients for both polarizations.
    (iv) The percent reflectance and transmittance for both polarizations. Verify conservation of energy

    AIM
    Study the reflected and transmitted phenomena of Plane wave under oblique incidence condition.

11. Use MATLAB to visualize the first four electromagnetic modes in a rectangular waveguide with a/b = 2.25 and plot the phase constant β of the fundamental mode in from 0.5 GHz up to 3.0 GHz.

    AIM
    Study the propagation of EM wave in rectangular waveguide and study the dispersion characteristics.

12. Write a MATLAB program that determines the first 20 modes supported by an air-filled rectangular waveguide and sorts them to be in ascending order, starting with the fundamental mode. The program should output a formatted table that labels each mode as either TEmn or TMmn along with its cutoff frequency. Create five difference tables, one for each of the following five cases: Table 1: a = 0.5 cm and b = 1.0 cm Table 2: a = 1.0 cm and b = 1.0 cm Table 3: a = 1.5 cm and b = 1.0 cm Table 4: a = 2.0 cm and b = 1.0 cm Table 5: a = 2.5 cm and b = 1.0 cm.

    AIM
    Study the propagation of EM wave in rectangular waveguide and study the effect of waveguide dimension on mode characteristics.

Text books:
    1. Principle of Electromagnetics, Matthew N.O. *Sadiku* & S.V. Kulkarni, Oxford University Press, Sixth Edition.

Reference books:
    1. Electromagnetics field Theory and Transmission Line G.S.N Raju, Pearson Education
    2. Electromagnetic Waves and Radiating Systems, 2/e, E. C. Jordan and K. G.Balmain, PHI.
    3. Electromagnetics, David Cheng, Prentice Hall

Gaps in the Syllabus (to meet Industry/Profession requirements)
    NA

POs met through Gaps in the Syllabus
    NA

Topics beyond syllabus/Advanced topics/Design
    Simulations based on advanced topics after completion of compulsory twelve experiments.

POs met through Topics beyond syllabus/Advanced topics/Design
    Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	(60)
Attendance Marks	12
Lab file Marks	12
Viva Marks	24
Day-to-day performance Marks	12
End SEM Evaluation	(40)
Lab quiz Marks	20
Lab performance Marks	20

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	3	3	3	1	1	1	1	2	1	3	3	2	1
CO2	3	3	3	3	3	1	1	1	1	2	1	3	2	2	2
CO3	3	3	3	3	3	1	1	1	1	2	1	3	2	2	2
CO4	3	3	3	3	3	1	1	1	1	2	1	3	2	2	2

CO5	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 301
Course Title: Digital Communication
Pre-requisite(s): Knowledge of Analog Communication, Probability and Random Signal Theory
Co- requisite(s): NA
Credits: L: 3   T: 0   P: 0   C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Fifth / Third
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

6.	To know the principles of sampling, Quantization and various waveform coding schemes.
7.	To learn the various baseband transmission schemes
8.	To learn the different digital modulation techniques
9.	To know the elements of information theory
10.	To know spread spectrum techniques

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate the concept of sampling, Quantization and various waveform coding schemes
CO2	Apply the concepts of various baseband transmission schemes.
CO3	Design and develop the different digital modulation systems
CO4	Apply the concepts of information theory for digital communication systems
CO5	Apply the concepts of spread spectrum techniques for digital communication systems

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to digital communication System, Sampling Process, Sampling Theorems for Low Pass and Bandpass Signals, Types of Sampling, Quantization of Signals, Companding, Different Encoding schemes like NRZ, Multilevel Binary, Bi-phase, Differential Manchester, Pulse Code Modulation, Differential Pulse Code Modulation, Delta Modulation and Adaptive Delta Modulation, Noise in Pulse Code Modulation and Delta Modulation Systems.	**10**
Module – II Matched Filter, Error Rate due to Noise, Intersymbol Interference, Nyquist Criterion for Distortion-less Baseband Binary Transmission, Geometric Representation of Signals, The Gram-Schmidt Orthogonalization Procedure, Maximum Likelihood Decoding, Correlation Receiver.	**8**
Module – III Digital Modulation Techniques: Amplitude Shift Keying, Binary Phase Shift Keying, Differential Phase Shift Keying, Quadrature Phase Shift Keying, M-ary PSK, Binary Frequency Shift Keying, M-ary FSK, and Minimum Shift Keying. Error Probability and Power Spectra of ASK, BPSK, QPSK and BFSK, Equalization Techniques, Synchronization and Carrier Recovery for Digital modulation.	**8**
Module – IV The concept of Amount of Information, Entropy, Information Rate, Shannon Fano and Huffman Source Coding Schemes, Shannon's theorem, Channel capacity, Capacity of Gaussian Channel, Bandwidth-S/N Trade off	**7**
Module – V Characteristics and Applications of Spread Spectrum, Direct Sequence Spread Spectrum, Effect of Thermal Noise, Single Tone Interference and Jamming, Code Division Multiple Access, PN Sequence, Frequency Hop Spread Spectrum, Time Hop Spread Spectrum.	**7**

Text Books:
1. "Principles of Communication Systems", 4/e, by H. Taub and D L Schilling, Goutam Saha, Tata McGraw Hills, ND.
2. "Communication Systems", 4/e by Simon Haykin, John Wiley and Sons, Delhi.
3. "Modern Digital and Analog Communication System" 4/e by B.P.Lathi, Zhi Ding, Oxford University Press

Reference Books:
1. Digital Communications Fundamental and Applications by Bernard Sklar, Pearson Education.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. P Ramakrishna Rao, "Digital Communication" TMH Education Private Limited 2011

Gaps in the Syllabus (to meet Industry/Profession requirements) : NA

POs met through Gaps in the Syllabus : NIL

Topics beyond syllabus/Advanced topics/Design:
     1. Estimation Theory for Communication System

POs met through Topics beyond syllabus/Advanced topics/Design Po2, Po3, Po4

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

    1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	3	3	1	1	3	2	2	1	3	3	2	2

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

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD 8
CD2	Tutorials/Assignments	CO2	CD1, CD 8 and CD9
CD3	Seminars	CO3	CD1, CD4, CD8 and CD9
CD4	Mini projects/Projects	CO4	CD1 and CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1 and CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC302
Course title: Communication System Lab.
Pre-requisite(s): Analog Communication
Co- requisite(s): Digital Communication
Credits: L: 0 T: 0 P: 3 C: 1.5
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Fifth/Three
Branch: Electronics & Communication Lab
Name of Teacher:

Course Objectives:
This course enables the students:

6.	To develop an understanding about the Analog Modulation Techniques, V-F conversion and Butterworth LPF.
7.	To develop an understanding about the signal sampling, quantization and its reconstruction
8.	To develop an ability to understand and design the various waveform coding techniques
9.	To develop an ability to evaluate and design various digital modulation Techniques
10.	To develop an ability to evaluate and design Time Division Multiplexing Technique

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Demonstrate understanding of the various Analog Modulation Techniques, V-F conversion and Butterworth LPF.

CO2	Analyse the signal sampling, quantization and its reconstruction.
CO3	Design the generation and detection of various waveform coding techniques such as PCM, DM and ADM
CO4	Design the modulators and demodulators for various digital modulation techniques such as ASK, PSK, FSK, QPSK, and QAM
CO5	Design system for Time Division multiplexing Technique

Syllabus

List of Compulsory experiments:

1. **Name of the Experiment: Generation and detection of Amplitude Modulated**
    AIM-1: Generation and detection of Amplitude Modulated wave and calculation of percentage modulation using ACL 01 and ACL 02 Kits
    AIM-2: Design of Amplitude Modulation, DSB-SC, and SCB-SC Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.

2. **Name of the Experiment: : Generation and detection of Frequency Modulated wave**
    AIM-1: Generation and detection of Frequency Modulated wave using ACL 03 and ACL 04 FM trainer Kits

    AIM-2: Design of Frequency Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.

3. **Name of the Experiment: Generation and detection of PAM, PWM, PPM**
    AIM-1: Generation and detection of PAM, PWM, PPM using DCL 08 Falcon kit.

    AIM-2: Design of PAM, PWM, PPM Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.

4. **Name of the Experiment: Design and implementation of 2nd and 4th order Low pass Butterworth filters**

   AIM-1: Design and implementation of 2nd and 4th order Low pass Butterworth filters using Multisim

   AIM-2: Design and implementation of 2nd and 4th order Low pass Butterworth filters

5. **Name of the Experiment: Investigation of Signal Sampling and Reconstruction**

   AIM-1: Investigation of Signal Sampling and Reconstruction using DCL 01 Falcon kit

   AIM-2: Investigation of Signal Sampling and Reconstruction using ALTAIR Solid Thinking Embed/Comm

6. **Name of the Experiment: Investigation of TDM system**

   AIM-1: Investigation of TDM system using DCL02 Falcon kit

8. **Name of the Experiment: Investigation of practical PCM system**

   AIM-1: Investigation of practical PCM system using DCL03 and DCL04 Falcon kit

9. **Name of the Experiment: Investigation of Delta Modulation system**

   AIM-1: Investigation of Delta Modulation and Adaptive Delta modulation system using DCL07 Falcon kit

10. **Name of the Experiment: Investigation of ASK, FSK, PSK modulation/demodulation**

   AIM-1: Investigation of ASK, FSK, PSK modulation/demodulation using trainer kits

   AIM-2: Design of ASK, PSK, FSK modulator/demodulator using ALTAIR Solid Thinking

   Embed/Comm

9. **Name of the Experiment: Investigation of MSK modulation/demodulation**

   AIM-1: Investigation of MSK modulation/demodulation using trainer kits

   AIM-2: Design of MSK modulator/demodulator using ALTAIR Solid Thinking

   Embed/Comm

10. **Name of the Experiment: Investigation of QAM modulation and demodulation**

   AIM-1 : Investigation of QAM modulation and demodulation using ST 2112 QAM trainer kit

AIM-2: Design of QAM modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

11. Name of the Experiment: Investigation of QPSK modulation and demodulation
AIM-1: Investigation of QPSK modulation and demodulation using ST 2112 QAM trainer kit

AIM-2: Design of QPSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

Text Book:

1. "Principles of Communication Systems", 2/e, by H. Taub and DL Schilling, Tata McGraw Hills, ND.
2. "Communication Systems", 4/e by Simon Haykin, John Wiley and Sons, Delhi.

Reference Books:

1. Simon Haykin, "Communication Systems", Wiley Eastern Limited, New Delhi, 2016, 4/e.
2. J. Schiller, "Mobile Communication" 2/e, Pearson Education, 2012.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**

Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –
      1. Student Feedback on Faculty
      2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	3	1	1	1	1	2	1	3	2	2	1
CO2	3	3	3	3	3	1	1	1	1	2	1	3	2	2	1
CO3	3	3	3	3	3	1	1	1	1	2	1	3	2	2	1
CO4	3	3	3	3	3	1	1	1	1	2	1	3	2	2	1
CO5	3	3	3	3	3	1	1	1	1	2	1	3	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5
CD2	Tutorials/Assignments	CO2	CD1, CD5
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5
CD4	Mini Projects/Projects	CO4	CD1, CD5
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC303
Course title: Microprocessors and Microcontrollers
Pre-requisite(s): EC203 Digital system Design
Co- requisite(s):
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B.Tech.
Semester / Level: V/03
Branch: ECE
Name of Teacher:

Course Objectives

1.	To explain the basic building blocks of a Microprocessor/ Microcontroller architecture and the operation with relevant timing diagrams.
2.	To demonstrate the knowledge of different addressing modes and instruction set of a Microprocessor/ Microcontroller in developing efficient programing logic.

3.	To develop the interfacing circuits for different applications with appropriate peripherals.
4.	To analyze the evolution of Microprocessor/Microcontroller and compare the different features.
5.	To design a Microprocessor/ Microcontroller based system suitable for industrial applications.

Course Outcomes

After the completion of this course, students shall be able to:

CO1	Define the architectural differences between Microprocessor and Microcontroller.
CO2	Apply the programming concepts for the design of efficient codes.
CO3	Make use of different I/O chips for the desired application by programming them in different modes.
CO4	Illustrate the advancements made to the recent generations Microprocessor/ Microcontroller.
CO5	Develop Microprocessor/ Microcontroller based products to meet the industrial requirements.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Review of SAP-I Concept, Introduction to 8085 Microprocessor : Architecture of 8085 Processor , Functions of all signals, Bus concepts, Multiplexed and De-multiplexed Bus, Instruction set, Addressing modes, Stack operation, Timing diagrams, Programming examples, Memory Organization, Memory Interfacing,	**10**

Memory Mapped I/O, I/O Mapped I/O, Data transfer schemes and Interrupt structure of 8085 Microprocessor.	
Module – II Introduction to 8086 Microprocessor: Architecture of 8086, concept of pipelining, pin diagram, difference between 8086 and 8088 microprocessor, maximum and minimum modes, Memory organization, advantages of memory segmentation, even and odd addressing of memory, Instruction set, Addressing modes, Stack operation, Timing diagrams, Programming examples, Memory interfacing and interrupt structure of 8086 microprocessor.	**10**
Module – III Peripheral Interfacing with 8086 Microprocessor: Architecture of 8255 I/O peripheral chip, Modes of operation, Hand shake mode operation, BSR mode, ADC 0801 and ADC 0808 Interfacing with 8086 microprocessor, Analogue multiplexed ADC, DAC 0808 specifications, DAC Interfacing, Programming examples for Generation of square wave, positive and negatives ramps, triangular and sine waves, Sample and Hold circuit, LF 398 and its applications in Data Acquisition. 8253 timer, Modes of operation, Applications, 8279 Keyboard/Display Interface, Different modes of operation, Interfacing, Programming examples	**7**
Module – IV Introduction to advanced Microprocessors: Evolution of Microprocessors, Harvard and Princeton architecture, Concept of CISC and RISC processors Evolutionary steps and Additional features of 80186, 80286, 80386, 80486 and Pentium Processors, Introduction to ARM processors.	**5**
Module – V Introduction to Microcontrollers: Architecture of 8051, instruction set, interrupt structure of 8051, programming examples, Introduction to 16-bit microcontrollers, Features of 16-bit microcontrollers such as 80196 and PIC24.	**8**

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Books recommended:
Textbooks:
1. Digital Computer Electronics, 2/e. by A. P. Malvino.
2. Microprocessor Architecture, Programming and Applications with 8085 by R. S. Gaonkar.
3. Advanced Microprocessors and Peripherals by K. M. Bhurchandi and A. K. Ray.
4. The 8051 Microcontroller and Embedded System by Muhammad Ali Mazidi.
5. ARM architecture reference manual, 2/e by David Seal.

Reference books:
1. Intel Manual's for 8085, 8086, 8051 and other peripheral chips.
2. Advanced Microprocessor" by Y. Rajasree.
3. Microprocessor and Interfacing, Programming of Hardware" by Douglas Hall.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			3		3	3	3	2
CO2	3	3	2	3	3	3	2			3		3	3	3	2
CO3	3	3	2	3	3	3	2			3		3	3	3	2
CO4	3	3	2	3	3	2	2			3		3	3	3	2
CO5	3	3	2	3	3	2	2			3		3	3	3	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1,CD2 and CD 8
CD2	Tutorials/Assignments	CO2	CD1
CD3	Seminars	CO3	CD1, CD2
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC304
Course title: Microprocessors and Microcontrollers Lab
Pre-requisite(s):
Co- requisite(s):
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/ 03
Branch: ECE
Name of Teacher:

Course Objectives

1.	To develop efficient 8085 based program for different tasks.
2.	To develop efficient 8086 based program for different tasks.
3.	To develop efficient 8051µc based program for different tasks.
4.	To build interfacing circuits for different tasks.
5.	To be able to develop microprocessor and microcontrollers based systems for industrial applications.

Course Outcomes

After the completion of this course, students shall be able to:

CO1	Demonstrate the programming concepts of 8085/8086/8051 for efficient coding.
CO2	Show the interfacing of different peripherals with 8085/8086/8051.
CO3	Analyse the output of different peripherals when programmed in different modes using 8085/8086/8051.
CO4	Develop the interfacing circuits for different applications with appropriate peripherals.
CO5	Design 8085/8086/8051 based system for various real time applications.

SYLLABUS

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC303 Microprocessors and Microcontrollers** is the syllabus for the **EC304 Microprocessors and Microcontrollers Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of experiments:
8085 AND 8086 PROGRAMMING

1. **Name of the Experiment**
   Data Transfers
   Aim1: REARRANGING BYTES
   Aim2: GROUPING ODD, EVEN, DIVIDE BY 4 AND DIVIDE BY 16 BYTES
   Aim3: FORMATION OF A THIRD BLOCK
   Aim4: FILLING UP 128 LOCATIONS

2. **Name of the Experiment**
   Arithmetic Operations
   Aim1: ADDITION OF 12 BYTES
   Aim2: MULTIPLICATION OF SINGLE BYTE BY SINGLE BYTE
   Aim3: ADDITION OF 18 BCD NO'S
   Aim4: ADDITION OF TWO 10-BYTE NO'S
   Aim5: ADDITION OF TWO 20-DIGIT BCD NO's:
   Aim6: BCD SUBTRACTION
   Aim7: MULTIPLICATION OF TWO 5-BYTE BINARY NUMBERS
   Aim8: BCD MULTIPLICATION
   Aim9: BINARY DIVISION
3. **Name of the Experiment**
   Logical Operations
   Aim1: CHECKING BITS OF A WORD
   Aim2: LOGICAL OPERATION
4. **Name of the Experiment**
   Data Processing
   Aim1: NUMBER OF BITS IN BYTES
   Aim2: MAXIMUM AND MINIMUM BYTES
   Aim3: SIZE OF A BLOCK ENDING WITH A SPECIFIED BYTE
   Aim4: SIZE OF A BLOCK STARTING WITH 00H AND ENDING WITH 60H

Aim5: SIZE OF A BLOCK ENDING WITH THREE ALTERNATE 00H
Aim6: NUMBER OF TIMES FFH OCCURS AS PAIR
Aim7: CONSECUTIVE MEMORY LOCATIONS WITH IDENTICAL DATA
Aim8: COUNT OF SPECIFIED BYTES
Aim9: ADDRESS OF LAST NON-BLANK CHARACTER
Aim10: REPLACING TRAILING ZEROS WITH BLANKS
Aim11: ADDING EVEN PARITY TO ASCII CHARACTERS

5. **Name of the Experiment**
   Sorting
   Aim1: SORTING IN DESCENDING ORDER
   Aim2: SORTING EVEN AND ODD PARITY BYTES
   Aim3: SORTING SIGNED BYTES
   Aim4: SORTING SIGNED BINARY BYTES IN ASCENDING ORDER
6. **Name of the Experiment**
   String Operations
   Aim1: COMPARISON OF TWO ASCII STRINGS
   Aim2: AN ASCII STRING TO BYTE CONVERSION
   Aim3: INSERTION TO A LIST
7. **Name of the Experiment**
   Parallel Communication
   Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING 8255.

   Aim2: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA THROUGH PORT A OF 8255 IN MODE – 0
   Aim3: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA THROUGH PORT A OF 8255 IN MODE – 1 THROUGH STATUS CHECK.
   Aim4: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING 8253.
   Aim5: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO GENERATE TRIANGULAR WAVE USING DAC 0808.
   Aim6: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO GENERATE SAW TOOTH WAVE OF MAGNITUDE 0 VOLT TO +4 VOLTS USING DAC 0808.
   Aim7: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONVERT ANALOG SIGNALS OF MAGNITUDE +3.5 VOLTS TO +5 VOLTS IN STEPS OF 0.1 VOLTS TO DIGITAL EQUIVALENT HEX VALUES.
   Aim8: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONTROL THE SPEED OF STEPPER MOTOR USING 8255 PPI.
   Aim9: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONTROL THE

TRAFFIC LIGHTS USING 8255 PPI

8. **Name of the Experiment**
   Serial Communication
   Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING SERIAL OUTPUT PIN
   Aim2: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA SERIALLY THROUGH SERIAL INPUT PIN.

9. **Name of the Experiment**
   Interrupts
   Aim1: To study the software and hardware interrupts of 8085.
   Aim2: To study the Interrupt controller 8259.
   Aim3: To study the Interrupt features of 8051.

10. **Name of the Experiment**
    Timers

Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CALCULATE THE CONVERSION TIME OF ADC USING 8253 TIMER.
Aim2: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO OBSERVE WAVEFORMS OF 8253 TIMER IN DIFFERENT MODES.

11. **Name of the Experiment**
    Keyboard and Display
    Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO FLASH AND ROTATE "HELP US" USING 8259 PIC.

12. **Name of the Experiment**
    Code Conversion
    Aim1: BINARY TO BCD CONVERSION
    Aim2: BCD TO BINARY CONVERSION
    Aim3: CONVERSION OF NIBBLES TO ASCII CODES
    Aim4: ASCII TO HEXADECIMAL CONVERSION

Books recommended:

Textbooks:

6. Microprocessor Architecture, Programming and Applications with 8085 by R. S. Gaonkar.
7. Advanced Microprocessors and Peripherals by K. M. Bhurchandi and A. K. Ray.
8. The 8051 Microcontroller and Embedded System by Muhammad Ali Mazidi.

Reference books:
4. Intel Manual's for 8085, 8086, 8051 and other peripheral chips.
5. Advanced Microprocessor" by Y. Rajasree.
6. Microprocessor and Interfacing, Programming of Hardware" by Douglas Hall.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	**(60)**
Attendance Marks	**10**
Lab file Marks	**06**
Day-to-day performance Marks	**44**
End SEM Evaluation	**(40)**
Lab quiz Marks	**08**
Lab Viva marks	**12**
Lab performance Marks	**20**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	3	3	3	3	3
Semester End Examination	3	3	3	3	3

Indirect Assessment
1. Student Feedback on Faculty
2. Student Feedback on Course

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**10**
Lab file Marks	**06**

Day-to-day performance Marks	44
End SEM Evaluation	**(40)**
Lab quiz Marks	08
Lab Viva marks	12
Lab performance Marks	20

Assessment Components	CO1	CO2	CO3	CO4
Progressive Evaluation	3	3	3	3
End SEM Evaluation	3	3	3	3

If satisfying < 34% = 1, 34-66% = 2, > 66% = 3

Indirect Assessment –

      1. Student Feedback on Faculty
      2. Student Feedback on Course Outcome

<u>Mapping between Objectives and Outcomes</u>

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	3	3	1	1			2		2	2	2	1
CO2	3	3	2	3	3	3	2			2		2	2	2	1
CO3	3	3	2	3	3	3	2			2		2	2	2	1
CO4	3	3	2	3	3	2	2			2		2	2	2	1
CO5	3	3	2	3	3	2	2			2		2	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD5, CD9
CD2	Tutorials/Assignments/Quiz (s)	CO2	CD5, CD9
CD3	Seminars	CO3	CD5, CD9
CD4	Mini projects/Projects	CO4	CD5, CD9

CD5	Laboratory experiments/teaching aids	CO5	CD5, CD9
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 305
Course Title: Signal Processing Techniques
Pre-requisite(s): Signals and Systems
Co- requisite(s):
Credits: L: 3   T: 1   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 5
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart students to:

11.	Understand the basic concepts of signals and system in frequency and Z- domain.
12.	Develop transfer function, and structure of digital systems.
13.	Develop an ability to design and apply analog filters.
14.	Design and implement the digital FIR and IIR filters.
15.	Understand the multi-rate signal processing and spectrum estimation.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Study the system representation and characteristics in frequency and Z-transform Domain.
CO2	Design and implement the digital system structures and analyse them.
CO3	Design of analog filters Butterworth filter, Chebyshev filter for various applications.
CO4	Design of digital FIR and IIR filters for various applications.

CO5	Implement multi rate signal processing and spectral estimation.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Discrete-Time Signals and system, concept of frequency in continuous and discrete time signal, LTI system as frequency selective filter, Inverse system and de-convolution, Discrete Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT), Periodic convolution, Direct evaluation of DFT, FFT algorithms- decimation in time and frequency, Z-transform, Analysis of LTI system in Z-domain, Relationship between Laplace and Z-transforms, Relationship between Fourier and Z-transforms.	10
Module – II Digital Filter Structures (FIR & IIR): Direct form I&II, cascade, parallel and ladder realizations, lattice structure, representation of numbers, quantization of filter coefficients, round-off effects.	8
Module – III Filter Function Approximations and Transformations. Review of approximations of ideal analog filter response, Butterworth filter, Chebyshev Type I & II, Elliptic filters. Frequency Transformations: Frequency transformation in analog domain, frequency transformation in digital domain.	8
Module – IV	8

Design of IIR Filter: Design based on analog filter approximations, Impulse invariance method, Matched Z-transformation, Bilinear transformation. Design of FIR Filters: Symmetric and antisymmetric FIR filters, design of linear phase FIR filters using windows and frequency – sampling methods, design of optimum equiripple linear phase FIR filters, comparison of FIR and IIR filters.	
Module – V Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, Poly phase filters, Estimation of Spectra from Finite-Duration Observations of Signals.	**6**

Text Books:
1. John G. Proakis, Dimitris G. Mamalakis, Digital Signal Processing, Principles, Algorithms and Applications
2. Alan V. Oppenheim Ronald W. Schafer, Digital Signal Processing, PHI, India.
3. S. K. Mitra - Digital Signal Processing: A computer based approach, TMH, 2001

Reference Books:
1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.

Gaps in the Syllabus (to meet Industry/Profession requirements)
1. Applications of signal processing techniques through hardware platform.

POs met through Gaps in the Syllabus
    NA

Topics beyond syllabus/Advanced topics/Design
    DSP Processor architectures

POs met through Topics beyond syllabus/Advanced topics/Design
    2

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

   1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3		2	1				1	1	1	2			
CO2	3	3		2	2				1	2	1	2			
CO3	2	3		2	3				1	1	1	2			
CO4	3	3		2	3				1	1	1	2			
CO5	3	2	1	1	2				1	1	1	2			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 306
Course Title: Signal Processing Lab
Pre-requisite(s): Signals & Systems
Co- requisite(s):
Credits: L: 3   T: 1   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 5
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart students to:

16.	Understand the basics of Signal Processing algorithms such as convolution and correlation via MATLAB implementation.
17.	Design system and analyse its characteristics in transform domain.
18.	Design of FIR and IIR filters.
19.	Develop skill for MATLAB code and its implementation in DSP processor.
20.	Apply the signal Processing techniques in various applications.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate understanding of MATLAB with signal processing perspective.
CO2	Design digital system and analyse its characteristics in transform domain.
CO3	Design and implement FIR and IIR filters.
CO4	Apply the knowledge of MATLAB to various set of signal processing problems.
CO5	Develop and apply the signal Processing Algorithms in various applications.

SYLLABUS

Experiments	(NO. OF Sessional Classes)

List of Compulsory experiments:
 	
1. Familiarization with MATLAB. Generation of the following sequence and to plot them using MATLAB:
    a. Unit Sample Sequence $\delta[n]$
    b. Unit Step Sequence u[n]
    c. Ramp Sequence n. u[n]
    d. Exponential Sequences
    e. Sine / Cosine Sequences
2. To generate the discrete time signal from analog signal using sampling theorem and analyse the aliasing effect.
 	
3. Verification of the following general properties of LTI system.
    a. Linearity
    b. Time-invariance
 	
4. Computation of the linear convolution of two finite-length sequences. Compare your result with that obtained by theoretical evaluation.
5. To compute the auto correlation/cross-correlation of two finite-length sequences. Compare your result with that obtained by theoretical evaluation.
6. Obtain Inverse Z-Transforms using the Partial Fraction Expansion and test its stability.
7. Cascade realization of the Linear-Phase FIR/ IIR transfer functions using MATLAB.
8. Find out the output of two Periodic Digital sequences using Circular Convolution. Compare your result with that obtained by theoretical evaluation.
9. Computation of N-point DFT and FFT of the length-N sequence using MATLAB and implement using TMS DSP processor.
10. Design of digital filter (LP/HP/BP) and evaluate its performance.
11. To realize the decimation, interpolation and sampling rate conversion of a signal.
12. To write a program and simulate using C language / assembly language for computation of Linear Convolution using TMS DSP Processor
	12

List of Optional experiments:	**8**

1. To develop a MATLAB program to convert Analog to Digital Frequencies using Bilinear Transformation.
2. To design a Butterworth filter using standard design steps (for LP, HP, BP & BR filters), i.e. find out the order of the filter when Pass Band Gain, Sampling frequency and Pass Band and Stop Band Cut-Off frequencies are given. Then find out the Normalized Transfer Function and Actual Transfer Function
3. To design a Chebyshev filter using standard design steps (general programs for LP, HP, BP & BR filter design)

Text Books:

1. Getting Started with MATLAB by RudraPratap, Oxford Publication

2. Digital Signal Processing: A computer-Based Approach by Sanjit K. Mitra, Mc-graw Hill

3. Digital Signal Processor: Architecture, Programming and Applications by B. Venkataramani and M. Bhaskar, Tata Mc-graw Hill

Reference Books:
1. Digital Signal Processing using Matlab by Vinay K. Ingle and John J. Proakis, Cengage Learning.

Gaps in the Syllabus (to meet Industry/Profession requirements)
   NA

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design
   Through experiments involving design/modelling of device/circuits on advanced topics

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	(60)
Attendance Marks	12

Lab file Marks	12
Viva Marks	24
Day-to-day performance Marks	12
End SEM Evaluation	(40)
Lab quiz Marks	20
Lab performance Marks	20

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	1	2		3	3				1	2		3			
CO2	2	2		3	3				1	2		3			
CO3	2	2		3	3				1	2		3			
CO4	1	2		3	3				1	2		3			
CO5	1	2		3	3				1	2		3			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD5
CD2	Tutorials/Assignments	CO2	CD5
CD3	Seminars	CO3	CD5
CD4	Mini Projects/Projects	CO4	CD5
CD5	Laboratory Experiments/Teaching Aids	CO5	CD5
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		

CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC307**
Course title: **Fundamentals of Data communication**
Pre-requisite(s): **basic concepts of communication**
Co- requisite(s):
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B.E
Semester / Level: VI
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students:

A.	To build an understanding of the fundamental concepts of Data Communication
B.	To analyze the performance of different flow control and error control mechanism and implement Error detection and correction scheme.
C.	Find out a suitable multiplexing scheme for effective utilization of the bandwidth.
D.	Implement different routing algorithm on a given network
E.	To justify the need of protocol and standards in data communication

Course Outcomes:

After the completion of this course, students will be:

CO1	Understand the basic concepts of data encoding and data transmission.
CO2	Explain different Data link control techniques like, error detection, correction, flow control and error control.
CO3	Demonstrate different multiplexing schemes and their practical application.
CO4	Compare the performance of different switching techniques.
CO5	Define the protocols and standards used in data communication

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Data Communication Techniques:: Basic Concepts, Analog and Digital Transmission, Transmission line Impairments, Channel Capacity, Guided Transmission media, Digital data to Digital Signal, Different encoding schemes like NRZ, Multilevel Binary, Bi phase, Differential Manchester, Scrambling techniques, Self clocking codes, CODEC and MODEM. Synchronous and Asynchronous transmission, Backward and Forward Error Control, Error detection techniques like CRC, Shift register implementation, Error correction, Block Code principles, Hamming distance, Interfacing standards like V.24/EIA-232.F, CCITT-X.21 Interface	9
Module – II Data Link Control: Line Configurations, Flow Control using Stop and Wait ARQ, Sliding window protocol, Error control using Stop and Wait ARQ, Go-back-to N ARQ, Selective Reject ARQ, Data Link Control Protocol HDLC, Basic characteristics, Frame structure and operation of HDLC, Data transparency control using bit stuffing, Utilization efficiency of a link, Point-to-Point Protocol (PPP), Introduction to LCP, PAP, CHAP, NCP and IPCP.	9
Module – III	8

Multiplexing and switched Network Frequency Division Multiplexing, Carrier standards, Synchronous Time Division Multiplexing, TDM link control, Digital Carrier systems, SONET/SDH, Statistical Time Division Multiplexing, Performance, Cable Modem, ADSL Design, Discrete multitone, xDSL. Comparison of Circuit switching, Message switching and Packet switching techniques, Digital switching concepts like Space division switching, 3-Stage Space division switch, Control Signalling, Common-channel Signalling, TDM Bus switch, TSI switch, Time Multiplexed Switches like STS and TST, Routing in circuit switched networks.	
Module – IV Packet Switching: Datagram packet switching and Virtual circuit Packet switching, Use of Least cost algorithms like Dijkstra's and Bellman-Ford algorithms, Routing characteristics, Routing strategies, Example system of ARPANET (all 3 generations) Congestion, Congestion control techniques, Traffic management, Congestion control in Packet switched networks, CCITT X.25 Interface.	**7**
Module – V Protocols : The need for a Protocol Architecture, OSI layered structure, TCP/IP Protocol Suite, Fundamental differences between OSI and TCP/IP, Primitives and PDUs. LAN protocol architecture, Function of LLC and MAC. Connecting devices like Repeaters, Hubs, Bridges, Two-layer switches, Routers and Three layer switches. IP header and IP addressing. Transport protocols TCP and UDP.	**7**

Text Books:

1. Data and Computer Communication, 7/e. by William Stallings.
2. Data Communication and Networking, 3/e. by Behrouz. A. Forouzan.

Reference Books:

1. Data Communication and Computer Networks by Prakash C. Gupta. Prentice Hall India Pvt., Limited

Gaps in the Syllabus (to meet Industry/Profession requirements)

Hardware implementation and testing of encoding techniques, link layer protocols, multiplexing techniques.

POs met through Gaps in the Syllabus

3, 4, 12

Topics beyond syllabus/Advanced topics/Design

- Network Security
- Application Layer protocol

POs met through Topics beyond syllabus/Advanced topics/Design

2, 3, 4, 12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	1	1	2	1	-	-	-	-	-	-	2	2	1	3
CO2	3	3	3	2	1	-	-	-	-	-	-	1	3	1	3
CO3	3	3	2	2	2	-	-	-	-	-	-	1	2	2	2
CO4	3	2	1	1	1	-	-	-	-	-	-	1	2	2	2
CO5	3	1	1	2	1	-	-	-	-	-	-	2	2	1	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 309
Course Title: Adaptive Signal Processing
Pre-requisite(s): Signals and Systems
Co- requisite(s):
Credits: L: 3 T: 1 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 5
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart students to:

21.	Understand the concept of adaptive systems and its characteristics.
22.	Impart knowledge on adaptive algorithms LMS and RLS.
23.	Impart knowledge on adaptive filter for optimal control.
24.	Demonstrate the concept of adaptive beam forming and array system.
25.	To help to design and apply adaptive filters for real- time applications.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate the adaptive systems and its characteristics and LMS algorithm.
CO2	Apply and analyse the RLS algorithms, lattice filters and Kalman filter.
CO3	Design and implement adaptive control techniques.
CO4	Implement the adaptive array and beam forming techniques in engineering applications.
CO5	Design and evaluate adaptive filters for adaptive noise cancellation, adaptive line enhancement and interference cancellation, prediction considering present day challenges and recent research development.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to adaptive systems - definitions and characteristics, Adaptive linear combiner : input signal and weight vector, the performance function, gradient and minimum mean square error, alternative expression of gradient, LMS, NLMS, sign-error, sign-data and FXLMS algorithms, transform domain LMS.	8
Module – II Recursive least square algorithm, windowed RLS, computational complexity, Block adaptive filter (time and DFT domains), adaptive lattice filters, Adaptive filters with Orthogonal signals, Kalman Filter.	8
Module – III Adaptive model control, Adaptive inverse control and model reference controls. Plant noise and the filtered-X LMS Algorithm, Inverse control using Filtered-X LMS algorithm.	8
Module – IV Adaptive array and adaptive beam forming: Sidelobe cancellation, Beam forming with a Pilot signal, Narrowband experiments , Broadband experiments, Characteristics of receiving arrays, Griffiths LMS Beamformer, Adaptive beamformer with pole and zeros, signal cancellation and distortion.	8

Module – V Applications of Adaptive Filters: Adaptive Noise Cancellation, Adaptive Line Enhancement, System identification, Channel equalization, Cancelling antenna sidelobe Intereference, Adaptive self tuning filter.	**8**

Text Books:

1. B.Widrow and S. D. Sterns, Adaptive Signal Processing, Pearson Education, 2nd Indian reprint, 2002.
2. D. G. Manolokis, V. K. Ingle and S. M. Kogar, "Statistical and Adaptive Signal Processing", Mc Graw Hill International Edition, 2000.
3. S. Haykin and T. Kailath, Adaptive Filter Theory, Pearson Education, 4th Edition, 2005.

Reference Books:

1. Digital Signal Processing 3/E by S.K.Mitra TMH Edition.
2. Fundamentals of adaptive filtering, A. H. Sayed, Wiley, 2003.
3. Monson H. Hayes, Statistical Digital Signal Processing and Modelling, Wiley, 2002

Gaps in the Syllabus (to meet Industry/Profession requirements)

2. Applications of adaptive signal processing techniques through hardware platform.

POs met through Gaps in the Syllabus

　　NA

Topics beyond syllabus/Advanced topics/Design

　　DSP Processor architectures

POs met through Topics beyond syllabus/Advanced topics/Design

　　2

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3		2	1				1	1	1	2			
CO2	3	3		2	2				1	2	1	2			
CO3	2	3	1	1	3				1	1	1	2			
CO4	3	3		2	3				1	1	1	2			
CO5	3	2	1	1	2				1	1	1	2			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC311
Course Title: Digital Signal Processor
Pre-requisite(s): Signals and Systems
Co- requisite(s):
Credits: L: 3 T: 1 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 5
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart students to:

1.	Understand the real time signal processing with hardware.
2.	Explain the architectures of DSP and General Purpose Processors.
3.	Learn to develop code on code Composer Studio.
4.	Write the real time DSP algorithm for real time signal using Processing.
5.	Apply the concept of the signal processing to understand the programming skills.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate understanding on the real time signal processing with hardware and software
CO2	Compare the architectures of DSP and General Purpose Processors.
CO3	Demonstrate understanding of DSP Instruction Set and Assembly Language Programming
CO4	Implement and evaluate the DSP algorithms in code composer studio.
CO5	Develop the DSP algorithm for processing of real time signal using DSP Processor.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction – DSP Tasks and Applications, Real-time Signal Processing, Representation of DSP algorithms; Number Representations and Arithmetic Operations - Fixed point and floating-point representations and arithmetic operations; Q notation	8
Module – II Typical DSP Hardware: Digital Signal Processor Architectures – CPU, Peripherals; Specific DSP processor architecture; Introduction to DSP systems and architecture; Texas Instruments family of DSP Processors, study of TMS320C6713/6416 Processor's architecture.	8
Module – III DSP Instruction Set and Assembly Language Programming – Instruction types; Parallel programming; Pipelining; Efficient programming; Arithmetic: Fixed point, floating point and residue arithmetic, Cordic architectures.	8
Module – IV Extensive parallel operations, MAC operations, different addressing techniques, common instructions used for extensive DSP applications, familiarity with Code Composer Studio.	8

Module – V DSP Algorithms and their Efficient Implementation - a) Linear filtering; b) FFT and spectrum analysis; c) Scalar and vector quantization, source coding, linear prediction coding; d) Function generation; Software Design for Low Power Consumption. Software Configurable processors, Application case studies in multimedia compression and communication	**8**

Text Books:

1. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Wiley, 2005
2. U. Meyer Baesse, "Digital Signal Processing with FPGAs", Springer, 2001

Reference Books:

1. Behrooz Parhami, "Computer Arithmetic Algorithms and Hardware Design", Oxford, 2000.
2. Shehrzad Qureshi, "Embedded Image Processing on the TMS320C6000 DSP" Springer, 2005.

Gaps in the Syllabus (to meet Industry/Profession requirements)

   NA

POs met through Gaps in the Syllabus

PO8 will be met though report-writing/presentation-based assignment

Topics beyond syllabus/Advanced topics/Design

   Teaching through research paper

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

   1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3		2	1				1	1	1	2			
CO2	3	3		2	2				1	2	1	2			
CO3	2	3	1	1	3				1	1	1	2			
CO4	3	3		2	3				1	1	1	2			
CO5	3	2	1	1	2				1	1	1	2			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC312**
Course title: **Digital Signal Processor Lab**
Pre-requisite(s): EC311 Digital Signal Processor
Co- requisite(s): EC305 Signal Processing Techniques
Credits: L: 0   T: 0   P: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Develop concept to process the signal with the help of DSP processor
2.	Demonstrate the concept of signal processing algorithm to implement in DSP processor.
3.	Understand the architecture of DSP Processor and development of programming concept.
4.	Grasp how to develop signal processing using Code composer studio to build a dedicated hardware for particular work.
5.	To elaborate the real time signal processing to control real time system

Course Outcomes

After the completion of this course, students will be able to:

CO1	Apply the concept of DSP processor to implement signal operation.
CO2	Illustrate the concept of signal processing algorithm to implement in DSP processor.
CO3	Explain the architecture of DSP Processor and development of programming concept.
CO4	Implement signal processing algorithm using Code composer studio to build a dedicated DSP processor hardware for particular work.
CO5	Develop real time signal processing-based inference and decision system

Syllabus

This Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, EC311 Digital Signal Processor is the syllabus for the EC312 Digital Signal Processor Lab. Following experiments are the guidelines for the students. However, the questions for exams are not limited to these experiments.

List of experiments:

1. To study the Code Composer Studio and architecture of TMS 320C6416/6473 DSP Kit.

2. Implementation of FFT and its analysis Using TMS 320C6416 DSP Kit.

3. Design and analysis of FIR filter using TMS 320C6416 DSP Kit.

4. To implement LMS Algorithm using TMS 320C6416 DSP Kit.

5. To write a program for finding the heart rate variability using TMS 320C6416 DSP Kit.

6. To write a MATLAB program for computation of the PSD of two Sinusoids using Analog discovery 2 kit.

7. Implementation of BPSK Digital modulation using Analog discovery 2 kit.

8. Visualise the spectrum of vocal fold vibration using Electroglottpograph using Analog discovery 2 kit.

9. Develop an algorithm for de-noising the biomedical signal and its implementation using TMS 320C6416 DSP kit.

10. Implementation of Noise cancellation in bio signal using TMS 320C6473 DSP Kit.

11. Implementation of Image segmentation using TMS 320C6473 DSP kit.

12. Implementation of Image compression using TMS 320C6473 DSP kit.

Textbooks:

1. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Wiley, 2005

2. U. Meyer Baesse, "Digital Signal Processing with FPGAs", Springer, 2001

Reference Books:

1. Behrooz Parhami, "Computer Arithmetic Algorithms and Hardware Design", Oxford, 2000.

2. Shehrzad Qureshi, "Embedded Image Processing on the TMS320C6000™ DSP: Examples in Code Composer Studio™ and MATLAB.

Gaps in the Syllabus (to meet Industry/Profession requirements)
     NA

POs met through Gaps in the Syllabus
     NA

Topics beyond syllabus/Advanced topics/Design
     Simulations based on advanced topics after completion of compulsory twelve experiments.

POs met through Topics beyond syllabus/Advanced topics/Design
     Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	(60)
Attendance Marks	12
Lab file Marks	12
Viva Marks	24
Day-to-day performance Marks	12
End SEM Evaluation	(40)

Lab quiz Marks	20
Lab performance Marks	20

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	3	3	2	1	1	1	2	3	2	3			
CO2	2	3	3	2	1	1	1	1	2	3	2	3			
CO3	3	3	3	3	3	2	2	2	2	3	3	3			
CO4	3	3	3	3	3	2	2	2	2	3	3	3			
CO5	1	1	1	1	1	1	1	1	1	1	1	2			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.

CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC313
Course title: Electronic Measurements
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering
Co- requisite(s):
Credits: **L: 3**   **T: 0**   **P: 0**   **C: 3**
Class schedule per week: 3
Class: B. Tech
Semester / Level: III/03 *In-depth Specialization/Programme Elective*
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the need and concept of measurement, calibration, standards, errors, static and dynamic performance characteristics of measuring instruments.
2.	Demonstrate the operating principles of different analog and digital instruments.
3.	Experiment and analyze various a.c. and d.c. bridges for the measurement.
4.	Explain the operation and construction of analog and digital CRO used for different parameter measurement in the department laboratory.
5.	Solve the problems of measuring non electrical parameters using different transducers.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Find and investigate errors and explain the static and dynamic characteristics of instruments.
CO2	Explain the working of different analog instruments (PMMC, Moving iron) and use them to design multi-range voltage, current and resistance measuring instruments.
CO3	Demonstrate the process of balancing different bridge networks to find the value of unknown arm components.
CO4	Summarize the working of analog and digital CRO.
CO5	Schematize the measurement of non-electrical parameters using different transducers.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction of measurements and measurement systems: Significance of measurements, different methods of measurements, Instruments used in measurements, Electronic Instruments and its classification, Elements of a Generalized Measurement System. Characteristics of instruments, Static characteristics, Errors in measurements, scale, range, and scale span, calibration, Reproducibility and drift, Noise, Accuracy and precision, Significant figures, Linearity, Hysteresis, Threshold, Dead time, Dead zone, Resolution and Loading Effects.	10
Module – II	10

Analogue and Digital Instruments: Classification and Principles of Operation, Working Details Moving Coil (PMMC) and Moving Iron Instruments Construction, DC Ammeter, DC Voltmeter, Series and Shunt type Ohmmeter. Analogue Electronic voltmeter, DC Voltmeter with chopper type DC amplifier, Advantages of digital over analogue processing. Digital Voltmeters Digital Multimeters, Digital frequency Meter.	
Module – III Introduction of DC and AC Bridges: Wheatstone Bridge, Kelvin Double Bridge, Maxwell's Bridge, and Hay's Bridge, Anderson's Bridge, Scherings Bridge, Wien's Bridge, Sources of errors in Bridges and their elimination by shielding and grounding. Q meter.	7
Module – IV Oscilloscopes: CRT, Construction, Basic CRO circuits, Block diagram of a modern oscilloscope, Y-amplifiers, X-amplifiers, Triggering, Oscilloscopic measurement. Special CRO's: Dual trace, Dual beam, Sampling oscilloscope, Storage CROs.	5
Module – V Transducers: Definition, Classification, Principle of Analogue transducer: Resistive (Strain Gauge, POT, Thermistor and RTD), Capacitive, Piezoelectric, Thermocouple and Inductive (LVDT) and RVDT) transducer, Working principle of Digital Transducer and Optical transducer. Application of above transducers to be discussed on the basis of Pressure, Displacement, Level, Flow and Temperature measurements.	8

Books recommended:
Textbooks:
1. "Electrical and Electronic Measurements and Instrumentation" by A. K. Sawhney.
2. "Modern Electronic Instrumentation & Measurement Techniques" by Helfrick& Cooper.

Reference books:

1. "Electronic Instrumentation", by H. S. Kalsi.

Gaps in the syllabus (to meet Industry/Profession requirements): Visit to CIF, BIT Mesra.

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment
1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	3	3	1	1			3		3	3	2	1
CO2	3	3	2	3	3	3	2			3		3	3	2	1
CO3	3	3	2	3	3	3	2			3		3	3	2	1
CO4	3	3	2	3	3	2	2			3		3	3	2	1
CO5	3	3	2	3	3	2	2			3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1,CD2,CD5,CD8
CD2	Tutorials/Assignments	CO2	CD1,CD2,CD5,CD8
CD3	Seminars	CO3	CD1,CD2,CD5,CD8
CD4	Mini Projects/Projects	CO4	CD1,CD2,CD5,CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD2,CD5,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC315
Course title: Introduction to Industrial Instrumentation
Pre-requisite(s): EC208 Electronic Measurements Lab
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 3x1
Class: B. Tech
Semester / Level: V/03
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the role of instrumentation for controlling different electrical or non-electrical process variables in process industry.
2.	Demonstrate the working of various components of an Automation System.
3.	Summarize the various control schemes used in industry.
4.	Experiment with PLC systems and its programming for controlling industrial processes.
5.	Schematize intelligent controllers for industrial applications.

Course Outcomes
After the completion of this course, students will be able to:

CO1	Reproduce the different working principles of transducers and also design transducers for measurement of non-electrical process variables.
CO2	Explain the role and working of different components of an industrial automation systems.
CO3	Investigate and analyse the various control schemes used in industry.
CO4	Demonstrate the working of PLC and its programming.
CO5	Apply the concept of intelligent controllers as dynamic controller to control the process with dynamic disturbances.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Review of Transducers**: Principles of operations and its classification, Characteristics, Technological trends in making transducers, Silicon sensors for the measurement of pressure, Level, Flow and Temperature, Bio-sensors ,types and its Application .Radiation Sensors, X -ray and Nuclear radiation sensors, Fiber optic sensors for Temperature, Liquid level, Fluid- flow measurement, Electro-analytical sensors: Electrochemical cell, Standard Hydrogen Electrode (SHE), Smart sensors.	10
Module – II **Components of Industrial Automation system:** Detailed study of each block involved in making of DAS, Signal Conditioners: as DA, IA, Signal Converters (ADC & DAC), Sample and hold, Designing of Pressure, Temperature measuring instrumentation system using DAS, Data logger. Introduction about Automation system, Concepts of Control Schemes, Types of Controllers, Components involved in implementation of Automation system i.e., DAS, DOS, Converter (I to P) and Actuators: Pneumatic cylinder, Relay, Solenoid (Final Control Element).	10
Module – III **Control Systems:** Concepts of Controllers Schemes, Types of Controllers, Computer Supervisory Control System (SCADA), Direct Digital Control's Structure and Software, Introduction to Distributed Digital Control.	7

Module – IV **Programmable Logic Controllers:** Introduction of Programmable logic controller, Principles of operation, Architecture of Programmable controllers, Programming the Programmable controller.	8
Module – V **Intelligent Controllers:** Introduction to Intelligent Controllers, Model based controllers, Predictive control, Artificial Intelligent Based Systems, Experts Controller, Fuzzy Logic System and Controller, Artificial Neural Networks, Neuro-Fuzzy Controller system.	5

Books recommended:

Textbooks:
1. "Computer-Based Industrial Control", by Krishna Kant, PHI.
2. "Process Control Instrumentation Technology", by Curtis D Johnson, Pearson Ed.

Reference books:
1. "Sensors and Transducers", 2/E by D. Patranabis

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			3		3	3	3	1
CO2	3	3	2	3	3	3	2			3		3	3	3	1
CO3	3	3	2	3	3	3	2			3		3	3	3	1
CO4	3	3	2	3	3	2	2			3		3	3	3	1
CO5	3	3	2	3	3	2	2			3		3	3	3	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD7, CD8
CD3	Seminars	CO3	CD1, CD2, CD7, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD7, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD7, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC316**
Course title: **Industrial Instrumentation Lab**
Pre-requisite(s): Electronic Measurement, Sensor and transducers,
Co- requisite(s): Electronic measurement Lab
Credits: L: 0   T: 0   P: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 03
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	To provide exposure to various measuring techniques for flow, level, vibration etc.
2.	To demonstrate the working of different actuators.
3.	To introduce virtual instrumentation with Lab VIEW software.
4.	To program PLC for different real time control application.
5.	To demonstrate various controllers parameter tuning.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate the measuring techniques for flow, level, vibration etc.
CO2	Actuate control signal using different actuators for controlling valves.
CO3	Able to design measuring instruments using Lab VIEW software.
CO4	Program PLC for given real time application.
CO5	Schematize various control loop for industrial application.

SYLLABUS

List of experiments:
  1.   **Name of the Experiment**
         FLOW MEASUREMENT
Aim1. Flow Measurement using orifice, U tube Manometer and Rotameter.
  2.   **Name of the Experiment**
         FLOW CONTROL LOOP
Aim1. Liquid flow control using Flow control loop trainer.

3.   Name of the Experiment
     VIBRATION MEASUREMENT
Aim1. Displacement Velocity and Acceleration measurement using Piezoelectric acceleration sensor.

4.   Name of the Experiment
     PNEUMATIC TRAINER
Aim1. Perform actuations using Pneumatic Actuator Trainer.

5.   Name of the Experiment
     PRESSURE CONTROL LOOP
Aim1. Pneumatic Pressure control using Pressure control loop trainer.

6.   Name of the Experiment
      LEVEL CONTROL LOOP
Aim1. Liquid Level control using Level control loop trainer
.

7.   Name of the Experiment
     I to P CONVERTOR
Aim1. Study of current to pressure converter.

8.   Name of the Experiment
     PLC-I
Aim1. Lift control using ABB PLC

9.   Name of the Experiment
     PLC-II
Aim1. Logic gate simulation on ABB PLC.

10.   Name of the Experiment
     PRESSURE GAUGE TESTER
Aim1. Calibration of pressure instruments using dead weight pressure gauge tester.

11.   Name of the Experiment
     Lab VIEW-I
Aim1. Design of function generator using Lab VIEW.

12.   Name of the Experiment
     Lab VIEW-II
Aim1. Design of CRO using Lab VIEW
.

Books recommended:
Textbooks:
3. "Computer-Based Industrial Control", by Krishna Kant, PHI.
4. "Process Control Instrumentation Technology", by Curtis D Johnson, Pearson Ed.

Reference books:
2. "Sensors and Transducers", 2/E by D. Patranabis

Gaps in the syllabus (to meet Industry/Profession requirements): Visit CIF lab at BIT Mesra.

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz(zes)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	3	3	3	3	3
Semester End Examination	3	3	3	3	3

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	3	1	1	1	1	1		1	2	2	1
CO2	3	3	3	3	3	1	1		1	1		1	2	2	1
CO3	3	3	3	3	3	1	1		1	1		1	2	2	1
CO4	3	3	3	2	2	1	1		1	1			2	2	1
CO5	3	3	3	3	3	1	1	1	1	1		1	2	2	1

Correlation Levels 1, 2 or 3 as defined below:
    1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD5
CD2	Tutorials/Assignments	CO2	CD5
CD3	Seminars	CO3	CD5, CD9
CD4	Mini Projects/Projects	CO4	CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD5, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

Course code: EC319
Course title: VLSI Systems
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201
Electronic Devices
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/03
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the static and dynamic behavior of MOSFET and CMOS inverter.
2.	Interpret the interconnect routing issues, interconnection problems and solutions in integrated circuits and apply the perceived knowledge.
3.	Appraise and analyse the characteristics of combinational logic gates in CMOS.
4.	Design and Evaluate the characteristics of sequential logic circuits.
5.	Create the NMOS/CMOS gain stages for desired gains and analyze their frequency responses.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Describe and illustrate the static and dynamic behavior of MOSFET and CMOS inverter.
CO2	Sketch interconnect parasitics. Explain the interconnect routing issues, interconnection problems and solutions in Integrated Circuit.
CO3	Diagram and explain the combinational logic circuits and illustrate their characteristics and analyse them.
CO4	Schematize the sequential logic circuits, assess their characteristics and summarize their features.
CO5	Design the NMOS/CMOS gain stages for desired gains, schematize their frequency responses and analyze them.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Static and dynamic behavior of MOSFET and CMOS inverter:** **The MOS(FET) Transistor**: Static Conditions, Dynamic Behavior, Secondary Effects. Static and Dynamic Behaviour of CMOS Inverter: Switching Threshold, Noise Margin formulation, Computing the Capacitances, Propagation Delay, Power, Delay, Power-Delay Product, Energy-Delay Product.	**8**
Module – II The Wire and Interconnection: Interconnect Parameters, Electrical Wire Models, Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques, **I/O structures Design:** VDD and VSS pads, output & input pads, tri-state and bi-	**8**

directional pads, application of Schmitt trigger in I/O pads, MOSIS I/O pads, Mixed-Voltage I/O pad.	
Module – III **Designing Combinational Logic Gates in CMOS:** **Static CMOS Design:** Complementary CMOS, Ratioed Logic, Pass-Transistor Logic (PTL), Complementary pass-transistor logic (CPL), **Dynamic CMOS Design and issues**, **Domino logic and issues, np-CMOS**, Introduction to the SPICE, Verilog, SystemVerilog with Design examples of inverter, NAND and NOR gates.	**8**
Module – IV **Designing Sequential Logic Circuits:** Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles: Pulse Registers, Sense-Amplifier Based Registers; Pipelining: Latch-versus Register-Based Pipelines, NORA-CMOS—A Logic Style for Pipelined Structures; Nonbistable Sequential Circuits, Design examples of latch, flip-flop and register using Verilog, SystemVerilog HDL.	**8**
Module – V	**8**

Basic NMOS/CMOS gain stages and their frequency responses: MOS Amplifier Topologies, Biasing, Realization of Current Sources, CS Core, CS stage With Resistive Load, Current-Source Load, and Diode-Connected Load, CS Stage with Source Degeneration, CG Stage with Biasing, Source Follower with Biasing, Cascode Stage as a Current Source, Cascode Stage as an Amplifier; general frequency response.	

Textbooks:
1. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd ed., Prentice Hall, 2003.
2. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 4th ed., Addison Wesley, 2011.
3. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 3rd ed., Pearson Education, 2006.

Reference books:
2. Behzad Razavi, "Fundamentals of Microelectronics," Wiley, 2009.
3. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis," SunSoft Press, 1996.
4. Stuart Sutherland, Simon Davidmann, Peter Flake, "SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling," 2nd ed., Springer, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements):
  1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus:
    10

Topics beyond syllabus/Advanced topics/Design:
    1. Memory and RF circuits.

POs met through Topics beyond syllabus/Advanced topics/Design:
    1. N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	3	3	1	1			3		3	3	2	1
CO2	3	3	2	3	3	3	2			3		3	3	2	1
CO3	3	3	2	3	3	3	2			3		3	3	2	1
CO4	3	3	2	3	3	2	2			3		3	3	2	1
CO5	3	3	2	3	3	2	2			3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC320
Course title: VLSI Systems Lab
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices
Co- requisite(s): EC319 VLSI Systems
Credits: L: 0   T: 0   P: 3   C: 1.5
Class period per week: 03
Class: B. Tech.
Semester / Level: V/03
Branch: ECE
Name of Teacher:
Course Objectives

This course enables the students to:

1.	Understand the structural, behavioural, data-flow models for digital circuits simulation.
2.	Apply their understanding to design digital circuits/universal gates and draw layout of the same.
3.	Analyse the MOS device characteristics and its model parameters.
4.	Integrate basic blocks to build a bigger module and evaluate the results.
5.	Create/develop digital and analog subsystems keeping design goals in consideration.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Translate/express their theoretical knowledge while modelling/designing the basic digital circuits using HDL and Xilinx ISE and observe and explain the simulation results.
CO2	Write HDL RTL codes for designing digital circuits, simulate HDL RTL codes, and observe/examine the results. Interpret the same for the correctness of their functionality. Sketch layouts of universal gates. Simulate and observe/examine the results. Interpret the same for the correctness of their functionality. Apply appropriate bias to the terminals of an nMOSFET/pMOSFET. Simulate and show the output and transfer curves. Determine various MOSFET parameters.
CO3	Outline a VHDL/Verilog model and write RTL codes for Moore/Mealy machines and digital circuits. Test for their operation and analyse the results.
CO4	Evaluate a properly biased short-channel nMOSFET and test it for the short-channel effects.
CO5	Design 2-input NAND gate using SCMOS and pseudo-nMOS logic families and design a 2-input XOR using symbols of 2-input SCMOS NAND gate to achieve design goal. Simulate the designs, test and validate the results. Design/develop single-stage

	and two-stage CMOS amplifiers. Simulate the design, test and validate the anticipated gain / frequency response.

SYLLABUS

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC319 VLSI Systems** is the syllabus for the **EC320 VLSI System Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of compulsory experiments:

1. Outline a model of seven-segment decoder to display HEX digits and translate the same into VHDL/Verilog/SystemVerilog RTL code. Simulate the design and find errors, if any. Observe and show the results.

2. Sketch/draw layouts of 2-input CMOS NAND gate and 2-input CMOS NOR gate by the direct translation of their schematics. Perform DRC (design rule checking) on the dawn layout and find design rule errors, if any. Simulate and observe/examine the results. Interpret the same for the correctness of their functionality.

3. Outline a VHDL/Verilog model and write RTL code for a Moore machine with the following state transition diagram. Simulate/compile the same using the Xilinx development software (**Xilinx ISE 8.1i.**/**10.1i**) and find errors, if any. Test for its operation and analyse the results.
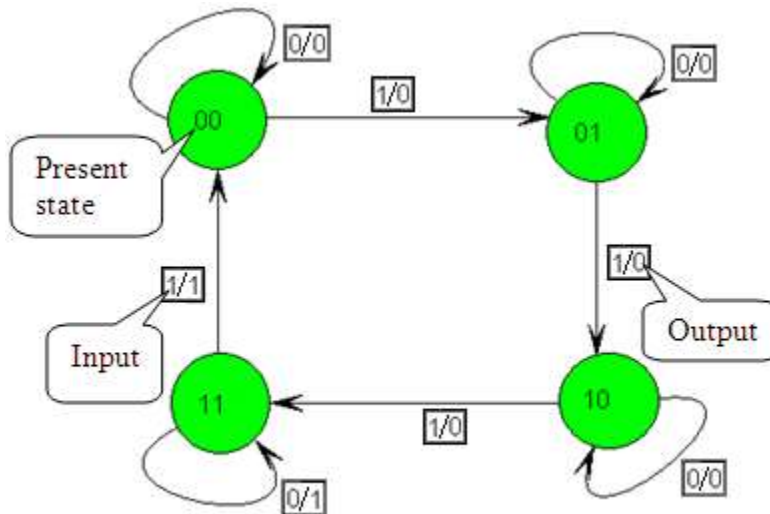
State diagram (Moore machine)

4. Outline a VHDL/Verilog model and write RTL code for a Mealy machine with the following state transition diagram. Simulate/compile the same using the Xilinx development software (**Xilinx ISE 8.1i.**/**10.1i**) and find errors, if any. Test for its operation and analyse the results.
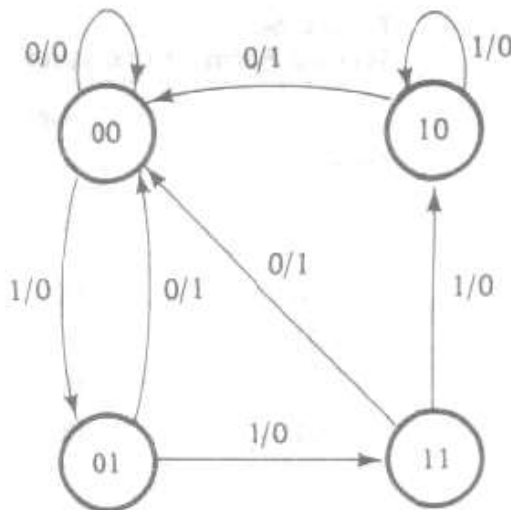
State diagram (Mealy machine)

5. Write a VHDL/Verilog/SystemVerilog RTL code to develop a tri-stated buffer controlled 4-channel multiplexer with each channel carrying 4 signals. Simulate/compile the same using the Xilinx development software (**Xilinx ISE 8.1i**./**10.1i**) and find errors, if any. Test and evaluate the obtained results.

6. Write VHDL/Verilog/SystemVerilog RTL code and develop/design an adder that adds three 8-bit binary number. Simulate using the Xilinx development software (**Xilinx ISE 8.1i**./**10.1i**) and find errors, if any, test and validate its operation.

7. Apply appropriate bias voltages to the terminals of an nMOSFET/pMOSFET. Change the bias voltage & simulate using Virtuoso Analog Design Environment of Cadence and show the I_D-V_D and I_D-V_G curves. Determine MOSFET parameters: r_{on}, μ_n, μ_p, g_m, g_{ds}, c_{gb}, c_{gs}, c_{gd}, V_{tn}, and V_{tp}.

8. Evaluate a properly biased short-channel nMOSFET and test it for the short-channel effects: channel length modulation (CLM), drain-induced barrier lowering (DIBL), V_t rolloff using Virtuoso ADE of Cadence.

9. Design 2-input NAND gate using SCMOS and pseudo-nMOS logic families with given specifications with the Virtuoso ADE of Cadence and design a 2-input XOR using symbols of 2-input SCMOS NAND gate to achieve propagation delay (t_p) not longer than 20 ns and average power consumption (P_{avg}) not higher than 10 μW. Simulate the designs, test and validate your anticipation. Simulate and report the propagation delay (t_p) and power consumption (P_{avg}) of your XOR gate. Load the input and output of XOR gate with single-stage NAND to make the input and output realistic.

10. Design a common source (CS) amplifier using an nMOSFET (Q_1) with a small-signal gain of at least 3 with respect to ground with the Virtuoso ADE of Cadence. Implement the load current with current source I_{DC} and pMOSFET current mirror, input device of which is Q_3 and output device of which is Q_2. Simulate the design, test and validate the anticipated gain.

11. Design an inverting differential amplifier with a gain of at least 3 with respect to ground using the Virtuoso ADE of Cadence. Simulate the design, test and validate the anticipated gain.

12. <mark>Design</mark> an Op Amp based square wave generator with a frequency of at least 1 MHz using the Virtuoso ADE of Cadence. <mark>Simulate</mark> the design, <mark>test</mark> and <mark>validate</mark> the anticipated frequency response.

List of optional experiments:

13. Write a VHDL/Verilog/SystemVerilog model and prepare a Linear-Feedback Shift Register (LFSR). Use the same to develop a Pseudo Random Sequence Generator (PRSG). Simulate and examine the results. Interpret the same for the correctness of its functionality. CO2

14. Write a VHDL/Verilog/SystemVerilog model and develop a Fibonacci LFSR with characteristic polynomial of $1 + x + x4$. Simulate it with the seed test pattern = 1000 and prepare a table with the results. Interpret the same for its correctness. CO2

15. Write a VHDL/Verilog/SystemVerilog model and develop an 8-bit barrel shifter. Simulate it with the seed test pattern = 11000110 and prepare a table and record the results for consecutive 8 clock pulses. Examine the same for its correctness. CO2

16. Draw the layout of an inverter with donut (round transistor) connection on Microwind 2.6a. Show the advantage of donut connection compared to the layout that is drawn by the direct translation of its schematic.

17. Draw the layout of 2-input NAND gate that has less drain area connected to the output node and show how this layout improves gate performance compared to the layout that is drawn by the direct translation of its schematic.

18. Draw the optimized layout of a 4-input domino AND gate to improve its performance and show how this layout improves gate performance compared to the layout that is drawn by the direct translation of its schematic.

19. Draw the layout of 2-input NOR gate that has less drain area connected to the output and show how this layout improves gate performance compared to the layout that is drawn by the direct translation of its schematic.

20. Write a VHDL/Verilog/SystemVerilog model and develop a 4:1-bit multiplexer. Simulate and synthesize the CPLD design using the Xilinx development software (Xilinx ISE 8.1i.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), use Spartan-2 CPLD Trainer Kit and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate and interpret the results displayed on the kit.CO2

21. Develop a VHDL/Verilog/SystemVerilog model and design a parameterized N-bit parity generator circuit. The model should provide both an odd parity and an even parity output. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use Spartan-3E FPGA Starter Kit), test and validate its operation. CO5

22. Write a VHDL/Verilog model and develop a 4×16 decoder. Simulate the design using the Xilinx development software (Xilinx ISE 8.1i/10.1i) and find errors, if any. Observe/examine the results. Interpret the same for the correctness of their functionality.

23. Outline a model of 4-bit ripple carry full adder and translate/express the same into VHDL/Verilog RTL code. Simulate/compile the same using the Xilinx development software (Xilinx ISE 8.1i./10.1i) and find errors, if any. Observe and show the results and explain the same.

24. Outline a VHDL/Verilog model and write RTL code for a synchronous counter` with the following states. Simulate/compile the same using the Xilinx Integrated Synthesis Environment (ISE) 8.1i./10.1i) and find errors, if any. Test for its operation and analyse the results.
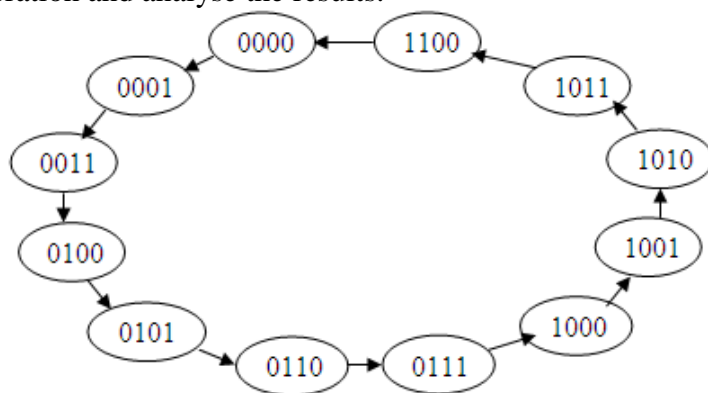
Textbooks:
4. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd ed., Prentice Hall, 2003.
5. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 4th ed., Addison Wesley, 2011.
6. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 3rd ed., Pearson Education, 2006.

Reference books:
5. Behzad Razavi, "Fundamentals of Microelectronics," Wiley, 2009.
6. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis," SunSoft Press, 1996.
7. Stuart Sutherland, Simon Davidmann, Peter Flake, "SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling," 2nd ed., Springer, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements):
1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus:
10.

Topics beyond syllabus/Advanced topics/Design:
1. Memory and RF circuits.

POs met through Topics beyond syllabus/Advanced topics/Design:
10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz(zes)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	1	1	1		3		3	3	3	2
CO2	3	3	3	3	3	1	1	1		3		3	3	3	2
CO3	3	3	3	3	3	1	1	1		3		3	3	3	2
CO4	3	3	3	3	3	1	1	1		3		3	3	3	1
CO5	3	3	3	3	3	1	1	1		3		3	3	3	1

Correlation Levels 1, 2 or 3 as defined below:

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

Course Delivery Methods

CD1		Lecture by use of boards/LCD projectors/OHP projectors
CD2		Assignments
CD3		Laboratory experiments/Teaching aids/Seminars
CD4		Mini Projects
CD5		Industrial visits/in-plant training
CD6		Self- learning such as use of NPTEL materials and internets
CD7		Simulation

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6, CD7
CO2	CD1, CD3, CD6, CD7
CO3	CD1, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC321
Course title: Microelectronic Devices and Circuits
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/03
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

6.	Understand the Physics of Modern Devices.
7.	Grasp the characteristics modern MOS Devices and apply the obtained knowledge.
8.	Appraise and analyse the CMOS Performance Factors.
9.	Evaluate the characteristics of Current Mirrors, Single- and -two Stage OTA.
10.	Comprehend the manufacturing principles of CMOS integrated circuits and create/develop their structures.

Course Outcomes

After the completion of this course, a student will be able to:

CO1	Describe and illustrate the Physics of Modern Devices.
CO2	Sketch and explain the modern MOS Devices.
CO3	Illustrate with the sketch the CMOS Performance Factors, diagram their characteristics and analyse them.
CO4	Design and schematize the Current Mirror, Single- and -two Stage OTA; assess their characteristics and summarize their features.
CO5	Appraise the Manufacturing steps and Layout of CMOS Integrated Circuits and create/develop/design their structures.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Basic Device Physics:** Modern CMOS Transistors: CMOS processes, CMOS process enhancements, **Metal-Silicon Contacts, High-Field Effects:** Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown	8
Module – II **MOS Devices:** Long-Channel MOSFETs, Short-Channel MOSFETs, MOSFET Scaling, Threshold Voltage: Various Definitions of Threshold Voltage, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage. MOSFET Channel Length: Various Definitions of Channel Length, Extraction of the Effective Channel Length. .	8
Module – III	8

CMOS Performance Factors: Basic CMOS Circuit Elements, Parasitic Elements, Sensitivity of CMOS Delay to Device Parameters, Performance Factors of Advanced CMOS Devices: MOSFETs in RF Circuits, Effect of Transport Parameters on CMOS Performance, Low-Temperature CMOS.	
Module – IV **Current Mirrors, Single- and -two Stage OTA:** Current Mirror, MOS Differential Pair: Qualitative Analysis, Large-Signal Analysis, Small-Signal Analysis; Frequency Response of Differential Pairs; Design of Current-sink CMOS inverting Amplifier, General Characteristics of the ideal CMOS OTA, Division of a two-stage uncompensated CMOS OTA into voltage-to-current and current-to-voltage stages, Functions of different stages, two-stage CMOS OTA.	**8**
Module – V **Manufacturing steps and Layout of CMOS Integrated Circuits:** **CMOS IC fabrication Steps**: Silicon Wafer, Diffusion, ion-implantation, annealing, etching, patterning or lithography, oxidation, sputtering, deposition, metallization, planarization; **Layout**: Design Rules, Stick Diagram, Layouts of Universal Gates & complex logic gates; Variability and Mismatch; **Analog Layout Considerations:** Analog design issues**,** common-centroid layout, capacitor & resistor layout and matching.	**8**

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Textbooks:
1. Neil H. E. Weste and Kamran Eshranghian, "Principles of CMOS VLSI Design: A Systems Perspective", 2nd ed., Addition-Wesley, 1993.
2. Y. Taur and T. H. Ning, "Fundamentals of Modern VLSI Devices," Cambridge University Press, NY, USA, 2/e, 2009.
3. Behzad Razavi, Fundamentals of Microelectronics, Wiley, 2009.
4. Neil H. E. Weste and David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th International Edition, Pearson Education, Inc., 2011.

Reference books:
1. Tony Chan Carusone, David A. Johns and Kenneth W. Martin, Analogue Integrated Circuit Design, 2/e, John Wiley & Sons, 2012.
2. Phillip E. Allen & Douglas R. Holberg, CMOS Analog Circuit Design, 3/e, Oxford University Press, 2012.

Gaps in the syllabus (to meet Industry/Profession requirements):
1. Hands-on-practical for Device/IC fabrication.

POs met through Gaps in the Syllabus:
10

Topics beyond syllabus/Advanced topics/Design:
1. CNFET
2. TFET
3. MTJ
4. Memristor
5. SET
6. RTD.

POs met through Topics beyond syllabus/Advanced topics/Design:
10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	3	3	1	1			3		3	3	2	1
CO2	3	3	2	3	3	2	1			3		3	3	2	1
CO3	3	3	2	3	3	2	1			3		3	3	2	1
CO4	3	3	2	3	3	3	1			3		3	3	2	1
CO5	3	3	2	3	3	3	1			3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2

CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC323
Course title: Microwave Theory and Techniques
Pre-requisite(s): EC257Electromagnetic Fields and Waves
Co- requisite(s): EC324 Microwave Engineering Lab.
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 03
Class: B. Tech.

Semester / Level:V/03
Branch:ECE
Name of Teacher:

Course Objectives

This course enables the students to:

6.	To appraise the requirements of Microwave engineering
7.	To develop ability to analyse microwave networks.
8.	To describe and analyse the operation of Microwave sources and amplifiers.
9.	To differentiate, describe, design and analyse the active and passive microwave components
10.	To differentiate, describe, design and analyse reciprocal and nonreciprocal components

Course Outcomes

After the completion of this course, students will be able to:

CO1	To describe the characteristics and applications of microwave engineering
CO2	To define microwave network theories and analyse the various microwave networks.
CO3	To design, characterize and describe microwave sources and amplifiers.
CO4	To differentiate, describe, design and analyse the active and passive microwave components
CO5	To differentiate, describe, design and analyse reciprocal and nonreciprocal components

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I	**8**

Introduction to Microwave and Microwave Network Analysis: Microwave Frequency bands, Applications of Microwaves, Equivalent Voltages and currents, Impedance and Admittance Matrices, Scattering Parameters, The Transmission (ABCD) Matrix.	
Module – II Passive Microwave Devices and Components: Basic Properties of Dividers and Couplers, The T-Junction Power Divider, Wilkinson Power Divider, Waveguide Directional Couplers, Quadrature (90∘) Hybrid, Coupled Line Directional Couplers.	**8**
Module – III **Microwave Tubes**: Limitations and Losses of conventional Tubes at Microwave Frequencies, Klystron, Travelling Wave Tube, Magnetron	**8**
Module – IV Microwave Filters: Filter Types and parameters, Realization of Butterworth and Chebyshev type filter, Filter Implementation.	**8**
Module – V	**8**

Design of Ferromagnetic Components: Intro to Ferromagnetic Material, Faraday rotation in ferrite, Ferrite Isolators, Ferrite Phase Shifters, Ferrite Circulators.	

Books recommended:
Textbooks:

8. David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.

Reference books:
1. S. Y. Liao , "Microwave Devices & Circuits", PHI 2nd Edition
2. R. Ludwig and G. Bogdanov, "RF Circuit Design, Theory and Applications", Pearson, 2nd Edition.
3. B. R. Vishvakarma, R U Khan, M K. Meshram, " Intoduction to Microwave Measurements"
4. R.E.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.

Gaps in the syllabus (to meet Industry/Profession requirements): Hands on experience on real-time industrial projects and management

POs met through Gaps in the Syllabus: PO11

Topics beyond syllabus/Advanced topics/Design: EMI-EMC due to electromagnetic radiations

POs met through Topics beyond syllabus/Advanced topics/Design: PO 6, PO 8

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2		1	1		1	1	1	1	1	3			
CO2	3	3	3	3	3	1	1	1	2	2	1	3			
CO3	3	3	3	3	3	1	1	1	2	2	1	3			
CO4	3	3	2	3	3	1	1	1	2	2	1	3			
CO5	3	3	2	3	3	1	1	1	2	2	1	3			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD4,CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD4, CD5, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD4, CD5, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD4,CD5, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC324
Course title: Microwave Engineering Lab
Pre-requisite(s): Electromagnetic Fields and Waves
Co- requisite(s):
Credits: L: 0   T: 0   P: 3   C: 1.5
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Fifth/Three
Branch: Electronics & Communication Engineering
Name of Teacher: ALL

Course Objectives:
This course enables the students:

11.	To develop an understanding about the measurements of the various microwave passive components.
12.	To develop an understanding about the measurements of the performance parameters of Microwave Crystal Detector and Gunn Diode.
13.	To develop an ability to understand a planar microwave filter.
14.	To develop an ability to understand a planar microwave coupler .
15.	To develop an ability to understand a microstrip planar power divider

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Demonstrate understanding of the measurements of the various microwave passive components.
CO2	Demonstrate understanding of the measurements of the performance parameters of Microwave Crystal Detector and Gunn Diode.
CO3	Design a planar microwave filter.
CO4	Design a planar microwave coupler and power divider
CO5	Design a microstrip planar power divider

Syllabus

List of Compulsory experiments:

7. **Name of the Experiment: Rectangular Waveguide**
    AIM-1: To Determine the Rectangular Waveguide Parameters

8. **Name of the Experiment: Waveguide T-Junctions**
    AIM-1: To Find out the Coupling Coefficients of E-plane and H-plane Tee.

9. **Name of the Experiment: Magic Tee**
    AIM-1: To Find out the Coupling Coefficients and Isolation of Magic Tee

4. **Name of the Experiment: Multi Hole Direction Coupler**
    AIM-1: To Find out the Coupling Factor, Directivity and Insertion Loss of a Multi Hole
          Direction Coupler

5. **Name of the Experiment:** Three Port Circulator
    AIM-1: To Find out the Coupling Coefficients and Isolation of a three port Circulator

6. **Name of the Experiment: Phase Shifter**
    AIM 1: To Find out the Isolation of an Isolator and amount of phase shift of a phase shifter

7. **Name of the Experiment: Variable Attenuator**
    AIM 1: To Determine the Attenuation of a Variable Attenuator

8. **Name of the Experiment:**, **Design of rectangular micro strip patch antenna using IE3D**

AIM 1: To Examine the square law characteristics of a Microwave Crystal Detector

9. **Name of the Experiment: Microstrip Low Pass Filter**
    AIM 1: Using the IE3D, Design a low pass filter whose input and output are matched to a 50 Ω impedance and that meets the following specifications: cut-off frequency of 3 GHz, equi-ripple of 0.5 dB, and rejection of at least 25 dB at approximately 1.5 times the cut-off frequency. Assume a dielectric material that results in a phase velocity of 60 % of the speed of light.

10. **Name of the Experiment:, Branch-line Quadrature Hybrid Junction**
    AIM 1: Using the IE3D, Design a 50 Ω branch-line quadrature hybrid junction, and plot the scattering parameter magnitudes from $0.5f_0$ to $1.5f_0$ where f_0 is the design frequency.

11. **Name of the Experiment:, Microstrip Power Divider**
AIM 1: Using the IE3D, Design a 3 dB equal power divider and plot the scattering parameter magnitudes from $0.5f_0$ to $1.5f_0$ where f_0 is the design frequency

List of Optional experiments:

1. **Name of the Experiment:, X-band Pyramidal Horn Antenna**
AIM 1: To Determine the Power gain, Radiation Pattern and 3dB Beamwidth of a X-band Pyramidal Horn Antenna

2. **Name of the Experiment:, KU- band Pyramidal Horn Antenna**
AIM 1: To Determine the Power gain, Radiation Pattern and 3dB Beamwidth of a KU-band Pyramidal Horn Antenna.

3. **Name of the Experiment:, Microstrip Antenna**
AIM 1: To Determine the Power gain, Radiation Pattern and 3dB Beamwidth of a Microstrip patch Antenna.

4. **Name of the Experiment:, Parabolic Disc Antenna**
    AIM 1: Measurement of Power gain, Radiation Pattern and 3dB Beamwidth of a Parabolic Disc Antenna.

5. **Name of the Experiment:, Coaxial Line**
    AIM 1: To Find out the Frequency and line parameters for a coaxial line.

6. **Name of the Experiment:, VHF Transmission Line**
    AIM 1: To Find out the frequency and line Parameters of a two wire VHF transmission line.

Text Book:

1. "David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.

Reference Books:

1. S. Y. Liao , "Microwave Devices & Circuits", PHI 2nd Edition
2. R. Ludwig and G. Bogdanov, "RF Circuit Design, Theory and Applications", Pearson, 2nd Edition.
2. B. R. Vishvakarma, R U Khan, M K. Meshram, " Intoduction to Microwave Measurements"

3. R.E.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

<u>**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**</u>

<u>**Direct Assessment**</u>

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**

Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –
      1. Student Feedback on Faculty
      2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	1	3	1	-	-	1	3	1	2	2	2	1
CO2	3	3	1	1	3	1	-	-	1	3	1	2	2	2	1
CO3	3	3	3	2	3	1	-	-	1	3	1	3	2	2	1
CO4	3	3	3	2	3	1	-	-	1	3	1	3	2	2	1
CO5	3	3	3	2	3	1	-	-	1	3	1	3	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5 ,CD8
CD2	Tutorials/Assignments	CO2	CD1, CD5,CD8
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5,CD8, CD9

CD4	Mini Projects/Projects	CO4	CD1, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC325
Course title: **Antenna and Wave Propagation**
Pre-requisite(s): Knowledge of Electromagnetic theory, Basic understanding of Network Theorem
Co- requisite(s): Electromagnetic Theory
Credits: L:3   T :0   P :0   C:3
Class schedule per week: 03/week
Class: B. Tech
Semester / Level: Fifth
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:

1.	To impart knowledge on the fundamental antenna parameters .
2.	To develop the concept of mechanism of radio wave propagation and applications.
3.	To Analyze the concepts associated with operating principles of antenna theory, antenna performance, operation ,classification and applications.

4.	To explain the concept and basic principles associated with the implementation of antenna arrays.
5.	To Apply the Antenna measurement techniques using microwave equipment setup.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the basic radiation mechanism and antenna parameters.
CO2	Design and characterize the various antenna arrays
CO3	Analyze the wire antennas and aperture antennas.
CO4	Apply the knowledge on the measurements of Antenna parameters.
CO5	Understand the concept of the wave propagation in free space.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Antenna Fundamentals**: Radiation mechanism - single wire, two wire, dipole and current distribution on thin wire, Radiated field components - Hertzian dipole, Half wave Dipole and Monopole Antenna. **Antenna Parameters:** Radiation Pattern, Beam Width, Radiation Power Density, Directivity and Gain, Bandwidth, Polarization, Input Impedance, Efficiency, Antenna Effective Length and Area, Antenna Temperature, Reciprocity Principle. Problem solving .	10

Module – II **Antenna Arrays:** Linear Array - Two element array, N-element linear array- Broadside array, End fire array- Directivity, Pattern Multiplication, Non-uniform excitation- Binomial Array, Problem solving	**9**
Module – III **Special Antennas:** Practical antennas VLF, LF, MF transmitting antennas ,resonant antennas & non resonant antennas , Wire Antennas- Small Loop Antenna, V-Antenna, Rhombic antenna, Helical antenna and Yagi-Uda antenna, Frequency Independent Antenna - Spiral and Log periodic antenna, **Aperture antennas** - Horn antenna, Parabolic Reflector antenna, Microstrip antenna.	**8**
Module – IV **Antenna Measurements**: Measurement of antenna impedance , Pattern measurements, Measurement of Antenna Gain, Beam width , Radiation resistance , Antenna efficiency , Directivity -Polarization.	**7**
Module – V **Propagation of radio waves**:	**6**

Mode of propagation Ground wave propagation, sky wave propagation Space wave propagation, atmospheric effects, structure of atmosphere General picture of ionosphere, and its effect on radio waves. skip distance, MUF, ionospheric propagation, Fading, Problem solving	

Text Books:

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007

2. .D. Kraus, R.J. Marhefka and Ahmad S Khan, Antennas and Wave Propagation, 4th Edition, Mc Graw Hill, 2010

Reference Book:

1. Antennas and Wave propagation by A.R.Harish, M.Sachidananda, Oxford University press ,Ist edition 2007,ISBN-13:978-0-19-568666-1,ISBN -10: 0-19-568666-7

Gaps in the Syllabus (to meet Industry/Profession requirements)
3.   Application of Simulation software /tools to design antenna for research and industrial requirements

POs met through Gaps in the Syllabus
        4,5,9
Topics beyond syllabus/Advanced topics/Design

2. Antenna synthesis and modeling
3. Fabrication of antennas and Testing

POs met through Topics beyond syllabus/Advanced topics/Design
        1,2,10,12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcomes	Program Outcomes(POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	1	2										
CO2	3	3	3	3	3	2	2	1		2		2			
CO3	3	3	3	3	3	2	2		1						
CO4	1	3	3	3	3	2		2		2	2	2			
CO5	1	2	1	2		2			3		3				

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD7,CD 8
CD2	Tutorials/Assignments	CO2	CD2,CD5, CD4
CD3	Seminars	CO3	CD2, CD6,CD 8,CD9
CD4	Mini Projects/Projects	CO4	CD4,CD5,CD6 ,CD7
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD6 ,CD8,
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC327
Course Title: Mobile and Cellular Communication
Pre-requisite(s): Knowledge of Communication process, probability theory, basic understanding of interference and noise in communication process, basic understanding of communication media.
Co-requisite(s):N/A
Credits: L: 3 T: 0   P: 0   C: 3
Class schedule per week: 03/week
Class: B. Tech.
Semester / Level: **Fifth/ Third**
Branch: **Electronics & Communication Engineering**
Name of Teacher:

Course Objectives
This course enables the students:

1	To understand cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication.
2	To comprehend the impact of interference on the cellular system capacity.
3	To comprehend different channel parameters causing impairments in signal propagation.
4	To understand impairment removal techniques in signal propagation
5	An understanding of multiple access techniques to support mobile cellular communication

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Explain cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication.
CO2	Analyze the impact of interference on the cellular system capacity.
CO3	Analyze different channel parameters causing impairments in signal propagation
CO4	Evaluate different methods of Channel impairments removal techniques.
CO5	Explain multiple access techniques to support mobile cellular communication

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I The cellular fundamentals: cellular communication and frequency reuse, general architecture of a cellular system, channel assignment strategies, hand-off in a cellular system. Evolution of mobile cellular communication: different generations of mobile cellular communication (1G, 2G. 2.5G, 3G and beyond), typical cellular standards (AMPS, GSM, GPRS, WCDMA, LTE, concept of LTE-advanced), 4G features and challenges, 5G vision.	**10**
Module – II Interference and cellular system capacity: co-channel interference and adjacent channel interference, power control, inter-symbol interference, enhancing cellular system capacity (cell splitting, sectorization, smart antenna technique, link adaptation and small cell deployment). .	**8**
Module – III Signal propagation in mobile communication : mobile cellular environment, multipath propagation and fading, free space propagation model, propagation path loss, outdoor propagation models (Okumura model & Hata model), indoor propagation models, power delay profile, channel parameters (delay	**8**

spread, doppler spread, coherence bandwidth, coherence time, LCR and ADF).	
Module – IV Diversity & combining techniques: diversity mechanisms (space, time, frequency and polarization), diversity gain and array gain, combining techniques (SC, MRC, TC and EGC), concept of equalization.	**7**
Module – V Multiple access schemes: duplexing schemes, FDMA, TDMA, SDMA, spread spectrum technique and CDMA, OFDMA, ALOHA and CSMA.	**7**

Text Book:

1. Vijay K. Garg, "Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint).

Reference Books:

1. Simon Haykin and Michael Moher, "Modern Wireless Communications", Parson Education, Delhi, 2005.
2. Theodore S Rappaport, "Wireless Communication: Principles and Practice" Prentice Hall of India, New Delhi, 2006, 2/e.
3. Sanjay Kumar, "Wireless Communication the Fundamental and Advanced Concepts" River
   Publishers, Denmark, 2015 (Indian reprint).

Gaps in the syllabus (to meet Industry/Profession requirements): Current technological developments in the field

POs met through Gaps in the Syllabus: PO1 & PO12

Topics beyond syllabus/Advanced topics/Design: Current research findings in the field of mobile cellular communication.

POs met through Topics beyond syllabus/Advanced topics/Design: PO1 & PO12
Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –
1. Student Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	1	1	1	1	2	2	1	2	3	2	2
CO2	3	3	2	3	2	1	1	1	2	2	1	1	3	2	2
CO3	3	3	2	3	2	1	1	1	2	2	1	1	1	2	3
CO4	3	3	2	3	3	1	1	1	2	2	1	1	3	2	1
CO5	3	3	2	3	3	1	1	1	2	2	1	1	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1,CD2,CD6, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD6, CD8

CD3	Seminars	CO3	CD1, CD2, CD6, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD6, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1,CD2,CD3, CD9
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC328
Course title: Mobile & Cellular Communication Lab
Pre-requisite(s): Knowledge of Communication process, probability theory, basic understanding of interference and noise in communication process, basic understanding of communication media.
Co- requisite(s):
Credits: L: 0   T: 0   P: 3   C: 1.5
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Fifth/Third
Branch: Electronics & Communication Engineering

Name of Teacher: ALL

Course Objectives:

This course enables the students:

1	To explain GSM modem and the GPRS system, Spread Spectrum and 4G -LTE.
2	To explain *the cellular frequency reuse concept, interference and handover mechanism*
3	To understand path loss and in estimation of received signal power
4	To identify Performance parameters related to cellular communication
5	To explain MIMO system

Course Outcomes:

After the completion of this course, students will be able to:

CO1	Experiment for GSM modem ,GPRS system, Spread Spectrum and 4G -LTE
CO2	Demonstrate the working of *cellular frequency reuse concept, interference and handover mechanism*
CO3	Design and Develop path loss models through simulation
CO4	To measure Performance parameters related to cellular communication
CO5	Demonstrate MIMO system

Syllabus

List of Compulsory experiments:

10. Name of the Experiment: Understanding GSM Handset Setup

AIM: Study the GSM modem and its different module for phone book access, setting up a call, sending SMS and identifying call history using AT commands.

11. Name of the Experiment: Understanding Direct Sequence Spread Spectrum Technique

AIM: Study of Direct Sequence Spread Spectrum Modulation and Demodulation process using Trainer Kit.

12. Name of the Experiment: Understanding 3G Mobile Communication System

AIM: To establish 3G Mobile Communication and observe SIM signal, switch fault and test various AT command on 3G terminal.

13. Name of the Experiment: Understanding 4G - VoLTE Smart Phone System

AIM: To establish 4G Communication and observe signal at various test points using Trainer kit.

14. **Name of the Experiment: Measurement of received signal power in mobile cellular communication**
AIM: Evaluate the impact of path loss for estimation of received signal power using Virtual Lab/MATLAB.

15. **Name of the Experiment: Measurement of *Signal to Interference and Noise Ratio***
AIM: *To Understand the concept of co-channel interference and evaluate Signal to Interference and Noise Ratio* using Virtual Lab/MATLAB for Fading Channels.

16. **Name of the Experiment: *Understanding cellular frequency reuse concept***
AIM: *Finding the co-channel cells for a particular cell and finding the cell clusters within certain geographic area* Virtual Lab/MATLAB.

17. **Name of the Experiment: *Downlink C/I ratio measurement***
AIM: *To understand the impact of many different parameters influencing the downlink C/I ratio like: Cell radius, Transmitter power of B.S, Frequency reuse, Sectoring, Shadowing, Base station height, Path loss exponent etc* using Virtual Lab/MATLAB for Fading Channels.

18. **Name of the Experiment: Understanding Handover Mechanism**
AIM: *To understand the Hard and Soft handover mechanism* using Virtual Lab/MATLAB for Fading Channels.

19. **Name of the Experiment: Analysis of wireless communication parameters**
AIM: *To study the outage probability, LCR & ADF in SISO for Selection Combining and MRC* using Virtual Lab/MATLAB for Fading Channels.

20. **Name of the Experiment: Analysis of delay spread for fading channel**
AIM: *To study the effect of delay spread on frequency selectivity channel* using Virtual Lab/MATLAB.

21. **Name of the Experiment: Channel Capacity evaluation for MIMO System**
AIM: To obtain and compare the channel capacity for SISO, SIMO, MISO and MIMO system Using Virtual Lab/MATLAB.

Text Book:

1. Theodore S Rappaport, "Wireless Communication: Principles and Practice" Prentice Hall of India, New Delhi, 2006, 2/e.

Reference Books:

1. Sanjay Kumar, "Wireless Communication the Fundamental and Advanced Concepts" River Publishers, Denmark, 2015 (Indian reprint).
2. J. Schiller, "Mobile Communication" 2/e, Pearson Education, 2012.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**

End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –
      1. Student Feedback on Faculty
      2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	1	2	2	2	2	2	2	1
CO2	3	3	1	2	3	1	2	1	2	2	2	2	2	2	1
CO3	3	2	1	2	3	1	2	1	2	2	2	2	2	2	1
CO4	3	3	1	2	3	1	2	1	2	2	2	2	2	2	1
CO5	3	2	1	2	3	1	2	1	2	2	2	2	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used

CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5
CD2	Tutorials/Assignments	CO2	CD1, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 329
Course Title: Information Theory and Coding
Pre-requisite(s): Knowledge of digital electronics, probability theory, basic understanding of communication system.

Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Fifth/Three
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

6.	An understanding of the fundamental knowledge of information
7.	An understanding of channel capacity to achieve efficient as well as reliable communication.
8.	An understanding of various Source and Channel Coding Techniques
9.	Fundamental understanding on block codes, cyclic codes and convolutional codes, also explore its practical challenges.
10.	An ability to design and provide solutions for practical low cost, efficient, reliable and secure communication system.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Have an ability to measure information from a discrete as well as continuous source
CO2	Have an ability to compute the capacity of discrete and continuous time channels in presence and absence of noise.
CO3	Have an ability to measure and evaluate entropy for lossy & lossless source coding..
CO4	Have an ability to ensure error free transmission of a discrete/ continuous message source using suitable channel coding techniques like linear block codes, cyclic codes, convolution codes and turbo codes.
CO5	Have an ability to provide practical solutions and apply the subject expertise for the well fare of society

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Source Coding:** Information measure, Entropy, Differential Entropy, Conditional Entropy, Rela[...] Entropy, Information rate, Mutual Information, Shannon's Source Coding Theor[...] Prefix Coding, Huffman Coding, Shannon-Fano Coding, Arithmetic Coding, Lemp[...] Ziv Algorithm, Rate Distortion Theory.	10
Module – II **Channel Capacity & Coding:** Channel Coding Theorem, Markov Sources, Discrete Channel with discrete No[...] BSC, BEC, Capacity of a Gaussian Channel, channel capacity for MIMO syst[...] Bandwidth-S/N Trade-off.	10
Module – III **Block Codes:** Galois Fields, Hamming Weight and Hamming Distance, Linear Block Co[...] Encoding and decoding of Linear Block-codes, Parity Check Matrix, Bounds for bl[...] codes, Hamming Codes, Syndrome Decoding.	7
Module – IV **Cyclic Codes:**	

Introduction to cyclic code, Method for generating Cyclic Codes, Matrix descript of Cyclic codes, Cyclic Redundancy Check (CRC) codes, Circuit implementation cyclic codes, Burst error correction, BCH codes.	**7**
Module – V **Convolutional Codes:** Introduction to Convolutional Codes, Polynomial description of Convolutional Co Generating function, Matrix description of Convolutional Codes, Viterbi Decoding Convolutional code, Introduction to Turbo Code, Introduction to Cryptograp Overview of Encryption Techniques.	**7**

Text Books:
1. "Information Theory, Coding & Cryptography", by Ranjan Bose, TMH, Second Edition.
2. "Communication Systems", by S. Haykin, 4th Edition, Wiley-Publication.

Reference Books:
1. "Elements of Information Theory" by Thomas M. Cover, J. A. Thomas, Wiley-Inter science Publication.
2. "Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, Wiley India Edition.
3. "Cryptography and Network Security", Fourth Edition, by William stallings

Gaps in the Syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design: PO1

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	1											3	2	1
CO2	3	3				1							3	2	2
CO3	3	3				1							3	2	1
CO4	3	3	1	3		1	1					2	3	2	3
CO5	3	3	1	3		1	1					2	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD8
CD2	Tutorials/Assignments	CO2	CD1 ,CD8
CD3	Seminars	CO3	CD1, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC331
Course title: Issues in Nanoscale CMOS Design
Pre-requisite(s): EC101Basics of Electronics and Communication Engineering, EC201 Electronic Devices
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/03
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand trend of technology scaling and its impact on device and circuit performance.
2.	Comprehend pitfalls in CMOS circuit and apply the perceived knowledge.
3.	Appraise and analyse the variability and reliability issues.
4.	Perceive the sources of variation and evaluate variation prevention techniques.
5.	Apprehend the advantages and pitfalls of silicon-on-insulator technology and create/design SOI device using TCAD tools.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Describe and illustrate the technology scaling and its impact on device and circuit performance.
CO2	Sketch and explain the pitfalls in CMOS circuits.
CO3	Diagram and explain the variability and reliability issues.
CO4	Summarize and schematize the sources of variation, assess the variation prevention techniques.
CO5	Design and schematize SOI devices and write issues in SOI technology.

MODULE	(NO. OF LECTURE HOURS)
Module – I **Technology Scaling and its impact on device and circuit performance**: Transistor Scaling, Interconnect Scaling, ITRS; Impacts of Technology Scaling on Design, Physical Limits of Technology Scaling, tunnelling current through thin oxides, Poor I-V characteristics due to short-channel effects, mobility degradation and velocity saturation, channel length modulation, substrate current-induced body effect (SCBE), drain-induced barrier lowering (DIBL).	8
Module – II **Pitfalls in CMOS Circuit:** Threshold drops, Ratio failures, Leakage currents, leakage prevention techniques; Charge sharing, Power supply noise, Hot spots, Minority carrier injection, Back-gate coupling, Diffusion input noise sensitivity, Process sensitivity, Domino Noise Budgets: Charge leakage, Charge sharing, Capacitive coupling, Noise feedthrough, Process corner effects, Soft errors; Manufacturing Issues.	8
Module – III **Variability and Reliability Issues:** Variability: Process variation, Supply voltage, Operating temperature, Design Corners; Reliability: Reliability Terminology, Oxide Wearout, Hot Carriers, Negative bias temperature instability (NBTI), Time-dependent dielectric breakdown (TDDB); Interconnect Wearout: Electromigration, Self-Heating, Soft Errors, Overvoltage Failure, Latchup and its prevention technique.	8

Module – IV **Sources of Variation and Variation Prevention Techniques:** Channel Length Variation, linewidth variation, line edge roughness, proximity effect, orientation Effect, topography effect, Threshold voltage variation, random dopant fluctuations (RDF), Oxide Thickness variation, Layout Effects, across-chip mobility variation; Impact of variation on Device and Circuit Performance, Variation in Delay, Variation in Power, Variation in Energy, Malfunctioning Device and Circuits, Matched Delays, Variation-Tolerant Design.	**8**
Module – V **Issues in SOI Technology:** Types of Silicon-on-Insulator Devices, Partially-depleted Silicon-on-Insulator device, Fully-depleted Silicon-on-Insulator device, pitfalls of Partially-depleted Silicon-on-Insulator device: history effect, pass-gate leakage, Self-heating, implications for circuit styles in Partially-depleted Silicon-on-Insulator devices, advantages of Silicon-on-Insulator CMOS process.	**8**

Textbooks:
1. Neil H. E. Weste and David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th International Edition, Pearson Education, Inc., 2011.
2. Y. Taur and T.H. Ning. Fundamentals of Modern VLSI Devices. Cambridge University Press, NY, USA, 2/e, 2016.

Reference books:
1. J. M. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective," 2nd ed., Pearson Education, 2016.
2. Alice Wang, Benton H. Calhoun, A. P. Chandrakasan "Sub-threshold Design for Ultra Low-Power Systems", Springer, 2006, ISBN-13: 978-0387335155.

Gaps in the syllabus (to meet Industry/Profession requirements):
1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus:
   10

Topics beyond syllabus/Advanced topics/Design:
   N/A

   10
Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	3	3	1	1			3		3	3	2	1
CO2	3	3	2	3	3	3	2			3		3	3	2	1
CO3	3	3	2	3	3	3	2			3		3	3	2	1
CO4	3	3	2	3	3	2	2			3		3	3	2	1
CO5	3	3	2	3	3	2	2			3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used

CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC333
Course title: **Sensors and Transducers**
Pre-requisite(s):
Co- requisite(s):
Course type: Elective
Credits:　　　L: 3　　T: 0　　P: 0
Class schedule per week: 03
Class: B.E
Semester / Level: VI
Branch: ECE
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

11.	To describe the operation of various sensors and their application
12.	To select an appropriate sensor for a given application

13.	Design a smart sensor using conventional sensors and microcontroller
14.	Compare analog and digital transducer.
15.	To discuss the latest technology in sensor development

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the principle of operation of different sensors and their applications
CO2	Classify sensors on different basis
CO3	Differentiate between smart sensor and conventional sensor
CO4	Demonstrate the operation of various digital transducer
CO5	Be updated on the recent trends in sensor technologies.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction** Introduction about sensors and transducers, Principles of operation and their classification, characteristics of sensors, Errors in measurement.	6
Module – II **Resistive and Inductive Transducer** Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: load and torque measurement, RTD, Thermistor, LDR, Self and mutual inductive transducers, LVDT, RVDT, eddy currents transducer .	10
Module – III **Capacitive and Piezoelectric transducer** The parallel plate capacitive sensor, variable permittivity capacitive sensor, stretched diaphragm variable capacitive transducer, piezoelectric transducers and their signal conditioning, photoelectric transducers, Hall Effect sensors.	10

Module – IV	**8**
Smart Sensor	
Principle, design approach, interface design, configuration supports, communication in smart transducer network. HART protocol.	
Module – V	**6**
Recent trends in sensor technology	
Digital transducer, Principles and applications of Fibre optic sensor, MEMS sensor, Bio sensor, Silicon sensor, sensors for robotics.	

Text Books:
1. Sensors and Transducers, by D. Patranabis. 2nd Edition
2. Elctrical & Electronics Measurements and Instrumentation by A.K Sawhney, Dhanpat Rai & Sons.
3. Transducers and Instrumentation, by Murthy D. V. S., Prentice Hall, 2nd Edition, 2011.

Reference Books:

1. Sensor and signal conditioning by John G. Webster, Wiley Inter Science,2nd edition, 2008

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: PO8 will be met though report-writing/presentation-based assignment

Topics beyond syllabus/Advanced topics/Design: Teaching through paper/ latest standards in data communication

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through paper

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	2	3	3		3	1	2	3	3	3	3	2	2	1
CO2	2	3	3	3		3	1	2	3	3	3	2	2	2	1
CO3	2	3	3	3		3	1	3	3	3	3	2	2	2	1
CO4	2	2	3	3	1	3	1	2	3	3	3	2	2	2	1
CO5	2	3	3	2	1	3	1	2	3	3	3	2	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, and CD 8
CD2	Tutorials/Assignments	CO2	CD1, and CD 8
CD3	Seminars	CO3	CD1, and CD 8
CD4	Mini Projects/Projects	CO4	CD1, and CD 8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, and CD 8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC335**
Course title: **Consumer Electronics**
Pre-requisite(s): EC101 Basics of Electronics and Communication Engineering,
Co- requisite(s):
Credits: L:3   T:0   P:0
Class schedule per week: 0x
Class: B. E.
Semester / Level:0X
Branch:
Name of Teacher:

Course Objectives
This course enables the students to:

1.	To describe the operating principles of different types of microphones and audio systems
2.	To explain the process of composite video signal transmission and reception.
3.	To familiarize with various devices related to telecommunication system.

4.	To Demonstrate the working of household electronics equipment with sketches of block diagram
5.	To illustrate the working principles of various consumer electronic devices.

Course Outcomes
After the completion of this course, students will be able to:

CO1	Demonstrate technical specification of Audio systems and its operation.
CO2	Identify and explain working of various colour analog and digital TV
CO3	Able to understand different telecommunication technology.
CO4	Able to understand the working of different household appliances.
CO5	Explain the basic functions of various consumer electronic goods and trouble shoots consumer electronics products

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I	**7**

Introduction to audio recorders and players Microphones, types of microphones, Magnetic Tape recorder, Audio compact disc system, High fidelity Audio system, Stereo sound system, Loudspeaker, Public address system, Magnetic sound recording.	
Module – II Introduction to Radio and TV Transmission & Reception FM and AM radio transmission and reception, Block diagram of TV transmitter, Television studios and Equipment, Antenna for TV transmitter, Block diagram of TV receiver, TV camera tube, Persistence of vision, Scanning, Synchronization, CCTR-B System, Composite video signal, Bandwidth of TV signal, Audio signal modulation, TV channel, Television Rx antenna, Feeder cable, Balun T/F, Monochrome picture tube, Black & white TV Rx, Colour TV signal, Colour TV Rx, PAL, NTSC, SECAM signal, compatibility, CCTV, Cable TV, Dish TV, HDTV, 3D TV	**10**
Module – III Introduction to Telecommunication Systems: Basics of Telephone system, Caller ID Telephone, Intercoms, Cordless Telephones, Cellular mobile systems, 2G, 3G and 4G technolog.	**10**
Module – IV Introduction to Home Electronics: Cord less Door Bell, Inverter, Digital Camera system, Microwave ovens, Washing Machines, Air Conditioners and Refrigerators.	**7**

Module – V Digital watch, Calculators, An electronic guessing game, Cordless Telephone, Mobile telephone, Cellular telephone, Battery telephone, Battery Eliminator, Battery charger, DC supply, DC supply operational amplifier, IC regulator, UPS, Inverter, Decorative Lighting, Microwave oven, LCD tunes with alarm.	**6**

Text books:
1. S.P. Bali, Consumer Electronics, Pearson Education,
2. R.R.Gulati, "Monochrome and Color Television", New Age International Publisher
3. B.R. Gupta and V. Singhal, "Consumer Electronics", S.K. Kataria & Sons,

Gaps in the Syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	3	2			1	2	3	2	1			
CO2	3	3	2	3	1			1	2	3	2	1			
CO3	3	3	2	2	1			1	2	3	2	1			
CO4	3	3	2	3	2			1	2	3	2	1			
CO5	3	3	2	3	2			1	2	3	2	1			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1 and CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD 8
CD3	Seminars	CO3	CD1 and CD 8
CD4	Mini Projects/Projects	CO4	CD1 and CD 8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD 8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC351**
Course title: **Fiber Optic Communication**
Pre-requisite(s): Knowledge of Semiconductor Devices, Electromagnetic Theory
Co-requisite(s): None
Credits:　　　L: 3　T: 0　P: 0　C: 3
Class schedule per week: 03
Class: B. Tech
Semester / Level: 06
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students:

1.	To demonstrate the different generations, elements required to establish the fiber optic link, the losses and the dispersion effects in fiber optic communication.
2.	To identify the types of couplers, optical sources for fiber optic communication system.
3.	To identify the types of photodiode, optical receivers in fiber optic communication system and understand system performance through the link power budget and dispersion limitations of digital fiber optic link.
4.	To understand WDM, optical amplifiers, optical switching in fiber optic networks.
5.	To understand different network topologies and nonlinear effects in fiber optic communication.

Course Outcomes
After the completion of this course, students will be able to:

CO1	Identify the elements required to establish the fiber optic link and determine the losses and the dispersion effects in fiber optic communication.
CO2	Choose the appropriate couplers, optical sources for fiber optic communication system.
CO3	Select the types of photodiodes/optical receivers in fiber optic communication system and assess the system performance through the link power budget and dispersion limitations of digital fiber optic link.
CO4	Implement the WDM, optical amplifiers, optical switching for fiber optic networks.
CO5	Analyze the different network topologies and nonlinear effects in fiber optic communication.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Generations of optical communication, Basic elements of an optical fiber transmission link, Fiber types and fiber parameters, Fiber material and fabrication methods, Ray and modal analysis in Step index(SI) and Graded index(GI) fibers, Modes in SI&GI fibers , Power flow in step index fibers, Attenuation mechanisms in optical fibers, Dispersion effects in optical fibers.	**10**
Module – II Structure and materials of LED and LD sources, Operating characteristics and modulation capabilities of the LED and LD sources, Source to Fiber Power launching and coupling, Lensing scheme for coupling improvement, Fiber to fiber coupling and alignment methods, Splicing techniques, Fiber Connectors.	**10**
Module – III Principle of PIN photodiode and Avalanche photodiode, Noise in photodetectors, Detector response time, Photodiode materials, Optical receiver configuration and performance, Pre-amplifier design for optical receiver, analog and digital receiver. Optical link design - BER calculation, quantum limit, power penalties, Point to point transmission links, Link power and rise time budget.	**7**
Module – IV WDM and DWDM operational principles, Optical couplers, Fiber Bragg grating, AWG router/multiplexer, Add/Drop Multiplexer, Optical amplifiers, Amplification mechanism of semiconductor optical amplifier(SOA) and Erbium doped fiber amplifier (EDFA), EDFA architecture, Optical switches, Wavelength converters.	**8**
Module – V SONET/ SDH architecture, SONET/ SDH Rings, All optical WDM networks, Single hop and multihop networks, Nonlinear effects on network performance, SRS, SBS, Self-phase modulation(SPM), Soliton pulses, Soliton based communication.	**5**

Text books:
1. "Optical Fiber Communications" G.Keiser, 3/e, McGraw Hill
2. "Optical Fiber Communication",J. M. Senior, PHI,2nd Ed.
3. "Optical Networking and WDM", Walter Goralski, Tata McGraw-Hill

Ref. Books:
1. "Introduction to Fiber Optics", Ghatak &Thyagarajan, Cambridge University press.
2. **"Optical Communications", J.H.Franz &V.K.Jain Narosa Publishing House.**
3. **"Fiber Optics Communication", Harold Kolimbiris, Pearson Education.**
4. **"Fundamentals of Fiber optics in telecommunication and sensor systems", B.P.Pal, New age International (P) Ltd.**
5. **"Optical Communication Networks", B.Mukherjee McGraw Hill.**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	60
Assignment / Quiz (s)	15

Indirect Assessment
    1. Student Feedback on Course Outcome

Mapping between Course Outcomes and Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	2	3	1	2		1	2	3	1	3	2	2
CO2	3	3	2	2	3	1	2		1	2	3	2	3	2	2
CO3	3	3	2	3	3	1	2		1	2	3	2	3	2	2
CO4	3	3	2	3	3	2	3	2	2	2	3	2	3	2	3
CO5	3	3	2	3	3	2	3	2	2	2	3	2	3	2	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6, CD7
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC353
Course title: Pulse, Digital and Switching System
Pre-requisite(s): Basic Electronic Engineering, Analog Circuits
Co-requisite(s): None
Credits: L: 3   T: 0   P: 0   C: 3.0
Class schedule per week: 03
Class: B. Tech
Semester / Level: 05
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students:

1.	To understand RC filter circuits, attenuators, RL, RLC circuits, ringing, clipper and clampers
2.	To understand Non-Linear Wave Shaping
3.	To realize various Multivibrators using transistors, op-amp and other discrete components
4.	To understand negative resistance devices and circuits
5.	To understand time base generator circuits or sweep circuits

Course Outcomes
After the completion of this course, students will be able to:

CO1	Understand the concept of linear wave shaping circuits
CO2	Understand the concept of non-linear wave shaping circuits
CO3	Demonstrate the Bistable, Monostable and Astable Multivibrators using discrete components
CO4	Evaluate the Negative Resistance circuits
CO5	Schematize voltage and current sweep circuits

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Linear Wave Shaping:** Introduction, Wave Shaping Circuits: High pass and low pass circuits, Response to sine, step, pulse, square, exponential and ramp inputs with different time constants, High pass as a differentiator, Low pass as an Integrator, Attenuators- response to step input, compensated attenuator, RL and RLC circuits and their response for step input, Ringing circuit.	10
Module – II **Non-Linear Wave Shaping:** Diode clippers, Transistor clippers, Clipping at two independent levels, Comparators, Applications of Voltage comparators. Clamping Operation, Clamping circuit taking Source and Diode resistances into account, Clamping Circuit Theorem, Practical Clamping Circuits, Effect of Diode Characteristics on Clamping Voltage, Synchronized Clamping.	10
Module – III **Switching Circuits and Multivibrators:** Switching Circuits: Astable, Monostable and Bistable Multivibrators (both collector and emitter coupled), Schmitt trigger circuit, Symmetric and Asymmetric triggering for bistable, Schmitt trigger circuit. Multivibrators using op-amp and IC 555 timer.	7
Module – IV **Negative Resistance Switching Circuits:** Negative resistance devices: Tunnel diode, UJT; Negative Resistance Switching Circuits: Voltage controlled and Current controlled negative resistance circuits, Negative–Resistance	7

Characteristics, Monostable, Bistable, and Astable operations, Applications using Tunnel diode and UJT.	
Module – V **Sweep circuits:** General features of a Time base Signal, Methods of Generating Time Base Waveform, Miller and Bootstrap Time base Generators-Basic Principles, Transistor Miller Time Base generator, Transistor Bootstrap Time Base Generator, Transistor Current Time Base Generators, Methods of Linearity improvement.	**6**

Text books:
1. "Pulse, Digital and Switching Waveforms", Millman and Taub, Tata McGraw-Hill
2. "Wave Generation and Shaping", L. Strauss, TMH.
3. "Solid State Pulse Circuits", David A. Bell, Prentice Hall India.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure
<u>**Direct Assessment**</u>

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
Mid semester examination	25
Two quizzes	20 (2×10)
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

<u>**Indirect Assessment**</u>
1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			3		3	3	3	3
CO2	3	3	2	3	3	2	1			3		3	3	3	3
CO3	3	3	2	3	3	2	1			3		3	3	3	3
CO4	3	3	2	3	3	3	1			3		3	3	3	3
CO5	3	3	2	3	3	3	1			3		3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6, CD7
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC354
Course title: Pulse, Digital and Switching System Lab
Pre-requisite(s): Basic Electronic Engineering, Analog Circuits
Co- requisite(s): Pulse, Digital and Switching System
Credits: L: 0   T: 0   P: 3   C: 1.5
Class periods per week: 03
Class: B. Tech.
Semester / Level: V
Branch: ECE
Name of Teacher:
Course Objectives
This course enables the students to:

1.	Know the response of RC high pass and low pass filter circuits
2.	Realize the diode clipper and clamper circuits
3.	Understand the operation of multrivibrator circuits
4.	Know the response of negative resistance device and design the sweep circuits
5.	Understand the sweep circuits

Course Outcomes
After the completion of this course, students will be able to:

CO1	Analyse the RC high pass and low pass filter circuits
CO2	Design and analyse the diode clipper and clamper circuits
CO3	Characterize and design the multrivibrator circuits
CO4	Characterize the negative resistance device and design the sweep circuits
CO5	Design of sweep circuits

Syllabus

List of Compulsory experiments:

Experiment No.	Name of the Experiments
1	Design of a low pass RC circuit for a given cutoff frequency and obtain its frequency response and observe the response for square waveform for T<<RC, T=RC and T>>RC. AIM1: Obtain the frequency response of a low pass RC circuit with sine wave input. AIM2: Plot the output for square wave input under T<<RC, T=RC and T>>RC.
2	Design of a high pass RC circuit for a given cutoff frequency and obtain its frequency response and observe the response for square waveform for T<<RC, T=RC and T>>RC. AIM1: Obtain the frequency response of a high pass RC circuit with sine wave input. AIM2: Plot the output for square wave input under T<<RC, T=RC and T>>RC.
3	Determination of the resonance frequency in a series RLC circuit and plotting of its waveforms. AIM1: Obtain the frequency response of a series RLC circuit. AIM2: Determine the resonance frequency in a series RLC circuit and compare this to the expected resonance value.
4	Construction of Diode Clipper circuits and plotting of its waveforms. AIM1: Design the Shunt Positive Clipper, Shunt Negative Clipper & Negative Bias series Clipper circuits and plot input-output waveforms. AIM2: Design the Positive bias series Clipper and Double ended shunt clipper and plot input-output waveforms.
5	Construction of Diode Clamper circuits and plotting of waveforms. AIM1: Design the Positive Clamper & Negative Clamper circuits and plot input-output waveforms. AIM2: Design the Positive Bias Clamper & Negative Bias Clamper circuits and plot input-output waveforms.
6	Design of Schmitt trigger circuit using transistor and generation of square wave from a given sine wave.

		AIM1: Design Schmitt Trigger circuit using BJT and plot waveforms. AIM2: Find the UTP, LTP and Hystersis of the Schmitt Trigger circuit.
7		Construction of astable multivibrator using transistor and to plotting of the output waveform. AIM1: Observe the waveforms of Astable Multivibrator at base and collector of the transistors. AIM2: Verify different states and find the frequency.
8		Construction of monostable multivibrator using transistor and plotting of the output waveform. AIM1: Observe the waveforms of Monostable Multivibrator at base and collector of the transistors. AIM2: Find the width of pulse.
9		Construction of bistable multivibrator using transistor and plotting of the output waveform. AIM1: Observe the waveforms of Bistable Multivibrator at base and collector of the transistors. AIM2: Verify different states.
10		Design of Miller Sweep circuit and plotting of the output waveform. AIM: Design of Miller Sweep circuit and plotting of the output waveform.
11		Design of Boot Strap Sweep circuit and plotting of the output waveform. AIM: Design of Boot Strap Sweep circuit and plotting of the output waveform.
12		Construction of UJT Relaxation Oscillator and plotting of its waveforms. AIM: Design of UJT relaxation Oscillator with a given frequency and to observe waveforms.

Text books:
 1. "Pulse, Digital and Switching Waveforms", Millman and Taub, Tata McGraw-Hill
 2. "Wave Generation and Shaping", L. Strauss, TMH.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

POs met through Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz(zes)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Indirect Assessment
1. **Student Feedback on Faculty**
2. **Student Feedback on Course**

Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			3		3	3	3	3
CO2	3	3	2	3	3	2	1			3		3	3	3	3
CO3	3	3	2	3	3	2	1			3		3	3	3	3
CO4	3	3	2	3	3	3	1			3		3	3	3	3
CO5	3	3	2	3	3	3	1			3		3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3, CD7
CO2	CD3, CD7
CO3	CD3, CD7
CO4	CD3, CD7
CO5	CD3, CD7

COURSE INFORMATION SHEET

Course Code: EC 355
Course Title: Time Frequency and Wavelet Transform
Pre-requisite(s): Signals and Systems, Signal Processing Techniques, Probability and Random Processes
Co- requisite(s):
Credits: L: 3   T: 0   P: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1	Understand the mathematical basis of the wavelet transform and its performance in the analysis of non-stationary signals.
2	Understand the concepts and properties of Continuous Wavelet Transform, Multi-Resolution Analysis, Discrete Wavelet Transform and Wavelet Packets.
3	Learn to implement Discrete Wavelet transform using Filter banks and Fast Lifting Scheme.
4	Learn the time domain and frequency domain approaches for the construction of wavelets.
5	Implement Discrete Wavelet Transform and Wavelet Packet Transform for various applications like

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate understanding on the wavelet transform and its performance in the analysis of non-stationary signals.
CO2	Describe the concept and properties of Continuous Wavelet Transform, Multi-Resolution Analysis, Discrete Wavelet Transform and Wavelet Packets.
CO3	Demonstrate understanding on Discrete Wavelet transform using Filter banks and Fast Lifting Scheme. And time domain and frequency domain approaches for the construction of wavelets.
CO4	Analyse the impact of Discrete Wavelet Transform and Wavelet Packet Transform for various applications like Signal compression, de-noising, detection of anomalies in ECG, EEG etc.
CO5	Apply the time frequency wavelet transform to extract the feature from real time signals

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Why wavelet transform? Stationary and Non-stationary Signal, Limitations of standard Fourier analysis, Introduction to time frequency analysis, Windowed Fourier transforms (STFT), Signal representation with continuous and discrete STFT, concept of time-frequency resolution, Resolution problem associated with STFT, Heisenberg's Uncertainty principle and time frequency tiling, Stock-well transform, Wigner-Ville transform, Cohen's Class distribution.	8
Module – II Continuous time wavelet transforms, Wavelet function and its properties, energy spectrum of wavelet, Nyquist Filters, Half band filters, Introduction, M-channel Filter banks, QMF banks, Perfect reconstruction systems, Alias free filter banks, Paraunitary perfect reconstruction Filter banks, Linear phase perfect reconstruction QMF banks.	9
Module – III Discrete wavelet transforms, Filter bank analysis of DWT, tiling of the time-frequency plane, dyadic grid sampling, Scaling function, Fast wavelet algorithm, compactly supported wavelets, Cascade algorithm, Franklin and spline wavelets.	9

Module – IV Wave Packet Analysis, Hilbert space frames. Frame representation. Representation of signals by frames. Iterative reconstruction. Frame algorithm. Construction of wavelets. Multiresolution analysis, Introduction to frames and biorthogonal wavelets.	**8**
Module – V Signal Analysis and synthesis, two-dimensional wavelet systems, Application of wavelet theory to signal denoising, image and video compression, multi-tone digital communication, transient detection.	**6**

Text Books:
1. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.
2. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
3. C. K. Chui, An Introduction to Wavelets, Academic Press Inc., New York, 1992.
4. A.N. Akansu and R.A. Haddad, Multiresolution signal Decomposition: Transforms, Subbands and Wavelets, Academic Press, Oranld, Florida, 1992.

Reference Book:
1. Gerald Kaiser, A Friendly Guide to Wavelets, Birkhauser, New York, 1995.
2. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, New Jersey, 1993.
3. B.Boashash, Time-Frequency signal analysis, In S.Haykin, (editor), Advanced Spectral Analysis, pages 418--517. Prentice Hall, New Jersey, 1991.

Gaps in the Syllabus (to meet Industry/Profession requirements)

Time frequency and wavelet transform is an advance course; hence it only lays down the foundation of pattern recognition and classification problem.

POs met through Gaps in the Syllabus
May be met through laboratory simulations, experiments, and design problems.

Topics beyond syllabus/Advanced topics/Design

5. Application of **Time frequency and wavelet transform** in the analysis of time varying signal.
6. Extraction of Pattern vector from time varying signal for the development of decision support system for various applications.

POs met through Topics beyond syllabus/Advanced topics/Design
Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	2	3	3	2	3	1	2	3	3	3	3			
CO2	2	2	3	3	2	3	1	2	3	3	3	3			
CO3	2	2	3	3	2	3	1	3	3	3	3	3			
CO4	2	2	3	3	2	3	1	2	3	3	3	3			
CO5	1	1	1	1	1	1	1	1	1	1		1			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 356
Course Title: Time Frequency and Wavelet Transform Lab**.**
Pre-requisite(s): MATLAB
Co- requisite(s):
Credits: L: 0   T: 0   P: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

16.	Write MATLAB code to understand the non-stationary signal.
17.	To understand behavior of real time signal in time-frequency plane.
18.	Illustrate the failure of FFT when time is important point find the happening of any event in the signal.
19.	Elaborate the concept of STFT and wavelet transform to overcome the discrepancy of FFT.
20.	Develop programming skills to find the engineering solution to minimize the effect of noise over observed signal.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Model the observed sensor data using MATLAB.
CO2	Represent the signal in time-frequency plane to retrieve unique information using MATLAB.
CO3	De-noise the simulated data as well as observed data to get the desired information using time-frequency analysis tools.

CO4	Apply the concept of time frequency analysis to explain real life data to retrieve unique information present in the data.
CO5	Visualize and solve practical pattern recognition problems.

SYLLABUS

LIST OF EXPERIMENTS:

Syllabus
Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, TIME FREQUENCY WAVELET TRANSFORM is the syllabus for the TIME FREQUENCY WAVELET TRANSFORM LAB. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of experiments:

1. To generate a sine wave with a linear change in frequency. Evaluate the time-frequency characteristic using the STFT. Sine wave should vary between 10 Hz and 200 Hz over a sec period. Assume a sample rate of 500 Hz.

2. Use Stockwell Transform to analyze any simulated signal or recorded signal in time frequency plane using S-Transform.

3. To generate a sine wave with a linear change in frequency. Evaluate the time-frequency characteristic using the Wigner-Ville Distribution. Sine wave should vary between 10 Hz and 200 Hz over a sec period. Assume a sample rate of 500 Hz.

4. To generate a sine wave with a linear change in frequency. Evaluate the time-frequency characteristic using the Cohen class Distribution. Sine wave should vary between 10 and 200 Hz over a sec period. Assume a sample rate of 500 Hz.

5. Generate 2 sinusoids that change frequency in a step-like manner. Apply the Continuous Wavelet Transform and plot results using the different wavelets.

6. Plot of Wavelet boundaries for various values of scale parameter 'a'. Determine the time and scale range of various popular Wavelet function.

7. Construct a waveform of 4 sinusoids plus noise. Decompose the waveform in 4 levels, plot each level, and then reconstruct the signal.

8. Application of DWT to nonlinear filtering (Signal De-noising using Threshold). Construct a waveform of 4 sinusoids plus noise. Decompose the waveform into levels, plot each level, and then reconstruct. Evaluate the two highest resolution high pass sub-bands and zero out those samples below some threshold value.

9. Discontinuity detection. Construct a waveform of 2 sinusoids with a discontinuity in the second derivative. Decompose the waveform into 3 levels to detect the discontinuity.

10. "Balance Tree Decomposition (Wavelet Packet)". Construct a waveform of 4 sinusoids plus noise. Decompose the waveform in 3 levels, plot outputs at the terminal level.

11. Balance Tree Decomposition applied to 2 EEG signals file ecg1.mat contains two 60 sec segments of ECG data in variables ecg1 and ecg2 (fs = 250 Hz). Decompose each segment using a 3-level balanced tree composition. Take as features the RMS value of each decomposed sub-band. Find two features (RMS values) that best differentiate between the two signals and plot the features from each segment on a 2D plot. Use a Daubechies 4 or 6 -element filter. Compare the output.

12. Apply DWT for image compression and evaluate its compression ratio.

Text Books:
1. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.
2. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
3. C. K. Chui, An Introduction to Wavelets, Academic Press Inc., New York, 1992.
4. A.N. Akansu and R.A. Haddad, Multiresolution signal Decomposition: Transforms, Subbands and Wavelets, Academic Press, Oranld, Florida, 1992.

Reference Book:
1. Gerald Kaiser, A Friendly Guide to Wavelets, Birkhauser, New York, 1995.
2. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, New Jersey, 1993.
3. B.Boashash, Time-Frequency signal analysis, In S.Haykin, (editor), Advanced Spectral Analysis, pages 418--517. Prentice Hall, New Jersey, 1991.

Gaps in the Syllabus (to meet Industry/Profession requirements)
        NA

POs met through Gaps in the Syllabus
        NA

Topics beyond syllabus/Advanced topics/Design
        Simulations based on advanced topics after completion of compulsory twelve experiments.

POs met through Topics beyond syllabus/Advanced topics/Design
        Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	(60)
Attendance Marks	12
Lab file Marks	12
Viva Marks	24
Day-to-day performance Marks	12
End SEM Evaluation	(40)
Lab quiz Marks	20
Lab performance Marks	20

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	3	3	2	1	1	1	2	3	2	3			
CO2	2	3	3	2	1	1	1	1	2	3	2	3			
CO3	3	3	3	3	3	2	2	2	2	3	3	3			
CO4	3	3	3	3	3	2	2	2	2	3	3	3			
CO5	1	1	1	1	1	1	1	1	1	1	1	2			

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

Course Code: EC357
Course Title: Adaptive Signal Processing
Pre-requisite(s): Digital Signal Processing
Co- requisite(s): Probability and Random Processes
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart students to:

21.	To understand speech production and human auditory model. To analyse structures of speech codecs and classification of speech coding techniques
22.	To understand different speech signal processing techniques
23.	To understand basics of scalar and vector quantization
24.	To understand basic of LPC and its variants for various applications
25.	To understand different coding techniques and speech coding standards

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the basics of production and auditory models and apply speech codecs for speech coding techniques
CO2	Apply various signal processing techniques to speech signal for its enhancement
CO3	Analyse the quality and properties of speech signal
CO4	Modify and enhance the speech and audio signals using coding techniques
CO5	Design and evaluate the performance of an application based speech recognition system.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction- Speech production and modelling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid; Requirements of speech codecs –quality, coding delays, robustness	8
Module – II Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation	8
Module – III Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types	8
Module – IV	8

Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction, Scalar Quantization of LPC- Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF, Linear Prediction Coding- LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model	
Module – V Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zero-state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP, Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards	**8**

Text Books:
3. L.R. Rabiner, B. H. Juang and B. Yegnanarayana, "Fundamentals of Speech Recognition", Pearson,   Education 2011
4. A. M. Kondoz, "Digital Speech", Second Edition (Wiley Students Edition), 2004.
5. 3. W. C. Chu, "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", Wiley Inter science, 2003.

Reference Books: NA

Gaps in the Syllabus (to meet Industry/Profession requirements)
4.   Applications of speech signal processing techniques through hardware platform.

POs met through Gaps in the Syllabus
     NA

Topics beyond syllabus/Advanced topics/Design
     Teaching through Research paper

POs met through Topics beyond syllabus/Advanced topics/Design
     2
Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	2	2	1	1			2	3	3	1	2	2
CO2	3	3	3	3	3	2	2			2	3	3	1	2	3
CO3	3	3	3	3	3	1	2		2	3	3	3	2	3	3
CO4	3	3	2	3	3	2	2	1	2	3	3	3	2	2	3
CO5	3	2	1	1	2	1	1		1	1	1	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD 8

CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC359**
Course title: **Microcontrollers and Interfacing**
Pre-requisite(s): Microprocessors Applications
Co- requisite(s):
Credits:　　　L: 3　　T: 1　　P:
Class schedule per week: 3x
Class: B. Tech
Semester / Level: VI/3
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:

1.	Explain the concept of microcontrollers and embedded system architecture.
2.	Develop assembly language programming skill in the student for 8051 microcontroller.
3.	Explain the interrupt and serial I/O features of 8051 microcontroller
4.	To outline the importance of different peripheral devices & their interfacing to 8051.

5.	Introduce embedded microcontrollers and their programming

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate the knowledge about microcontrollers and embedded systems architecture.
CO2	Write 8051 based assembly language program for given problem.
CO3	Will be able to interface 8051 with peripheral devices.
CO4	Will be able to communicate 8051 with peripheral devices using serial and parallel I/O and design and implement microcontroller based system for given application
CO5	Schematize the microcontroller based real time systems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Microcontrollers, Microprocessors vs Microcontrollers, History and Applications of Microcontrollers, 8051 Architecture, Introduction, Features, Pin details, Internal Memory organization, General purpose RAM, Bit addressable RAM, Register banks, Special function Registers.	**10**
Module – II 8051 Addressing Modes, Boolean Processor, External Memory Addressing, Interrupt Structure and priorities, 8051 Instruction types like Data movement, Logic, Arithmetic, Control transfer and Program Control Instructions, Instruction Set in detail. 8051 Programming examples like Arithmetic and Logic	**10**

operation, Branching, Looping, Stock Operations, Subroutines, Parameter passing, A few Industrial examples, Software and Hardware Development tools, Environments, Assembly Language, Interpreters, Debugging hints.	
Module – III 8051 Interrupts and Timers/counters: Basics of interrupts, 8051 interrupt structure, Timers and Counters, 8051 timers/counters, programming 8051 timers in assembly and C. 8051 Serial Communication, connections to RS-232, Serial communication Programming in assembly and C.	**7**
Module – IV Basics of I/O concepts, I/O Port Operation, Interfacing 8051 to LCD, Keyboard, I/O devices interfacing with 8051 using 8255A, parallel and serial ADC, DAC, Stepper motor interfacing and DC motor interfacing and programming.	**8**
Module – V Introduction to Embedded Microcontrollers, 68 HC11 and 68 HC12 Microcontrollers, Software and Hardware development, I/O Resources, CPU12 Programming model, Basic Assembly Programming techniques, Introduction to Real time I/O and Multitasking.	**5**

Text books:
1. Mohamed Ali Mazidi, Janice Gillispie Mazidi, "The 8051 microcontroller and embedded   systems", Pearson education, 2004
2. "Programming and Customising the 8051 Microcontroller", by Myke Predko

Reference books:
1. "Advanced Microprocessor and Microcontrollers", by S.K. Venkata Ram.

Gaps in the syllabus (to meet Industry/Professional requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design
Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	2	2	2		1	1		1	2	2	1
CO2	3	3	2	3	2	1	1		1	1		1	2	2	1
CO3	3	3	2	3	3	1	1		1	1		1	2	2	1
CO4	3	3	3	2	2	2	2		1	1		1	2	2	1
CO5	3	3	2	3	2	1	1		1	1		1	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1,CD5,CD 8

CD2	Tutorials/Assignments	CO2	CD1,CD5,CD 8
CD3	Seminars	CO3	CD1,CD5,CD 8
CD4	Mini Projects/Projects	CO4	CD1,CD5,CD 8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD5,CD 8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **EC360**
Course title: **Microcontroller Lab**
Pre-requisite(s):
Co- requisite(s):
Credits: L: 3   T: 0   P: 0

Class schedule per week: 03
Class: B. Tech.
Semester / Level: 03
Branch: ECE
Name of Teacher:

Course Objectives

1	To introduce the basics of microcontroller and its applications
2	To develop the assembly language programming skills in the student for microcontrollers
3	To expertise working with Keil compiler and embedded C programming
4	To give practical training for interfacing I/O devices with 8051
5	To discuss the real time applications of microprocessor and microcontrollers

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate the working of microcontroller and its programming
CO2	Write 8081 based assembly language program.
CO3	Interface the I/O devices with and 8051
CO4	Design circuits for various real time applications with microcontrollers
CO5	Able to work with Keil compiler and embedded C programming

Syllabus

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, EC359 Microcontrollers and Interfacing is the syllabus for the EC360 Microcontroller Lab. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of Compulsory experiments:
  8051 PROGRAMMING

1. DATA TRANSFER OERATIONS (BLOCK MOVE/ SORTING)
2. ARITHMETIC OPERATIONS (ADD, SUB, DIV)
3. BOOLEAN ARITHMETIC AND LOGICAL OPERATION (SET, RESET, MOVE)
4. CODE CONVERSION (ASCII TO HEX, HEX TO ASCII, BINARY TO BCD)
5. DELAY SUBROUTINES USING DIFFERENT REGISTER BANKS
6. TIMERS OPERATION IN DIFFERENT MODES
7. COUNTER OPERATIONS
8. SERIAL I/O PROGRAMMING AT DIFFERENT BAUD RATE
9. INTERRUPT SERVICE ROUTINES

INTERFACING

1. LCD PANNEL AND HEX KEYBOARD INTERFACE
2. ADC INTERFACING FOR INPUTTING SENSOR DATA
3. DAC INTERFACING FOR WAVEFORM GENERATION
4. STEPPER MOTOR CONTROL
5. DC MOTOR CONTROL

Text Book:
1. Mohamed Ali Mazidi, Janice Gillispie Mazidi, "The 8051 microcontroller and embedded systems", Pearson education, 2004

Reference Book:

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	(60)
Attendance Marks	10
Lab file Marks	06
Day-to-day performance Marks	44
End SEM Evaluation	(40)
Lab quiz Marks	08
Lab Viva marks	12
Lab performance Marks	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	3	3	3	3	3
Semester End Examination	3	3	3	3	3

Indirect Assessment
1. Student Feedback on Faculty
2. Student Feedback on Course

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	(60)
Attendance Marks	10
Lab file Marks	06
Day-to-day performance Marks	44
End SEM Evaluation	(40)
Lab quiz Marks	08
Lab Viva marks	12
Lab performance Marks	20

Indirect Assessment –
      1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	2	3	3	1	1			2		2	2	2	1
CO2	3	3	2	3	3	3	2			2		2	2	2	1
CO3	3	3	2	3	3	3	2			2		2	2	2	1
CO4	3	3	2	3	3	2	2			2		2	2	2	1
CO5	3	3	2	3	3	2	2			2		2	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD5, CD9
CD2	Tutorials/Assignments/Quiz (s)	CO2	CD5, CD9
CD3	Seminars	CO3	CD5, CD9
CD4	Mini projects/Projects	CO4	CD5, CD9
CD5	Laboratory experiments/teaching aids	CO5	CD5, CD9
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC361
Course title: Digital Systems Design with FPGAs
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201
Electronic Devices
Co- requisite(s):
Credits:　　　L: 3　　T: 0　　P: 0　　C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand Implementation strategies for digital ICs.
2.	Interpret timing Issues in digital circuits and apply the perceived knowledge.
3.	Appraise and analyse the arithmetic building blocks.
4.	Design and Evaluate the characteristics of memory and array structures.
5.	Validate and test manufactured circuits.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Describe and illustrate with diagram the Implementation strategies for digital ICs.
CO2	Sketch and explain timing Issues in digital circuits.
CO3	Diagram and explain the arithmetic building blocks, illustrate their characteristics and analyse them.
CO4	Design and schematize the memory cell and array structures, assess their characteristics and summarize their features.
CO5	Schematize and write the principles of manufactured circuit test techniques. Integrate the techniques with circuit to be tested, validate and test the circuit.

MODULE	(NO. OF LECTURE HOURS)
Module – I **Implementation strategies for digital ICs:** From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Array-Based Implementation Approaches: Pre-diffused (or Mask-Programmable) Arrays, Pre-wired Arrays: The write-once or fuse-based FPGA, The non-volatile FPGA, The volatile or RAM-Based FPGA, Implementation Platforms of the Future.	**8**
Module – II **Timing Issues in digital circuits:** Timing Classification of Digital Systems, Synchronous Design: Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques; Self-Timed Circuit Design: Self-Timed Adder Circuit, Completion-Signal Generation with an example of DCVSL, Self-Timed Signaling with an example of Muller C-element, Practical Examples of Self-Timed Logic such as Self-resetting 3-input OR; Synchronizers and Arbiters: Static Timing Analysis (STA), Design examples of clock and test bench using Verilog/SystemVerilog HDL	**8**
Module – III **Designing arithmetic building blocks:** Full **Adder** Circuit Design Considerations, **Multiplier** Design Considerations; **Power and Speed Trade-off's in Datapath Structures:** Design Time Power-Reduction Techniques, Run-Time Power Management, Reducing the Power in	**8**

Standby (or Sleep) Mode, **Design examples** of Datapath using Verilog/ SystemVerilog HDL.	
Module – IV **Designing memory and array structures:** Memory classification, Memory Architectures and Building Blocks; The Memory Core: Read-Only Memories, Flash Memory, Static Random Access Memory (SRAM), Memory Peripheral Circuitry: The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers.	8
Module – V **Validation and test of manufactured circuits:** Boundary-Scan Design, Built-in Self-Test (BIST), Test-Pattern Generation, Fault Models: Stuck-At Faults, Short-Circuit and Open-Circuit Faults, Fault Coverage, Delay Fault Testing, Automatic Test-Pattern Generation (ATPG), FPGA-assisted testing.	8

Textbooks:
7. J. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd Edition, Prentice Hall, 2003.
8. Neil H. E. Weste and David Money Harris, CMOS VLSI Design – A Circuits and Systems Perspective, Addison Wesley, 4/e, 2011.

Reference books:
9. Samir Palnitkar, Verilog HDL: A guide to Digital Design and Synthesis, SunSoft Press, 1996.
10. Stuart Sutherland, Simon Davidmann, Peter Flake, SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling, 2/e, Springer, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements):
   1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus:
      10

Topics beyond syllabus/Advanced topics/Design:
   1. Analog and RF circuits**.**

POs met through Topics beyond syllabus/Advanced topics/Design:

10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	3	1	1			1		1	3	2	1
CO2	3	3	2	3	3	3	1			1		1	3	2	1
CO3	3	3	2	3	3	2	2			1		2	3	2	1
CO4	3	3	2	3	3	2	1			1		2	3	2	1
CO5	3	3	2	3	3	3	1			1		2	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

Course code: EC362
Course title: Digital Systems Design with FPGAs Lab
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices
Co- requisite(s): EC361 Digital Systems Design with FPGAs
Credits: L: 0   T: 0   P: 3   C: 1.5
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE
Name of Teacher:

Course Objectives

Course Objectives

This course enables the students to:

A.	Understand the modelling styles of HDLs such as VHDL, Verilog and SystemVerilog for designing/developing digital circuits.
B.	Apply their understanding to design/develop given digital circuits using various modelling styles of VHDL/Verilog/SystemVerilog.
C.	Analyse and explain the outputs displayed on the prototyping board.
D.	Appraise the simulated/compiled/synthesized/downloaded CPLD/FPGA designs and evaluate the results.
E.	Develop CPLD/FPGA designs and create necessary configuration bitstream files and download them on the prototyping kit.

Course Outcomes

After the completion of this course, students will be able to:

| CO1	Outline models of digital circuits and translate the same into VHDL/Verilog/SystemVerilog program. Simulate, compile, synthesize, and download CPLD designs onto the prototyping kit and demonstrate/show the results displayed on the kit and explain the same.
CO2	Write VHDL/Verilog/SystemVerilog model and develop given digital circuits. Simulate and synthesize the CPLD design. Use Spartan-2 CPLD Trainer Kit and download the design onto it. Demonstrate and interpret the results displayed on the kit.
CO3	Outline VHDL/Verilog/SystemVerilog model and given design digital circuits. Simulate and compile/synthesize the CPLD design, download the same onto the prototyping kit (Spartan-2 CPLD Trainer Kit). Test and analyse the outputs displayed on the kit
CO4	Write VHDL/Verilog/SystemVerilog model of given digital circuit. Simulate and compile/synthesize the FPGA design and find errors, if any. Create the FPGA configuration bitstream file, download the same onto the prototyping kit (Spartan-3E FPGA Starter Kit) and test its operation and evaluate outputs displayed on the kit.
CO5	Develop VHDL/Verilog/SystemVerilog model and design given digital circuits. Simulate and compile/synthesize the FPGA design, create the FPGA configuration bitstream file, download the same onto the prototyping kit (Spartan-3E FPGA Starter Kit), test and validate its operation.

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC361 Digital Systems Design with FPGAs** is the syllabus for the **EC362 Digital Systems Design with FPGAs Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of Compulsory experiments:
5. Outline a model of clock generator and test bench for simulating a digital circuit and translate the same into VHDL/Verilog/SystemVerilog RTL codes. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i**.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate/show the results displayed on the kit and explain the same.

6. Write VHDL/Verilog/SystemVerilog RTL codes and develop a sign-magnitude adder. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i**.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it. Observe/examine the results for their correctness.

7. Outline a switch-level Verilog/SystemVerilog model and write RTL codes for the circuit shown below. Experiment with the prototyping kit (**Spartan-3E FPGA Starter Kit**), test and analyse its operation.
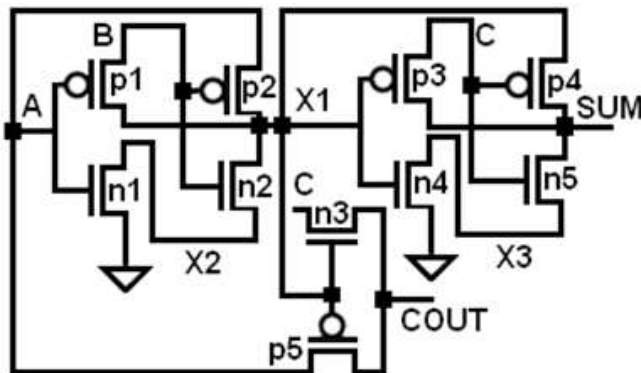
8. Outline a VHDL/Verilog/SystemVerilog model and design a stopwatch. Simulate and compile/synthesize the FPGA design using the Xilinx development software (**Xilinx ISE 14.1i**.) and find errors, if any. Create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and evaluate its operation.

9. Develop a VHDL/Verilog/SystemVerilog model and design a digital multiplier. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.

10. Develop a VHDL/Verilog/SystemVerilog model and design a traffic signal controller. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.

11. Design 2-input XOR gate using complex gate and use the same to design a 1-bit full adder within the given specification to achieve propagation delay (t_p) of OUTPUT CARRY no longer than 100 ns and average power consumption (P_{avg}) not higher than 100 μW. Simulate the designs, test and validate your anticipation using Cadence EDA tool. Load the input and output of the designed full adder with inverters to obtain realistic input and output. Simulate and report the propagation delay (t_p) and power consumption (P_{avg}) of your design.

12. Develop a 4-bit full adder utilizing the previously designed 1-bit full adder within the given specification to achieve propagation delay (t_p) of the FINAL CARRY no longer than 1 μs and average power consumption (P_{avg}) not higher than 1 mW. Simulate the designs using Cadence EDA tool, test and validate your anticipation. Load the input and output of the designed full

adder with 1-bit full adder to obtain realistic input and output. Simulate and report the propagation delay (t_p) and power consumption (P_{avg}) of your design.

13. Design a positive-edge-triggered D flip-flop with setup time and hold time no longer than 10 ns and 15 ns respectively. Simulate using Cadence EDA tool and find errors, if any. Test its functionality, tabulate the obtained results for setup time and hold time and compare the same with the given specifications.

14. Develop a 4-bit register based on the previously designed positive-edge-triggered D flip-flop. Simulate using Cadence EDA tool and find errors, if any. Test its functionality.

15. Design a JK flip-flop with setup time and hold time no longer than 20 ns and 25 ns respectively. Simulate using Cadence EDA tool and find errors, if any. Test its functionality, tabulate the obtained results for setup time and hold time and compare the same with the given specifications.

16. Develop a 4-bit presettable counter based on the previously designed a JK flip-flop. Simulate using Cadence EDA tool and find errors, if any. Test its functionality.

List of optional experiments:

17. Develop a VHDL/Verilog/SystemVerilog model and design a floating-point adder. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.

18. Develop a VHDL/Verilog/SystemVerilog model and design a FIFO buffer. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.

19. Develop a VHDL/Verilog/SystemVerilog model and design a divider. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.

20. Develop a VHDL/Verilog/SystemVerilog model and design a BINARY-TO-BCD conversion circuit. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.

21. Write a VHDL/Verilog/SystemVerilog model and develop a 1:4-bit demultiplexer. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i**.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate and interpret the results displayed on the kit.

22. Write a VHDL/Verilog/SystemVerilog model and develop a 4-bit magnitude comparator. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i**.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate and interpret the results displayed on the kit.

23. Outline a VHDL/Verilog/SystemVerilog model and design a seven-segment display decoder. Simulate and compile/synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i**.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), download CPLD design (using the iMPACT programming software and the JTAG cable) onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**), test and analyse the outputs displayed on the kit.

24. Develop a VHDL/Verilog/SystemVerilog model and design a simple processor that performs basic operations such as ADD, SUM, MUL and DIV using 8-bit operands. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.

25. Outline a VHDL/Verilog/SystemVerilog model and design a 16:4-bit encoder. Synthesize the circuit, download the configuration bitstream file onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**) and verify its operation. Simulate and compile/synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i**.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), download CPLD design (using the iMPACT programming software and the JTAG cable) onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**), test and analyse outputs displayed on the kit.

26. Outline a VHDL/Verilog/SystemVerilog model and design a modulo-N binary up-counter with synchronous Clear control signal. Simulate and compile/synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i**.) and find errors, if any. Create the CPLD configuration bitstream file (*.jed), download CPLD design (using the iMPACT programming software and the JTAG cable) onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**), test and analyse outputs displayed on the kit.

27. Write a VHDL/Verilog/SystemVerilog model of 2-by-2 register. Simulate and compile/synthesize the FPGA design using the Xilinx development software (**Xilinx ISE 14.1i**.) and find errors, if any. Create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**) and test its operation and evaluate output displayed on the kit.

28. Write an 8x8 RAM VHDL/Verilog/SystemVerilog model. Simulate and compile/synthesize the FPGA design using the Xilinx development software (**Xilinx ISE 14.1i**.) and find errors, if any. Create the FPGA configuration bitstream file (*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**) and test its operation and evaluate output displayed on the kit.

Textbooks:

9. J. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd ed., Prentice Hall, 2003.
10. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 4th ed., Addison Wesley, 2011.
11. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 3rd ed., Pearson Education, 2006.

Reference books:

11. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis," SunSoft Press, 1996.
12. Stuart Sutherland, Simon Davidmann, Peter Flake, "SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling," 2nd ed., Springer, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements):

1. Hands-on-practical for CMOS digital IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus:

10

Topics beyond syllabus/Advanced topics/Design:

1. Mixed-signal circuit design.

POs met through Topics beyond syllabus/Advanced topics/Design:

10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz(zes)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5

Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	1	1	1		3		3	3	3	1
CO2	3	3	3	3	3	1	1	1		3		3	3	3	2
CO3	3	3	3	3	3	1	1	1		3		3	3	3	2
CO4	3	3	3	3	3	1	1	1		3		3	3	3	2
CO5	3	3	3	3	3	1	1	1		3		3	3	3	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6, CD7
CO2	CD1, CD3, CD6, CD7
CO3	CD1, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC363
Course title: Nanoelectronics
Pre-requisite(s): EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 03
Class: B. Tech.

Semester / Level: VI/03
Branch: ECE
Name of Teacher:

This course enables the students to:

11.	Understand the theory of Classical Particles, Classical Waves, Quantum Particles, Quantum Mechanics of Electrons, Free and Confined electrons.
12.	Interpret the various aspects of Electrons Subject to a Periodic Potential – Band Theory of Solids and apply the perceived knowledge.
13.	Appraise and analyse the characteristics of the theory of Coulomb Blockade and the Single-Electron Transistor.
14.	Perceive models of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots and evaluate their characteristics.
15.	Apprehend Nanowires, Ballistic Transport and Spin Transport models and develop/integrate them for their applications.

Course Outcomes

After the completion of this course, a student will be able to:

CO1	Describe and illustrate the theory of Classical Particles, Classical Waves, Quantum Particles, Quantum Mechanics of Electrons, Free and Confined electrons.
CO2	Sketch and explain various aspects of Electrons Subject to a Periodic Potential – Band Theory of Solids.
CO3	Illustrate with the sketch of theory of Coulomb Blockade and the Single-Electron Transistor, diagram their characteristics and analyse them.
CO4	Appraise the models of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots, schematize their characteristics, assess and summarize their features.
CO5	Schematize the structure of Nanowires, and and design Field Effect Transistors that have carrier with Ballistic Transport and Spin Transport. Schematize their characteristics and prepare an inference.

MODULE	(NO. OF LECTURE HOURS)

Module – I **Classical Particles, Classical Waves, Quantum Particles, Quantum Mechanics of Electrons, Free and Confined electrons:** Introduction to nanoelectronics, Origins of Quantum Mechanics, Light as Wave, Light as a Particle, Electrons as Particles, Electrons as Waves, Wave packets and Uncertainty, General Postulates of Quantum Mechanics, Time-Independent Schrodinger's Equation, Free Electrons, Free Electron Gas theory of Metals, Electrons Confined to a Bounded Region of Space and Quantum Numbers, Quantum Dots, Wires and Wells.	**8**
Module – II **Electrons Subject to a Periodic Potential – Band Theory of Solids**: Crystalline Materials, Electrons in a Periodic Potential, Kronig-Penney Model of Band Structure, Band theory of Solids, Graphene and Carbon Nanotubes, Tunneling Through a potential Barrier, Potential Energy Profiles for Material Interfaces, Applications of Tunnelling.	**8**
Module – III **Coulomb Blockade and the Single-Electron Transistor:** Coulomb Blockade, The Single-Electron Transistor, Single Electron Transistor logic; Other SET and FET Structures: Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs, Molecular SETs and Molecular Electronics; Density of States, Classical and Quantum Statistics.	**8**
Module – IV **Models of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots:** Semiconductor Heterostructures and Quantum Wells, Quantum Wires and Nanowires; Quantum Dots and Nanoparticles, Fabrication Techniques for Nanostructures: Lithography, Nanoimprint Lithography, Split-Gate Technology, Self-Assembly.	**8**

Module – V	8
Nanowires, Ballistic Transport and Spin Transport: Classical and Semiclassical Transport, Ballistic Transport, Carbon Nanotubes and Nanowires, Transport of Spin, and Spintronics: The Transport of Spin,-Spintronic Devices and Applications.	

Textbooks:

1. George W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.

Reference books:
1. John H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
2. Charles P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003.

Gaps in the syllabus (to meet Industry/Profession requirements):
1. Hands-on-practical for Device fabrication.

POs met through Gaps in the Syllabus:
10

Topics beyond syllabus/Advanced topics/Design:
1. TFET
2. MTJ
3. Memristor
4. RTD.

POs met through Topics beyond syllabus/Advanced topics/Design:
10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	3	1	3	3	1	1			3		3	3	2	1
CO2	3	3	2	3	3	3	1			3		3	3	2	1
CO3	3	3	1	3	3	3	1			3		3	3	2	1
CO4	3	3	1	3	3	1	1			3		3	3	2	1
CO5	3	3	2	3	3	3	1			3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC365
Course Title: Radar and Navigation Systems
Pre-requisite(s): Microwave Theory and Techniques
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Sixth/Third
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

26.	To appraise an overview of Radar Systems and Radar Equation.
27.	To perceive the CW, FM, MTI and Pulse Doppler Radar
28.	To grasp the detection of radar signals in noise
29.	To understand the navigation, radio direction finding and radio ranges
30.	To understand the different types of navigation systems and landing

Course Outcomes

After the completion of this course, students will be able to:

| CO1 | Able to explain Radar Systems and Radar Equation. |
| CO2 | Able to demonstrate CW, FM, MTI and Pulse Doppler Radar |

CO3	Able to explain the detection of radar signals in noise
CO4	Able to demonstrate the concept of navigation, radio direction finding and radio ranges
CO5	Able to demonstrate the concept of navigation systems and landing

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Radar System and Radar Equation:** Introduction, History and Applications of Radar, Radar Block Diagram and Operation, Radar Frequencies, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Probability density Functions, Signal-to-noise Ratio, Integration of Radar Pulses, Radar Cross Section of Targets, Cross-section Fluctuations, Transmitter Power, Pulse Repetition Frequency and Range Ambiguities, Antenna parameters, System Losses, Propagation Effects	10
Module – II **CW, FM, MTI and Pulse Doppler Radar:** The Doppler Effect, CW Radar, Frequency-Modulated CW Radar, Airborne Doppler Navigation, Multiple CW radar, Delay line Cancellers, Multiple or Staggered Pulse Repetition Frequencies, Range gated Doppler Filters, Block Diagram of Digital Signal Processor, Example of MTI radar Processor, Pulse Doppler Radar, Non coherent MTI, MTI from moving platform, Other types of MTI, Airborne Radar	10
Module – III	7

Detection of Radar Signals in Noise: Introduction, Matched-Filter Receiver, Correlation Detector, Detection Criteria, Detector Characteristics, Performance of the Radar Operator, Automatic Detection, Constant-False-Alarm-Rate (CFAR) Receiver	
Module – IV **Introduction to Navigation, RDF and Radio Ranges** Introduction to Navigation, Methods of Navigation, Loop Antenna, Loop input circuits, aural null direction finder, Goniometer, Errors in Direction Finding, Adcock Direction Finder, Direction finding at very high frequency, Automatic Direction Finder, Range and accuracy of direction finder, LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment, Range and Accuracy of VOR	**7**
Module – V **Convolutional Codes:** **Navigation Systems and Landing:** LORAN, DECCA navigation system, Instrument Landing System, Ground controlled Approach System, Microwave landing system , Distance Measuring Equipment, operation of DME, TACAN Doppler navigation-Doppler Effect, Doppler frequency equations, Track stabilization, Doppler Spectrum, GPS principle of operation, Position location determination, principle of GPS receiver and applications, Differential GPS, Navstar GPS.	**6**

Text Books:
1. M.I. Skolnik, "Introduction to Radar System",McGraw Hill 2nd Edition.
2. N. S. Nagaraja "Elements of Electronic Navigation, 2nd edition, Tata McGraw-Hill Education

Reference Books:

1. Radar Systems and Radio Aids to Navigation, Sen & Bhattacharya, Khanna publishers
2. Radar Principles", Peyton Z. Peebles ,JohnWiley, 2004
3. J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004
4. Radar Systems Analysis and Design Using MATLAB, Bassem R. Mahafza,. CHAPMAN & HALL/CRC
5. Radar Engg. Hand Book M.I. Skolnik, Publisher: McGraw Hill
6. Roger J Suullivan, "Radar Foundations for Imaging and Advanced Topics".
7. Global Navigation Satellite Systems Insights into GPS, GLONASS, Galileo, Compass, and others B. Bhatta BSP Books
8. K. K. Sharma " Fundamentals of Radar, Sonar and Navigation Engineering" 4th Edition Katson Books

Gaps in the Syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus: PO10 will be met though report-writing/presentation-based assignment

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design: PO1

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

   1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)	Program Specific Outcomes (PSOs)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	3	2	2	1	3	2	3	1	3	3	2	1
CO2	3	3	2	3	2	2	1	3	2	3	1	3	3	2	2
CO3	3	3	2	3	2	2	1	3	2	3	1	3	3	2	1
CO4	3	3	2	3	2	2	1	3	2	3	1	3	3	2	3
CO5	3	3	2	3	2	2	1	3	2	3	1	2	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD8
CD2	Tutorials/Assignments	CO2	CD1 ,CD8
CD3	Seminars	CO3	CD1, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC366
Course title: Advanced Microwave Engineering Lab
Pre-requisite(s): Electromagnetic Fields and Waves Microwave Theory and Techniques
Co- requisite(s):
Credits: L: 0   T: 0   P: 3   C: 1.5
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Sixth/Three
Branch: Electronics & Communication Engineering
Name of Teacher: ALL

Course Objectives:
This course enables the students:

16.	To develop an understanding about the propagation of modes in free space and waveguides.

17.	To develop an understanding about the RF behavior of passive components, matching network and microstrip resonators.
18.	To develop an ability to understand about the waveguide coupler, bandpass filter and propagation characteristics in ferrite medium.
19.	To develop an ability to understand about microwave transistor amplifier and microstrip transmission line.
20.	To develop an ability to understand a microstrip reconfigurable bandpass filter and monopole microstrip antenna

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Demonstrate understanding of the propagation of modes in free space and waveguides.
CO2	Demonstrate understanding of the RF behavior of passive components, matching network and microstrip resonators.
CO3	Design a waveguide coupler, bandpass filter and understanding of propagation characteristics in ferrite medium.
CO4	Design a microwave transistor amplifier and microstrip transmission line.
CO5	Design a reconfigurable bandpass filter and monopole microstrip antenna

Syllabus

List of Compulsory experiments:

22. Name of the Experiment: Propagation mode in free space
   AIM-1: Analysis of various propagation mode in free space.

23. Name of the Experiment: Propagation modes in waveguide
   AIM-1: Analysis of propagation modes in waveguide.

24. Name of the Experiment: RF behavior of passive components
   AIM-1: Using MATLAB, obtain the RF behavior of passive components (Resistor, Capacitor and Inductor)

 5. Name of the Experiment: Matching network

AIM-1: Using MATLAB, design an L-section matching network to match a series RC with given load and line impedance at a frequency.

12. Name of the Experiment: Microstrip resonator

AIM-1: Consider a microstrip resonator constructed from a $\frac{\lambda}{2}$ length of 50 Ω open circuited microstrip line. For a given substrate, using MATLAB, at a given resonance frequency, compute the required length of line, propagation constant, attenuation due to conductor loss and dielectric loss and unloaded "Q" of resonator

13. Name of the Experiment: Waveguide coupler

AIM 1: Using MATLAB, obtain coupling and directivity versus frequency plot for the four hole Chebyshev waveguide coupler for X band

14. Name of the Experiment: Bandpass filter

AIM 1: Using MATLAB, Design a third order bandpass filter having a 0.5 dB equal-ripple response for the required center frequency, bandwidth and the impedance.

15. Name of the Experiment:, Propagation in ferrite medium

AIM 1: Using MATLAB, plot and analyze the phase and attenuation constant verses frequency curve for RHCP and LHCP plane propagation in ferrite medium

16. Name of the Experiment: RF transistor amplifier

Using MATLAB, Obtain and plot the stability regions of a given transistor amplifier parameters on Smith Chart. If amplifier is unstable then suggest the method to stabilize it.

17. Name of the Experiment:, Microstrip transmission line

AIM 1: Using IE3D/HFSS, design a 50 ohm microstrip transmission line for 90 degree phase shift. Calculate the required dimensions of microstrip using MATLAB.

18. Name of the Experiment:, Reconfigurable bandpass filter

AIM 1: Using IE3D/HFSS, Design a reconfigurable bandpass filter for WIMAX and WLAN applications

19. Name of the Experiment:, Monopole microstrip antenna

AIM 1: Using IE3D/HFSS, Design a CPW fed monopole microstrip antenna on a given substrate

Text Book:

2. "David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.
3. R. Ludwig and G. Bogdanov, "RF Circuit Design, Theory and Applications", Pearson, 2nd Edition.

Reference Books:

3. S. Y. Liao , "Microwave Devices & Circuits", PHI 2nd Edition
2. B. R. Vishvakarma, R U Khan, M K. Meshram, " Intoduction to Microwave Measurements"

3. R.E.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –
    1. Student Feedback on Faculty
    2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	3	1	-	-	1	3	1	2	2	2	1
CO2	3	3	2	2	3	1	-	-	1	3	1	2	2	2	1
CO3	3	3	3	3	3	1	-	-	1	3	1	3	2	2	1
CO4	3	3	3	3	3	1	-	-	1	3	1	3	2	2	1
CO5	3	3	3	3	3	1	-	-	1	3	1	3	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5 ,CD8
CD2	Tutorials/Assignments	CO2	CD1, CD5,CD8, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5,CD8, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5, CD8, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD8, CD9

CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 367
Course Title: Computer Networking
Pre-requisite(s): Fundamentals of Data Communication
Co- requisite(s):
Credits: L: 3   T: 1   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Sixth
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	Understand the different network topologies, transmission media and different MAC sub-layers used in the design of a Local Area Network (LAN) and Wireless LAN's.
2.	Familiarize the layer of operation and working of different intermediate devices, network layer protocols and internet addressing mechanism.
3.	Familiarize with the transport layer protocols to be used as an end-to-end service provider.

4.	Illustrate different encryption and message authentication schemes to provide security at different layers.
5.	To outline the functioning of the Application layer and different protocols of application layers e.g. HTTP, SMTP, WWW, FTP, VOIP etc.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Recall the basic reference model of LAN, their topologies and different types of intermediate systems in a network used.
CO2	Understand the basics of various internet protocols and their functioning.
CO3	Understand the basics of various internet and transport protocols and their functioning.
CO4	Explain the significance of network security in a public network like internet.
CO5	Analyze the different application layer protocols and their functioning.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Local Area Network:** Local Area Networks: Background, Topologies and Transmission Media, LAN standards IEEE 802 reference Model, Logical Link Control. **Medium Access Control:** Medium Access Control, IEEE 802.3 Medium Access Control, Ethernet, Fast Ethernet, Gigabit Ethernet, Token Ring and FDDI, IEEE 802.5 Transmission Medium Options. **Connecting devices and Backbone Networks:** Bridges, Functions of a Bridge, Bridge Protocol Architecture, Fixed routing, Spanning tree approach, Connecting devices like Repeaters, Hubs, Bridges ,Two-layer switches, Routers and Three	**11**

layer switches, Backbone Networks, Bus Backbone, Star Backbone, Connecting remote LANs.	
Module – II **Internetworking Operations:** Principles of Internetworking, Requirements, Architectural approaches, Connectionless Internetworking, Addressing, Routing techniques, Static versus Dynamic Routing, **Internet Protocols:** IPv4, Internet Control Message Protocol (ICMP), IPV6 Structure, Header, CIDR Addressing, ICMPV6. **Internet work Operations:** Unicast and Multicast routing, Autonomous Systems, Unicast routing protocol OSPF, Internet Group Management Protocol (IGMP), Border Gateway Protocol, Integrated Service Architecture, ISA Approach, Components, Services, Queuing Discipline, Resource Reservation Protocol (RSVP), Differentiated Services (DS).	**10**
Module – III **Transport layer operations:** Connection Oriented Transport Protocol Mechanisms, Reliable Sequencing networks services, Unreliable network services, TCP Services, TCP Header Format, TCP Mechanisms, TCP Implementation policy options, TCP Congestion Control, Retransmission Timer Management, Window Management, Quality of Service, User datagram Protocol (UDP).	**7**
Module – IV Network Security : Passive and Active Attacks, Symmetric Encryption, Encryption Algorithms, Key Distribution, Traffic Padding, Message Authentication, Hash function, Secure Hash function, Public-key Encryption, Digital Signature, RSA Public Key Encryption algorithm, Key Management, Secure Socket layer and Transport layer Security, SSL Architecture, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol, IP level security IPSEC, Application layer security PGP, Firewall, Virtual Private Networks.	**7**

Module – V **Application Layer Protocols:** Distributed Applications: Electronic Mail, Simple Mail Transfer Protocol (SMTP), Multipurpose Internal Mail Extension (MIME), Client Server Model, Socket Interface, Simple Network Management Protocol (SNMP) SNMP V2 and SNMP V3, Hypertext Transfer Protocol (HTTP) Overview Message Entities, World Wide Web (WWW), HTML, Common Gateway Interface (CGI), Voice over IP (VOIP).	**5**

Text Books:

1. Data and Computer Communication, 7/e. by William Stallings.
2. Data Communication and Networking, 3/e. by Behrouz. A. Forouzan.

Reference Books:
1. The Internet and its protocols: A comparative approach. by Adrian Farrel.
2. Computer Networks 4/e by Andrew S. Tanenbaum.

Gaps in the Syllabus (to meet Industry/Profession requirements):

1. Simulation of different types of networks and their performance comparison.

POs met through Gaps in the Syllabus
     3, 4 and 12

Topics beyond syllabus/Advanced topics/Design
1. Hardware implementation of MAC protocols.
2. Hardware implementation of Bridges and Routers.
3. Setting up of a practical internetwork.

POs met through Topics beyond syllabus/Advanced topics/Design

     2, 3, 4, 12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10

Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	1	1	2	1	-	-	-	-	-	-	2	2	1	3
CO2	3	3	3	2	1	-	-	-	-	-	-	1	3	1	3
CO3	3	3	2	2	2	-	-	-	-	-	-	1	2	2	2
CO4	3	2	1	1	1	-	-	-	-	-	-	1	2	2	2
CO5	3	1	1	2	1	-	-	-	-	-	-	2	2	1	3

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1
CD2	Tutorials/Assignments	CO2	CD1
CD3	Seminars	CO3	CD1 CD2
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC369
Course Title: Wireless Networks
Pre-requisite(s): Basic Sciences
Co- requisite(s):
Credits: L: 3 T: 1 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Sixth/Three
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

31.	Explain basics of wireless networks system
32.	Explain network protocols used for WPAN, WLAN and WWAN.
33.	Explain Transmission control protocol
34.	Explain IPv4 and IPV6 addressing system
35.	An ability to explain the functioning, protocols, capabilities and application of various wireless communication networks.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate an understanding on basics of Wireless network system
CO2	Demonstrate an ability to identify the protocol for network environment based on geographical condition, dimension and resource condition
CO3	Demonstrate an understanding on IP addressing protocol
CO4	Demonstrate an understanding on basics of Wireless network system

CO5	Explain the functioning, protocols, capabilities and application of various wireless communication networks.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Ad-hoc wireless networks : MANET and WSN, security in wireless networks, energy constrained networks, adhoc versus Infrastructure based wireless networks	9
Module – II Wireless personal area networks (bluetooth, network connection establishment in bluetooth, bluetooth protocol stack, bluetooth link type, bluetooth security. ZigBee: components & network Topologies. ultra wideband communication	9
Module – III Wireless local area and metropolitan area networks: WLAN Technology, network architecture, protocol architecture, physical layer, data link layer, medium access methods, security in 802.11 systems, WLAN standards. Wireless metropolitan area networks (WiMAX).	8
Module – IV Wireless wide area networks: GSM, GPRS, 3G wireless systems, evolution of cdma2000, differences between cdma2000 & WCDMA. HSPA and LTE.	8

Module – V Wireless network protocols: mobile network layer protocol (mobile IP, Ipv4 vs. IPv6, IPv6, IPv6 transition mechanism, dynamic host configuration protocol), mobile transport layer protocol (traditional TCP, classical TCP improvements), agent discovery, agent advertisement, registration, authentication, route optimisation, mobility support for IPV6.	**7**

Text Books:
1. J. Schiller, "Mobile Communication" 2/e, Pearson Education, 2012.
2. Vijay K Garg, "Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint)

Reference Books:
1. Behrouz A. Forouzan, "Data Communications and Networking", McGraw-Hill, 2007
2. Sanjay Kumar, "Wireless Communication the Fundamental and Advanced Concepts" River Publishers, Denmark, 2015 (Indian reprint).

Gaps in the Syllabus (to meet Industry/Profession requirements) : Nil

POs met through Gaps in the Syllabus : NA

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	-	-	-	-	-	-	-	2	3	2	1
CO2	3	3	3	3	2	-	-	-	-	-	-	1	3	2	1
CO3	3	3	3	3	2	-	-	-	-	-	-	1	3	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	1	3	2	2
CO5	3	3	3	3	2	-	-	-	-	-	-	2	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD 8
CD2	Tutorials/Assignments	CO2	CD1, CD 8 and CD9
CD3	Seminars	CO3	CD1, CD 8 and CD9
CD4	Mini Projects/Projects	CO4	CD1 and CD 8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD 8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC370
Course title: Wireless Networking Lab
Pre-requisite(s): Fundamental Knowledge of Communication System, basic understanding of communication process and communication media
Co- requisite(s):
Credits: L: 0 T: 0 P: 3 C: 1.5
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Sixth/Three
Branch: Electronics & Communication Engineering
Name of Teacher: ALL

Course Objectives:
This course enables the students:

21.	To develop an ability to design various kind of wired/wireless networks using network simulator.
22.	To evaluate and compare the performance of several network protocols (AODV, DYMO etc).
23.	To design and interpret wireless sensor networks and standards
24.	To design and examine the hardware setup for wireless Wide Area network
25.	To design and examine the hardware setup for wireless sensor network

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Have an ability to design and evaluate various kind of wired/wireless networks.
CO2	Be able to analyze and compare the performance of various routing protocols (like AODV, DYMO etc) for wireless adhoc network as well as for infrastructure based wireless network.
CO3	Have an ability to design and interpret wireless networks and standards (WLAN, Bluetooth etc) through simulation software as well as evaluate the impact of various system parameters on wireless standards.
CO4	Have an ability to design and analyze the hardware setup for wireless Wide Area network
CO5	Have an ability to design and analyze the hardware setup for

Syllabus

List of Compulsory experiments:

25. Name of the Experiment: Set up link to analyze flow of operation (packets)
AIM-1:Study and demonstrate the flow of operation (packets) in QualNet Network Simulator GUI.

26. Name of the Experiment: Set up link to analyze Ad hoc mode scenario
AIM-1: Design and evaluate an Ad hoc mode scenario using QualNet Network Simulator.

27. Name of the Experiment: Set up link to analyze infrastructure mode scenario
AIM-1: To configure and evaluate an infrastructure mode scenario using QualNet Simulator GUI.

28. Name of the Experiment: Set up link to measure effect of mobility in an Ad hoc mode scenario
AIM-1: Configure and estimate the effect of mobility to the data transferred in an Ad hoc mode scenario.

29. Name of the Experiment: : Set up link to measure effect of mobility in an infrastructure mode scenario
AIM-1: Configure and estimate the effect of mobility to the data transferred in an infrastructure mode.

30. Name of the Experiment: Compare AODV and DYMO
AIM-1: Compare two routing protocols (AODV and DYMO) in ad hoc mode scenario.

31. Name of the Experiment: Configure VOIP Application Layer Protocol
AIM-1: **Configure** VOIP Application layer protocol based on H.323 in an infrastructure.

32. Name of the Experiment: *Evaluate performance of Multicasting Application*
AIM-1: Configure and evaluate a multicasting application in a wired/wireless scenario.

11. Name of the Experiment: *GSM Setup*

AIM-1: Assembly of GSM set up and real time study of GSM 07. 05 and 07.07 AT commands (such as network registration call control call setting etc at least 10 command).

12. **Name of the Experiment: Wireless Sensor Network**
    AIM 1: To Interface analog sensor with Scientech 2311 Wireless sensor network.

13. **Name of the Experiment: Temperature and Light Sensor**
    AIM 1:To develop a code to read temperature and light sensor data from sensor module attached to the radio module using SENSnuts GUI platform

14. **Name of the Experiment: Level Based Routing**
    AIM 1:To create a LBR (level based routing) based multi-hop network using SENSnuts GUI platform.

Text Book:

1. Vijay K. Garg, "Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint).

Reference Books:

1. Theidore S Rappaport, "Wireless Communication: Principles and Practice" Prentice Hall of India, New Delhi, 2006, 2/e.
2. Lab. Manuals concerning each experiment.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –
1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	3	1	2	1	2	2	2	2	2	2	1
CO2	3	3	2	2	3	1	2	1	2	2	2	2	2	2	1
CO3	3	2	2	2	3	1	2	1	2	2	2	2	2	2	1
CO4	3	3	2	2	3	1	2	1	2	2	2	2	2	2	1
CO5	3	2	2	2	3	1	2	1	2	2	2	2	2	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 371
Course Title: Introduction to Electromagnetic Compatibility
Pre-requisite(s): Electromagnetic Field and Waves
Co- requisite(s):
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level:
Branch: Electronics and Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

36.	Explain requirement of EMI & EMC concept and impart knowledge on different units and standards used for Electromagnetic compatibility in electronic/electric system.
37.	Develop an ability to analyze, measure and evaluate the radiated and conducted emissions to examine the compatibility.
38.	Develop an ability to analyze and evaluate the impact of EMI mitigation techniques such as shielding and grounding.
39.	Develop an ability to explain the impact of EMI on system design.
40.	Review and present the literature ethically and also develop the skill to work individually or in a team.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Explain the requirement of EMI & EMC concept and impart knowledge on different units and standards used for Electromagnetic compatibility in electronic/electric system.
CO2	Analyze, measure and evaluate radiated and conducted emissions to examine the electromagnetic compatibility.
CO3	Analyze and evaluate the impact of EMI mitigation techniques such as shielding and grounding.
CO4	Explain the impact of EMI on system design.
CO5	Review and write the literature related to EMI & EMC to report it ethically.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** A brief history of EMI/EMC, Analysis of EMI, Type of Noise and Interference, Electromagnetic Compatibility, Radiated Emission and susceptibility, Conducted Emission and Susceptibility, Benefits of good EMC Design, Brief description of EMC regulations, Examples of EMC related problems. EMC requirements for Electronic Systems: Government regulations, Requirement for Commercial products and Military products, Radiated Emission limits for Class A, Class B, FCC and CISPR, measurement of Emissions for verification of compliance: Radiated Emission and Conducted Emissions, Typical product emissions, Additional product requirements, design constraints for products, Advantages of EMC Design.	8
Module – II **Conducted Emission and Susceptibility:** Measurement of Conducted emission: LISN, Common and Differential mode currents, Power supply filters: Basic properties of filters, A generic power supply filter topology, Effect of filter elements on common and differential mode currents, Separation of conducted emissions into common and differential mode components for diagnostic purpose, Power supplies: Linear and SMPS, Effect of Power Supply Components on Conducted emissions, Power Supply and Filter placement, Conducted Susceptibility.	9
Module – III	9

Radiated Emission and Susceptibility: Simple Emission models for wires and PCB lands: Differential mode versus Common mode currents, Differential mode current emission model, Common mode current emission model, Current probes, Simple susceptibility models for wires and PCB lands: Shielded cables and surface transfer impedance.	
Module – IV **Cross talk:** Three conductor transmission lines and crosstalk, Transmission line equations for lossless lines, The per unit length parameters: Homogeneous versus Inhomogeneous media, Wide separation approximation for wires, Numerical methods for other structures, The Inductive-Capacitive Coupling Approximation model: Frequency domain Inductive-Capacitive coupling model, Time domain Inductive-Capacitive coupling model, Lumped circuit approximate models. Shielded Wires: Per unit length parameters, Inductive and Capacitive Coupling, Effect of Shield grounding, Effect of pigtails, Effects of Multiple shields, MTL model predictions, Twisted wires: Per unit length parameters, Inductive and Capacitive Coupling, Effects of Twist, Effects of Balancing.	8
Module – V **Shielding:** Shielding Effectiveness, Far field Sources: Exact solution, Approximate solution, Near field sources: Near field versus far field, Electric sources, Magnetic sources, Low frequency, magnetic field shielding, Effect of Apertures. System Design for EMC: Shielding and Grounding, PCB Design, System configuration and design, Electrostatic Discharge, Electromagnetic Pulse, Diagnostic tools.	6

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| | |

Text books:

1. Paul, C., Introduction to Electromagnetic Compatibility, John Wiley & Sons, 1992.

Reference books:

1. Ott, W. Henry, Electromagnetic Compatibility Engineering, John Wiley & Sons, 2009.

Gaps in the Syllabus (to meet Industry/Profession requirements)

The gaps in the syllabus would be met by Assignment, Lectures and presentation.

POs met through Gaps in the Syllabus
May be met through laboratory simulations, experiments, and design problems.

Topics beyond syllabus/Advanced topics/Design
7. EM Interference issues in automobiles and aircrafts.
8. EM interference issues in high speed circuit design.

POs met through Topics beyond syllabus/Advanced topics/Design
Assignments & Seminars

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	1	-	1	2	-	-	-	1	1	-	1	3	1	2
CO2	-	1	-	1	1	-	-	-	1	1	-	1	2	2	2
CO3	3	1	-	1	1	-	-	-	1	1	-	1	2	2	2
CO4	1	1	1	1	1	1	1	1	1	1	-	1	3	3	3
CO5	1	1	1	1	2	1	1	2	1	1		2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD5, CD8, CD9.
CD5	Laboratory Experiments/Teaching Aids	CO5	CD4, CD5, CD7, CD9
CD6	Industrial/Guest Lectures		

CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC373
Course title: Introduction to Sensor and Transducer
Pre-requisite(s): EC101 Basis of Electronics and Communication Engineering
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C: 3
Class schedule per week: 04
Class: B. Tech.
Semester / Level: 01/01
Branch: ALL B. Tech.
Name of Teacher:

Course Objectives:

This course enables the students:

1	To understand principle of transduction.
2	To Select a resistive/inductive sensor for specific application.
3	To design sensor based on capacitive/magnetic property.
4	To understand the operation of radiation sensor.
5	To compare the operation of radiation sensor.

Course Outcomes:

After the completion of this course, students will be able to:

CO1	Explain the principle of transduction . Classify sensor based on different parameters like measurand, principle of operation, energy etc.
CO2	Select a resistive/inductive sensor for specific application
CO3	Apply the capacitive/magnetic property for sensor design
CO4	Explain the operation of radiation sensor
CO5	Differentiate between conventional sensor and smart sensor.

MODULE	(NO. OF LECTURE HOURS)
Module-1 Definition, principle of sensing & transduction, classification and characteristics of sensor. Mechanical and Electromechanical sensor;	6
Module-2	

Resistive : potentiometric sensor, Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes.; Resistive Temperature sensor. Inductive sensor: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, LVDT: Construction, material, output input relationship.	**10**
Module-3 Capacitive sensors: variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity; Stretched diaphragm type: microphone, response characteristics; Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors. Magnetic sensors: Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics;	**10**
Module-4 Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction,, response, Geiger counters, Scintillation detectors;	**6**
Module-5 Smart Sensor: characteristics of a smart sensor. components of smart sensor, Construction and working of smart sensor using silicon. Information Coding/Processing, Data Communication and Automation using smart sensor.	**8**

Text Books:
2. Electrical & Electronics Measurements and Instrumentation By A.K.Shawhney, Dhanpat Rai & Sons.
3. Electronics instrumentation By H. S. Kalsi [TMH]

Reference Book:
1. "Sensors and Transducers", 2/E By D. Patranabis

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Quizzes
CD3	Assignments/Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid SEM Examination Marks	25
End SEM Examination Marks	50
Quizzes	10+10
Assessment by teacher	5

Assessment Components	CO1	CO2	CO3	CO4
Mid SEM Examination Marks	3	3	3	3
End SEM Examination Marks	3	3	3	3

Quizzes	3	3	3	3
Assessment by teacher	3	3	3	3

Indirect Assessment –

    1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	3	1	1				3	
CO2	3	2	2	2	3	1	1				3	
CO3	3	3	1	2	3	1	2		1	1	3	2
CO4	3	2	1	2	3	1	2		2	1	3	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD3, CD8
CD2	Quizzes	CO2	CD1, CD2, CD3, CD8
CD3	Assignments/Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD8

CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC375
Course title: High Speed Electronic
Pre-requisite(s): EC101 Basics of Electronics and Communication Engineering, EC201
Electronic Devices
Co- requisite(s):
Credits: <mark>L: 3   T: 0   P: 0   C: 3</mark>
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE
Name of Teacher:

<mark>Course Objectives</mark>

<mark>This course enables the students to</mark>:

1.	<mark>Understand</mark> RF Behavior of Passive Components.
2.	<mark>Interpret</mark> the Microwave Characteristics of Field Effect Transistors.and <mark>apply</mark> the perceived knowledge.
3.	Appraise and <mark>analyse</mark> the Distributed System and Transmission Line Theory.
4.	Design and <mark>Evaluate</mark> the LNA and RF Power Amplifiers.
5.	<mark>Design/create</mark> the Mixers, PLLs and Oscillators.

<mark>Course Outcomes</mark>

<mark>After the completion of this course, students will be able to:</mark>

CO1	<mark>Describe</mark> and <mark>illustrate</mark> the RF Behavior of Passive Components.
CO2	<mark>Sketch</mark> and <mark>Explain</mark> Microwave Characteristics of Field Effect Transistors.

CO3	Diagram and explain the use of Distributed System and Transmission Line Theory. Illustrate their characteristics and analyse them.
CO4	Design and schematize LNA and RF Power Amplifiers, assess their characteristics and summarize their features.
CO5	Design and schematize Mixers, PLLs and Oscillators, assess their characteristics and summarize their features.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **RF Behavior of Passive Components:** Interconnect at Radio Frequencies - Skin Effect, Resistors, Capacitors, Inductors, Transformers, Monolithic Transformer Realizations, Interconnect Options at High Frequencies, MOSFET as Switches, Electrostatic Discharge (ESD).	8
Module – II **Microwave Characteristics of Field Effect Transistors:** *Review of MOSFET*: Dynamic Elements, High-Frequency Figures of Merit, Technology scaling in the long-channel limit, Operation in Week inversion; MOS device physics in short-channel regime. ***Modulation-doped field-effect transistor***	8

(MODFET): Basic Device Structure, I-V Characteristics, Equivalent Circuit and Microwave Performance, Advanced Device Structures.	
Module – III **Distributed System and Transmission Line Theory:** Introduction, Maxwell's equation & Kirchhoff's laws, Link between lump and distributed regimes, Driving-point impedance of iterated structures; Transmission line in more detail: Lumped model for lossy transmission line, Characteristic impedance of a lossy transmission line, The propagation constant (γ), Relationship of propagation constant (γ) to line parameters. Behavior of finite-length transmission lines.	**8**
Module – IV **LNA and RF Power Amplifiers:** *Low-noise amplifiers*: LNA topologies; Design Examples; *RF Power Amplifiers*: General Considerations, Class A, AB, B and C Power Amplifiers, Class D Amplifiers, Class E Amplifiers; Performance Metrics, Summary of PA Characteristics, RF PA Design Examples, Additional Design Considerations.	**8**
Module – V **Mixers, PLLs and Oscillators:** *Mixers*: Active Downconversion Mixers; Upconversion Mixers. *Phase-Locked Loops*: General considerations: Transceiver architectures, Basic Concepts. *Oscillators*: Performance parameters, basic principles.	**8**

==Textbooks:==
6. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits," 2nd ed., Cambridge University Press, 2004.
7. SM Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3/e, Wiley-Interscience, 2006.

8. Behzad Razavi, RF Microelectronics, 1e, Prentice Hall, 1998.
9. Behzad Razavi, RF Microelectronics, 2e, Prentice Hall, 2012.

Reference books:
1. John W. M. Rogers, Calvin Plett, Radio Frequency Integrated Circuit Design, Artech House, 2010.
2. Reinhold Ludwig and Pavel Bretchko, RF Circuit Design Theory and Application, Pearson Education, 2000.

Gaps in the syllabus (to meet Industry/Profession requirements):
1. Hands-on-practical for IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus:
    10
Topics beyond syllabus/Advanced topics/Design:
    N/A

POs met through Topics beyond syllabus/Advanced topics/Design:
    10

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)	Program Specific

		1	2	3	4	5	6	7	8	9	10	11	12	Outcomes (PSOs) 13	14	15
CO1		3	3	2	3	3	1	1			3		3	3	2	1
CO2		3	3	2	3	3	3	2			3		3	3	2	1
CO3		3	3	2	3	3	3	2			3		3	3	2	1
CO4		3	3	2	3	3	2	2			3		3	3	2	1
CO5		3	3	2	3	3	2	2			3		3	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 377
Course Title: Introduction to Communication System
Pre-requisite(s): Good understanding of mathematical tools like integration, differentiation etc.
Co- requisite(s):
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: OE/Three
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

41.	Explain basics of analog and digital communication system and modulation-demodulation schemes
42.	Explain the method to design analog and digial modulation-demodulation system
43.	Explain the concept of sampling, quantization and coding required for various Pulse modulation schemes.
44.	Explain the concept of multiplexing schemes
45.	Explain to evaluate the performance of communication system in the presence of noise.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate an understanding on communication system and representation of signals.
CO2	Demonstrate an understanding on different methods of Analog and Digital modulation and demodulation schemes.
CO3	Demonstrate an understanding on design, operation and applications of Analog and Digital modulation and demodulation schemes
CO4	Demonstrate an understanding on Multiplexing Scheme and Heterodyne receiver

CO5	Evaluate the performance of communication system in the presence of noise.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Overview of electronic communication systems, need for modulation, amplitude modulation, generation and detection of AM waves, DSB-SC modulation, generation and detection of DSB-SC waves, SSB modulation and demodulation, comparison between AM, DSB-SC and SSB, frequency division multiplexing, noise in communication system, signal to noise ratio, Shannon's theorem, channel capacity, bandwidth S/N trade-off.	**10**
Module – II Angle modulation, frequency modulation and phase modulation, NBFM, WBFM, generation of FM wave, demodulation of FM wave, superheterodyne receiver, Frequency Division Multiplexing.	**10**
Module – III Pulse modulation: sampling theorem, pulse amplitude modulation, time division multiplexing, PAM modulator and demodulator, pulse duration modulation, PDM modulator and demodulator, pulse position modulation, PPM modulator and demodulator. Analog to digital conversion:, quantization process, pulse code modulation, differential pulse code modulation, delta modulation	**7**
Module – IV Digital modulation and transmission: BFSK, DPSK, QPSK, M-ary PSK, QASK, BFSK, M-ary FSK, MSK, pulse shaping to reduce inter-channel and inter-symbol	**6**

interference. Spread spectrum modulation and its use, PN sequence generation and its characteristics,	
Module – V Noise in communication system, various types of noise, équivalent noise band width, noise température, signal to noise ratio, noise figure, shannon's theorem, channel capacity, bandwidth S/N trade-off, mutual information and channel capacity	**7**

Text Books:
1. Herbert Taub, Donald L Schilling and Gautam Saha "Communication Systems" McGraw Hill Education (India), pvt. Ltd., New Delhi, 4th edition, 2013.

Reference Books:
1. Simon Haykin, "Communication Systems" Wiley, 4th edition, 2001.
2. D. Roddy & J. Coolen, "Electronics Communication", 4th Edition, PHI, 2005

Gaps in the Syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design: PO2

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	1	-	-	-	-	-	-	-	2	3	2	1
CO2	3	3	3	3	2	-	-	-	-	-	-	1	3	2	2
CO3	3	3	3	3	2	-	-	-	-	-	-	1	3	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
CO5	3	3	3	3	2	-	-	-	-	-	-	1	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD8
CD2	Tutorials/Assignments	CO2	CD1 ,CD8
CD3	Seminars	CO3	CD1, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC379
Course title: **Control Systems**
Pre-requisite(s):EC205 Signals and Systems
Co- requisite(s):
Course type: Core
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B.E
Semester / Level: VII/IV
Branch: ECE
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1	
2	
3	
4	
5	

Course Outcomes

After the completion of this course, students will be able to:

CO1	Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form.
CO2	Characterize any system in Laplace domain to illustrate different specification of the system using transfer function concept.
CO3	Interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
CO4	Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.
CO5	Formulate different types of analysis in frequency domain to explain the nature of stability of the system.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **MODULE – I** Introduction:, Examples of control systems and applications, Basic components of control systems, Open loop and closed loop control systems, Effect of feedback on overall gain, Stability and external disturbances, Classification of control system : Linear and nonlinear continuous and digital, Time invariant and time varying, Minimum phase and non-minimum phase systems etc. Linearization of nonlinear systems using Taylor's series.	**6**
Module – II Control System Components and Basic Control Actions: Sensors and encoders in control system, Potentiometer, Tachometers, incremental encoders, Synchros, Block Diagrams and Signal Flow Graph: Block diagrams of control systems, Block diagram reduction, Signal Flow Graph (SFG) - Basic properties of SFG, SFG algebra, Gain formula to SGP, Application of gain formula to block diagrams.	**10**
Module – III Time Response of Control Systems: Transient and steady state response, Time response specifications, typical test signals, Steady state error, and error constant, Stability- Absolute, relative and conditional stability, Dominant poles of transfer function. Root Locus Methods: Root locus concept, Properties and construction of root locus, Determination of relative stability from root locus, Root sensitivity to parameter variation, Root contours, Systems with transportation lag and effect of adding poles or zeros.	**8**
Module – IV Concepts of State, State Variables: Development of state-space models. State and state equations, State equations from transfer function Transfer function from state equations, State transition matrix, Solution of State equation, Transfer Matrix, State variables and linear discrete time systems, Controllable and observable State models, Asymptotic state observers. Control system design via pole placement. Design of P, PI, PD and PID controllers.	**10**

Module – V Bode Analysis and Introduction to Design: Frequency response specifications, Correlation between time and frequency domain Bode plot, Determination of stability using Bode plot, Introduction to compensation design using Bode plot. Other Frequency Domain Tools: Nyquist stability criterion, Theory of Magnitude phase plot, Constant M, constant N circle and Nichols chart.	**6**

Text Books:

1. I. J. Nagrath & Gopal, "Control Systems Engineering", 4th Edition New Age   International Publication.

2. K. Ogata, "Modern Control Engineering", 3rd Edition, Pearson Education.

Reference Books:

1. Norman Nise, "Control System Engineering, 4th Edition, Wiley.

2. Graham C. Goodwin, "Control System Design", PHI.

3. B. C. Kuo, "Automatic Control System", 7th Edition, PHI.

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1															
CO2															
CO3															
CO4															
CO5															

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, and CD 8
CD2	Tutorials/Assignments	CO2	CD1, and CD 8
CD3	Seminars	CO3	CD1, and CD 8
CD4	Mini Projects/Projects	CO4	CD1, and CD 8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, and CD 8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		

CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC381
Course Title: Error Correcting Codes
Pre-requisite(s):): Digital communication
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Six/Three
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

46.	An understanding of Mathematical Preliminaries for error correcting codes and fundamental knowledge of block codes.
47.	An understanding of BCH and Reed-Solomon Codes with its applications.
48.	Fundamental understanding on Convolutional codes & Viterbi decoding
49.	Fundamental understanding on Trellis coded modulation.
50.	Fundamental understanding on Modern iterative coding (Turbo codes and LDPC codes).

Course Outcomes

After the completion of this course, students will be able to:

CO1	Utilize the fundamental knowledge of block codes for concerned applications.
CO2	Demonstrate the BCH and Reed-Solomon Codes for practical applications.
CO3	Have an ability to demonstrate the Convolutional encoding with Vitebi decoding.
CO4	Have an ability to demonstrate Trellis coded modulation.
CO5	Have an ability to demonstrate the Modern iterative coding (Turbo codes and LDPC codes).

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Mathematical Preliminaries and Block codes** Fields, groups, and subgroups; Binary Linear Block Codes; Singleton bound; Hamming Bound; Sydrome decoding;	9
Module – II **BCH and Reed-Solomon Codes**	9

BCH Codes; Reed-Solomon Codes; Decoding BCH and RS Codes; Finding the Error Locator Polynomial: Berlekamp-Massey Algorithm; Non-Binary BCH and RS Decoding: Forney's Algorithm.	
Module – III **Convolutional codes and Trellis coded modulation** Coding gain; ML and MAP decoders; Soft-versus hard-decision decoding; Convolutional Codes: Encoders and Viterbi decoding; Trellis coded modulation.	**8**
Module – IV **Turbo codes** Encoders, Turbo decoder. Implementation aspects of turbo codes: MAP decoder and MAXLOGMAP decoder for convolutional codes, design and architecture, Turbo codes in the WiMax/3GPP standards.	**8**
Module – V **Low density parity check codes** Low-density Parity-check Codes: Ensembles of LDPC codes, Message-passing decoders, Threshold phenomenon and density evolution. LDPC codes in the WiMax standard.	**6**

Text Books:
1. Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, WileyIndia Edition.
2. "ErrorControl Coding, Second Edition", by Shu Lin and D. J. Costello, Pearson Press, 2004.

Gaps in the Syllabus (to meet Industry/Profession requirements) :Nil

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	1											3	2	1
CO2	3	3				1							3	2	2
CO3	3	3				1							3	2	1
CO4	3	3				1							3	2	3
CO5	3	3	1	3		1	1					2	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD8
CD2	Tutorials/Assignments	CO2	CD1 ,CD8
CD3	Seminars	CO3	CD1, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 383
Course Title: DSP Architecture for VLSI
Pre-requisite(s): Electronic Devices, VLSI Systems, Digital Signal Processing
Co- requisite(s):
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions imparting to students to:

1.	Understand the concept of DSP, FIR filters and show the FPGA implementation in DSP
2.	Analyze transformation techniques and implement the FPGA.
3.	Recognize the pipelining and parallel processing for IIR filters using FPGA.
4.	Develop the algorithms for fast convolution and synchronous pipelining and implement the FPGA.
5.	Demonstrate the asynchronous pipelining using FPGA.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Recognize the concept of DSP, FIR filters and FPGA for DSP.
CO2	Demonstrate the transformation techniques and demonstrate the implementation of FPGA.
CO3	Apply the knowledge of pipelining and parallel processing for IIR filters using FPGA.
CO4	Develop the algorithms for fast convolution and synchronous pipelining using FPGA
CO5	Show the asynchronous pipelining using FPGA.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **An overview of DSP concepts**: Pipelining of FIR filters. Parallel processing of FIR filters, Pipelining and parallel processing for low power, Combining Pipelining and Parallel Processing. FPGA Architecture.	**8**
Module – II Transformation Techniques: Iteration bound, Retiming, Folding and Unfolding, Implementation of FGPA in DSP.	**8**
Module – III **Digital Filters:** Pipeline interleaving in digital filters, Pipelining and parallel processing for IIR filters, Low power IIR filter design using pipelining and parallel processing, Pipelined adaptive digital filters.	**8**
Module – IV **Algorithms for fast convolution:** Cook-Toom Algorithm, Cyclic Convolution. Algorithmic strength reduction in filters and transforms: Parallel FIR Filters, DCT and inverse DCT, Parallel Architectures for Rank-Order Filters.	**8**

Module – V **Synchronous, Wave, and Asynchronous Pipelines:** Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining, Implementation of wave-pipelined systems, Asynchronous pipelining.	**8**

Text Books:

1. K.K.Parhi, VLSI Digital Signal Processing Systems, John-Wiley, 2007

Reference Books:
1. U. Meyer -Baese, Digital Signal Processing with FPGAs, Springer, 2004
2. Wayne Burleson, Konstantinos Konstantinides, Teresa H. Meng, VLSI Signal
3. Processing,1996.
4. Richard J. Higgins, Digital signal processing in VLSI, 1990.
5. Sun Yuan Kung, Harper J. Whitehouse, VLSI and modern signal processing, 1985
6. Magdy A. Bayoumi, VLSI Design Methodologies for Digital Signal Processing, 2012
7. Earl E. Swartzlander, VLSI signal processing systems, 1986.
8. Recent literature in Optimizations of Digital Signal Processing Structures for VLSI.

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: PO8 will be met though report writing/presentation-based assignment

Topics beyond syllabus/Advanced topics/Design: Teaching through latest research paper
POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through paper

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment

First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	2	3	3	3	2	3	2	3	3	1
CO2	3	3	3	3	3	2	3	3	3	3	3	2	3	3	2
CO3	3	3	3	3	3	2	2	3	2	2	2	2	3	3	2
CO4	3	3	3	2	3	3	2	2	2	3	2	2	3	3	1
CO5	3	3	3	3	3	3	2	3	2	2	3	2	3	3	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		

CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC 385
Course Title: Physical Design Automation
Pre-requisite(s): Electronic devices, VLSI Systems
Co- requisite(s):
Credits: L: 3   T: 0   P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level:
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions imparting to students to:

1.	Recognize the requirement of VLSI design automation tools.
2.	Analyze the layout compaction, placement and routing in Chip design
3.	Understand the role of floor planning & routing in complex ICs design.
4.	Utilize the capability of EDA tools for analysis, simulations and logic synthesis of complex circuits.
5.	Show the high level synthesis for development of hardware model

Course Outcomes

After the completion of this course, students will be able to:

CO1	Recognize the importance of EDA tools for VLSI Circuit design.
CO2	Apply the knowledge of layout compaction, placement and routing for complex chip design.
CO3	Develop a floor planning & routing skills for complex ICs design.
CO4	Utilize the capability of EDA tools for analysis, simulations and logic synthesis of complex circuits.
CO5	Demonstrate the high level synthesis for development of hardware model

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **VLSI Design Automation:** Introduction of EDA Tools, algorithms and system design, Structural and logic design, Transistor level design, Layout design, Verification methods, Design management tools.	7
Module – II **Layout Design Techniques:** Layout compaction, placement and routing, Design rules, symbolic layout, Applications of compaction, Formulation methods, Algorithms for constrained graph compaction, Circuit representation, Wire length estimation, Placement algorithms, Partitioning algorithms.	9
Module – III **Floor Planning and Routing:** Floor planning concepts, Shape functions and floor planning sizing, local routing. Area routing, Channel routing, global routing and its algorithms.	8
Module – IV **Simulation and Logic Synthesis**: Gate level and switch level modeling and simulation, Introduction to combinational logic synthesis, ROBDD	8

principles, implementation, construction and manipulation, twolevel logic synthesis.	
Module – V **High-level Synthesis:** Hardware model for high level synthesis, Internal representation of input algorithms, Allocation, assignment and scheduling, Scheduling algorithms, Aspects of assignment, High Level transformations.	**8**

Text Books:

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley, 1998.
2. N.A.Sherwani, "Algorithms for VLSI Physical Design Automation", (3/e), Kluwer, 199.

Reference Books:
1. S.M. Sait, H. Youssef, "VLSI Physical Design Automation", World scientific, 1999.
2. M.Sarrafzadeh, "Introduction to VLSI Physical Design", McGraw Hill (IE), 1996.
3. Recent literature in Physical Design Automation.

    Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: PO8 will be met though report writing/presentation-based assignment

Topics beyond syllabus/Advanced topics/Design: Teaching through latest research paper
POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through paper

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	2	3	3	3	2	3	2	2	3	2
CO2	3	3	3	3	3	2	3	3	3	3	3	2	2	3	2
CO3	3	3	3	3	3	2	2	3	2	2	2	2	2	3	1
CO4	3	3	3	2	3	3	2	3	2	3	2	2	2	3	1
CO5	3	3	3	3	3	3	2	3	2	2	3	2	2	3	1

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD1 and CD9
CD3	Seminars	CO3	CD1, CD2 and CD3
CD4	Mini Projects/Projects	CO4	CD1 and CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1 and CD2
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

Course Code: EC387
Course Title: Wireless Communication
Pre-requisite(s):): Knowledge of analog and digital communication
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Six/Three
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

51.	An understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards and various multiple access techniques.
52.	An understanding on cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication.

53.	An ability to analyze different channel parameters, causes of impairments in signal propagation and impairment removal techniques.
54.	An ability to explain the architecture, functioning and protocols of various wireless communication networks.
55.	An ability to explain the capabilities and application of various wireless communication networks

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate an understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards and various multiple access techniques.
CO2	Demonstrate an understanding on cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication.
CO3	Analyze different channel parameters, causes of impairments in signal propagation and impairment removal techniques.
CO4	Explain the architecture, functioning and protocols of various wireless communication networks.
CO5	Explain the capabilities and application of various wireless communication networks.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Overview of wireless communication** An overview of wireless communication, future vision, history of wireless communication, EM spectrum, basic elements in wireless communication systems, wireless communication system and standards: satellite communication system, GPS, paging system, cordless phone, wireless local loop, RFID.	9

Module – II **Cellular communication and frequency reuse** General architecture of a cellular system, hand-off in a cellular system, co-channel interference and adjacent channel interference, power control, evolution of mobile cellular communication (1G, 2G. 2.5G, 3G and beyond), typical cellular standards (AMPS, GSM, GPRS, WCDMA, LTE, concept of LTE-advanced.	**9**
Module – III **Mobile cellular environment** Multipath propagation and fading, free space propagation model, propagation path loss, outdoor and indoor propagation models, channel parameters (delay spread, doppler spread, coherence bandwidth, coherence time, LCR and ADF).	**8**
Module – IV **Wireless communication networks** Wireless personal area networks (Bluetooth, UWB and ZigBee), wireless local area networks (IEEE 802.11, network architecture, medium access methods, WLAN standards), wireless metropolitan area networks (WiMAX), Ad-hoc wireless networks.	**8**
Module – V **Multiple access schemes** Duplexing schemes, FDMA, TDMA, SDMA, spread spectrum technique and CDMA, OFDMA, ALOHA and CSMA.	**6**

Text Books:

2. Vijay K Garg, "Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint)

Reference Books:

1. Simon Haykin and Michael Moher, "Modern Wireless Communications", Parson Education, Delhi, 2005
2. Sanjay Kumar, "Wireless Communication the Fundamental and Advanced Concepts" River Publishers, Denmark, 2015 (Indian reprint).

Gaps in the Syllabus (to meet Industry/Profession requirements) :Nil

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CO1	3	2	1	1	-	-	-	-	-	-	-	2	3	2	1
CO2	3	2	1	1	1	-	-	-	-	-	-	2	3	2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	2	3	2	1
CO4	3	3	3	4	2	-	-	-	-	-	-	2	3	2	3
CO5	3	3	3	4	2	-	-	-	-	-	-	2	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD8
CD2	Tutorials/Assignments	CO2	CD1 ,CD8
CD3	Seminars	CO3	CD1, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: EC389
Course Title: Radar Signal Analysis
Pre-requisite(s): Microwave Theory and Techniques
Co- requisite(s):
Credits: L: 3   T: 0   P: 0   C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Sixth/ third
Branch: Electronics & Communication Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

56.	To appraise an overview of Radar Systems.
57.	To perceive the Target Detection, Pulse Integration and Pulse Compression
58.	To grasp Matched Filter and Ambiguity Function-Analog and Discrete Coded Waveforms.
59.	To understand the concept of Radar Clutter.
60.	To grasp the Doppler and Adaptive Array Processing

Course Outcomes

After the completion of this course, students will be able to:

CO1	Able to explain the Radar Systems.
CO2	Able to demonstrate Target Detection, Pulse Integration and Pulse Compression
CO3	Able to explain Matched filter and Ambiguity Function-Analog and Discrete Coded Waveforms
CO4	Able to demonstrate the Radar Clutter

CO5	Able to demonstrate the Doppler and Adaptive Array Processing

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Radar Systems (an overview):** Range Measurements, Range Resolution, Doppler Frequency, Coherence, The Radar Equation, Surveillance Radar Equation, Radar Cross Section, Radar Equation with Jamming, Noise Figure Effects of the Earth's Surface on the Radar Equation, Atmospheric Attenuation,	10
Module – II **Target Detection, Pulse Integration and Pulse Compression:** Target Detection in the Presence of Noise, Probability of False Alarm, Probability of Detection, Pulse Integration, Target Fluctuating, Probability of False Alarm Formulation for a Square Law Detector, Probability of Detection Calculation, Computation of the Fluctuation Loss, Cumulative Probability of Detection, Constant False Alarm Rate (CFAR), Time-Bandwidth Product, Radar Equation with Pulse Compression, Basic Principal of Pulse Compression, Correlation Processor, Stretch Processor	10
Module – III	7

Matched Filter and Ambiguity Function:	
The Matched Filter SNR, Mean and Variance of the Matched Filter Output, General Formula for the Output of the Matched Filter, Waveform Resolution and Ambiguity, Range and Doppler Uncertainty, Target Parameter Estimation, Examples of the Ambiguity Function, Stepped Frequency Waveforms, Nonlinear FM Ambiguity Diagram Contours, Interpretation of Range-Doppler Coupling in LFM Signals, Discrete Code Signal Representation, Pulse-Train Codes, Phase Coding, Frequency Codes, Ambiguity Plots for Discrete Coded Waveforms	
Module – IV **Radar Clutter:** Clutter Cross Section Density, Surface Clutter, Volume Clutter, Clutter RCS, Clutter Spectrum, Moving Target Indicator (MTI), PRF Staggering, MTI Improvement Factor, Subclutter Visibility, Delay Line Cancelers with Optimal Weights	7
Module – V **Doppler and Adaptive Array Processing:** CW Radar Functional Block Diagram, Pulsed Radars, Introduction to Adaptive Array Processing, General Arrays, Linear Arrays, Nonadaptive Beamforming, Adaptive Array Processing	6

Text Books:

1. Bassem R. Mahafza, Radar Signal Analysis and Processing Using MATLAB, Chapman and Hall/CRC, 2008.

Reference Books:
1. M.I. Skolnik, "Introduction to Radar Systems" 3/e, TMH, New Delhi, 2001
2. Nathanson, F. E., Radar Design Principles, New York, McGraw-Hill, 2nd Edition, 1991
3. Toomay, J. C., Radar Principles for the Non-Specialist, New York, Van Nostrand, Reinhold, 1989
4. Buderi R., The Invention That Changed the World, New York, Simon and Schuster, 1996
5. R.J Sullivan, Radar foundation for imaging & advanced concepts, PHI, 2004.
6. Mark A Richards, Fundamentals of Radar Signal Processing,McGrah -Hill Company, 2005.

Gaps in the Syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus: PO8 will be met though report-writing/presentation-based assignment

Topics beyond syllabus/Advanced topics/Design : Teaching through paper

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through paper

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)	Program Specific

	1	2	3	4	5	6	7	8	9	10	11	12	Outcomes (PSOs)		
													13	14	15
CO1	3	3	3	2	2	1	1	3	2	3	3	3	3	2	1
CO2	3	3	3	2	2	1	1	3	2	3	3	3	3	2	2
CO3	3	3	3	2	2	1	1	3	2	3	3	3	3	2	1
CO4	3	3	3	2	2	1	1	3	2	3	3	3	3	2	3
CO5	3	3	3	2	2	1	1	3	2	3	3	2	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD8
CD2	Tutorials/Assignments	CO2	CD1 ,CD8
CD3	Seminars	CO3	CD1, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1,CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		