INSTITUTE OF ENGINEERING AND TECHNOLOGY
DEEN DAYAL UPADHYAYA GORAKHPUR UNIVERSITY, GORAKHPUR
(दीन दयाल उपाध्याय गोरखपुर विश्वविद्यालय, गोरखपुर)

COURSE STRUCTURE
&
SYLLABUS

FOR

B. TECH.

Electronics & Communication Engineering

ON

AICTE MODEL CURRICULUM

[Effective from the Session: 2024-25]

Curriculum for Bachelor of Technology
ELECTRONICS & COMMUNICATION ENGINEERING
Course structure & Semester-wise credit distribution

A. Structure of Bachelor of Technology (B. Tech) program:

Category	Breakup of Credits
Humanities and Social Sciences including Management courses	13
Basic Science courses	17
Basic Engineering courses including workshops, drawing, basics of Electrical/Electronics/mechanical/computer etc.	19
Department core courses	64
Department elective courses relevant to the chosen specialization/branch	12
Open subjects – Electives from other technical and /or emerging subjects	12
Project work, seminar, and internship in industry or elsewhere	21
Ability Enhancement Courses (AEC) offered by the university	08
Skill Enhancement Courses (SEC) offered by the university	09
Mandatory Non-Credit Courses: Environmental Science & Induction training	(**Non-Credit**)
Total	**175**

B. Category of Courses:

Basic Science Courses

S. No.	Course Code	Course Title	Credits
1.	ECHE101	Engineering Chemistry	3+0
2.	ECHE151	Engineering Chemistry Lab	0+1
3.	EPHY101	Engineering Physics	3+0
4.	EPHY151	Engineering Physics Lab	0+1
5.	EMAT101	Engineering Mathematics-I	3+0
6.	EMAT 102	Engineering Mathematics-II	3+0
7.	EMAT 201	Engineering Mathematics-III	3+0
Total			**17**

Basic Engineering Courses

S. No.	Course Code	Course Title	Credits
1.	ECE101	Basic Electronics Engineering	3+0
2.	ECE151	Basic Electronics Engineering Lab	0+1
3.	ECE102	Basic Electrical Engineering	3+0
4.	ECE152	Basic Electrical Engineering Lab	0+1
5.	ME101	Engineering Graphics & Design	0+2
6.	CSE101	Programming for Problem Solving	3+0
7.	CSE151	Programming for Problem Solving Lab	0+1
8.	ME102	Workshop Practices	0+2
9.	ME103	Fundamental of Mechanical Engineering and Mechatronics	3+0
Total			**19**

Humanities & Social Sciences Including Management

S. No.	Course Code	Course Title	Credits
1.	HSM101	Professional Communication	3+0
2.	HSM151	Professional Communication Lab	0+1
3.	HSM201	Managerial Economics	3+0
4.	HSM301	Organization Behavior	3+0
5.	HSM401	Universal Human Values-II: Understanding Harmony and Ethical Human Conduct	3+0
Total			**13**

ECE Department Courses

S. No.	Course Code	Course Title	Credits
1.	ECE201	Electronic Devices	3+0
2.	ECE251	Electronic Devices Lab	0+1
3.	ECE202	Digital Electronics & Logic Design	3+0
4.	ECE252	Digital Electronics & Logic Design Lab	0+1
5.	ECE203	Signals and Systems	3+0
6.	ECE204	Network Analysis and Synthesis	3+0
7.	ECE205	Probability Theory and Stochastic Processes	3+0
8.	ECE206	Analog Circuits	3+0
9.	ECE256	Analog Circuits Lab	0+1
10.	ECE207	Microprocessor & Microcontroller	4+0
11.	ECE257	Microprocessor & Microcontroller Lab	0+1
12.	ECE208	Engineering Electromagnetics	4+0
13.	ECE258	Engineering Electromagnetics Lab	0+1
14.	ECE301	Computer Architecture & Organization	3+0
15.	ECE302	Control Systems	3+0
16.	ECE303	Digital Signal Processing	4+0
17.	ECE353	Digital Signal Processing Lab	0+1
18.	ECE304	Analog and Digital Communication	3+0
19.	ECE354	Analog and Digital Communication Lab	0+1
20.	CSE304	Computer Networks	4+0
21.	CSE354	Computer Networks Lab	0+1
22.	ECE305	Embedded Systems	3+0
23.	ECE355	Embedded Systems Lab	0+1
24.	ECE306	Wireless and Mobile Communication	4+0
25.	ECE307	VLSI Design	4+0
26.	ECE357	VLSI Design Lab	0+1
Total			**64**

ECE Department Project work, Seminar and Internship in Industry

S. No.	Course Code	Course Title	Credits
1.	ECESI401	Seminar	0+2
2.	ECESI402	Internship	0+2
3.	ECEP201	Micro Project	0+2
4.	ECEP301	Mini Project	0+3
5.	ECEP401	Major Project	0+12
		Total Credits	**21**

ECE Department Elective Courses

Student has to adopt any one course from the list of each Elective

(Duration: 12 Weeks, **Credit:** 3)

S. No.	Course Code	Course Title	SME Name/Dept	Institute	NPTEL	Credits
Department Elective Course-1 (Sem-VI)						
1.	ECEL301	Information Theory and Coding	Dept. of ECE	IET,DDUGU	**NA**	3+0
	ECEL302	VLSI Technology	Dept. of ECE	IET,DDUGU	**NA**	
	ECEL303	Multirate DSP	Prof. R. David Koilpillai	IITM	https://onlinecourses.nptel.ac.in/noc20_ee21/preview	
	ECEL304	Circuit Analysis for Analog Designers	Prof. Shanthi Pavan	IITM	https://onlinecourses.nptel.ac.in/noc22_ee34/preview	
	ECEL305	Optical Fiber Sensors	Prof Balaji Srinivasan	IITM	https://onlinecourses.nptel.ac.in/noc21_ee40/preview	
Department Elective Course-2 (Sem-VII)						
2.	ECEL401	Nano Electronics	Dept. of ECE	IET,DDUGU	**NA**	3+0
	ECEL402	Speech Processing	Dept. of ECE	IET,DDUGU	**NA**	
	ECEL403	Microwave Engineering	Prof. Ratnajit Bhattacharjee	IITG	https://onlinecourses.nptel.ac.in/noc23_ee102/preview	
	ECEL404	Principles And Techniques of Modern Radar Systems	Prof. Amitabha Bhattacharya	IITKGP	https://onlinecourses.nptel.ac.in/noc23_ee133/preview	
	ECEL405	Introduction To Wireless and Cellular Communications	Prof. David Koilpillai	IITM	https://onlinecourses.nptel.ac.in/noc23_ee79/preview	
Department Elective Course-3 (Sem-VII)						
3.	ECEL406	Satellite Communication	Dept. of ECE	IET,DDUGU	**NA**	3+0
	ECEL407	Antennas and Wave Propagation	Dept. of ECE	IET,DDUGU	**NA**	
	ECEL408	Fiber Optic Communication Technology	Prof. Deepa Venkitesh	IITM	https://onlinecourses.nptel.ac.in/noc23_ee80/preview	
	ECEL409	C-Based VLSI Design	Prof. Chandan Karfa	IITG	https://onlinecourses.nptel.ac.in/noc23_cs114/preview	
	ECEL410	Digital Image Processing	Prof. Prabir Kumar Biswas	IITKGP	https://onlinecourses.nptel.ac.in/noc23_ee118/preview	
Department Elective Course-4 (Sem-VIII)						
4.	ECEL411	Wireless Sensor Networks	Dept. of ECE	IET, DDUGU	**NA**	3+0
	ECEL412	High Speed Electronics	Dept. of ECE	IET, DDUGU	**NA**	
	ECEL413	Machine Learning for Engineering and science applications	Prof. Balaji Srinivasan and Prof. Ganapathy	IITM	https://onlinecourses.nptel.ac.in/noc19_cs82/preview	
	ECEL414	Optical Wireless Communications for Beyond 5G Networks and IoT	Prof. Anand Srivastava	IIITD	https://onlinecourses.nptel.ac.in/noc23_ee61/preview	
	ECEL415	An Introduction to Artificial Intelligence	Prof. Mausam	IIITD	https://onlinecourses.nptel.ac.in/noc22_cs56/preview	
Total						**12**

Note- *If required, the Department may also offer suitable additional elective courses (12 week duration or having 3 credits only) based on the available Online mode from SWAYAM (only from NPTEL Domain)*.

Link: ***https://archive.nptel.ac.in/noc/NPTELSemester.html***

Mandatory Non-Credit (NC) Courses

S. No.	Course Code	Course Title	Credits
1.	--	Induction Program (3-weeks)	---
2.	ENV201	Environment & Ecology	2+0 (**NC**)

Mandatory Student Induction Program

The Essence and Details of Induction program can also be understood from the 'Detailed Guide on Student Induction program', as available on AICTE Portal.
(Link: **https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf**).

Induction program (mandatory)	Three-week duration
Induction program for students to be offered right at the start of the first year.	Physical activity
	Creative Arts
	Universal Human Values-I
	Literary
	Proficiency Modules
	Lectures by Eminent People
	Visits to local Areas
	Familiarization to Dept./Branch & Innovations

Engineering Open Elective Courses

The student can opt any engineering open elective subject(s) that are offered in a particular semester, except the subject(s) with his/ her own department code.

S. No.	Department	Course Code	Course Title	Credits	
1.	ECE	ECOE01	Introduction to Microcontrollers and Embedded Systems	3+0	Engineering Open Elective Course-1
	IT	ITOE01	Introduction to OOP with C++		
	CSE	CSEOE01	Web Technology		
	ME	MEOE01	Renewable Energy Resources		
2.	ECE	ECOE02	Introduction To MEMs	3+0	Engineering Open Elective Course-2
	IT	ITOE02	Introduction to Virtualization and Cloud Computing		
	CSE	CSEOE02	Web Application Development using Python		
	ME	MEOE02	Advanced Manufacturing Techniques		
3.	ECE	ECOE03	Digital VLSI Design	3+0	Engineering Open Elective Course-3
	IT	ITOE03	Cyber Law and Ethics		
	CSE	CSEOE03	Front-End Technologies		
	ME	MEOE03	Maintenance Engineering and Management		
4.	ECE	ECOE04	Wireless Communication and Networks	3+0	Engineering Open Elective Course-4
	IT	ITOE04	Internet of Things		
	CSE	CSEOE04	Back-End Technologies		
	ME	MEOE04	Operation Research		

Note:

1. *If required, the student can earn the credit through Online mode from SWAYAM (only from NPTEL Domain)* ***Link:*** ***https://archive.nptel.ac.in/noc/NPTELSemester.html*** *offered by the Department.*
2. *Department may also offer suitable additional engineering open elective courses (12 week duration or having 3 credits only) based on the available Online mode from SWAYAM (only from NPTEL Domain).*

AEC and SEC Offered by the University for Implementation of NEP2020 (University Mandatory Course)

The university offers a pool of courses for AEC and SEC to implement NEP2020. The student has to select one course under the SEC category in the first, second, and third semesters (repetition of courses is not allowed). In the same context, the student has to select one course under the AEC category in the first, second, third, and fourth semesters (repetition of courses is not allowed).

As per **NEP2020**, year-wise credit requirements for the award of ***"Certificate in Electronics & Communication Engineering"***, ***"Diploma in Electronics & Communication Engineering"***, ***"Bachelor of Vocation (B. Voc.) in Electronics & Communication Engineering"***, and ***"B. Tech. in Electronics & Communication Engineering"*** are given below:

After Year	Credit Requirement	Credit Distribution	Eligibility of
1st	47	*After earning 47 credits in the first year (22 credits in the first semester and 25 credits in the second semester)*	Certificate in ***Electronics & Communication Engineering***
2nd	93	*47 credits from the first year and 46 credits in the second year (22 credits in the third semester and 24 credits in the fourth semester)*	Diploma in ***Electronics & Communication Engineering***
3rd	138	*47 credits from the first year 46 credits in the second year and 45 credits in the third year (23 credits in the fifth semester and 22 credits in the sixth semester)*	Bachelor of Vocation (B. Voc.) in ***Electronics & Communication Engineering***
4th	175	*47 credits from the first year 46 credits in the second year, 45 credits in the third year, and 37 credits in the fourth year (16 credits in the seventh semester and 21 credits in the eighth semester)*	Bachelor of Technology (B. Tech.) in ***Electronics & Communication Engineering***

Bachelor of Technology

ELECTRONICS & COMMUNICATION ENGINEERING

Course Structure

	Semester I				
	S. No.	**Category**	**Course Code**	**Course Title**	**Credits**
First Year	**1.**	Basic Science Course	ECHE101	Engineering Chemistry	3+0
	2.	Basic Science Course	EMAT101	Engineering Mathematics-I	3+0
	3.	Humanities and Social Sciences including Management Course	HSM101	Professional Communication	3+0
	4.	Basic Engineering Course	ECE101	Basic Electronics Engineering	3+0
	5.	Basic Science Course	ECHE151	Engineering Chemistry Lab	0+1
	6.	Humanities and Social Sciences including Management Course	HSM151	Professional Communication Lab	0+1
	7.	Basic Engineering Course	ECE151	Basic Electronics Engineering Lab	0+1
	8.	Basic Engineering Course	ME101	Engineering Graphics & Design	0+2
	9.			Induction Program	
	10.	SEC Course		**SEC-x**	03
	11.	AEC Course		**AEC-x**	02
				Total credits	**22**
	The students have to choose one course from each (SEC, and AEC)				

	Semester II				
	S. No.	**Category**	**Course Code**	**Course Title**	**Credits**
First Year	**1.**	Basic Science Course	EPHY101	Engineering Physics	3+0
	2.	Basic Science Course	EMAT 102	Engineering Mathematics-II	3+0
	3.	Basic Engineering Course	CSE101	Programming for Problem Solving	3+0
	4.	Basic Engineering Course	ECE102	Basic Electrical Engineering	3+0
	5.	Basic Engineering Course	ME103	Fundamental of Mechanical Engineering and Mechatronics	3+0
	6.	Basic Science Course	EPHY151	Engineering Physics Lab	0+1
	7.	Basic Engineering Course	CSE151	Programming for Problem Solving Lab	0+1
	8.	Basic Engineering Course	ECE152	Basic Electrical Engineering Lab	0+1
	9.	Basic Engineering Course	ME102	Workshop Practices	0+2
	10.	**SEC Course**		**SEC-x**	**03**
	11.	**AEC Course**		**AEC-x**	**02**
				Total credits	**25**
	The students have to choose one course from each (SEC, and AEC)				

	Semester III				
	S. No.	**Category**	**Course Code**	**Course Title**	**Credits**
Second Year	**1.**	Department Course	ECE201	Electronic Devices	3+0
	2.	Department Course	ECE202	Digital Electronics & Logic Design	3+0
	3.	Department Course	ECE203	Signals and Systems	3+0
	4.	Department Course	ECE204	Network Analysis and Synthesis	3+0
	5.	Department Course	ECE205	Probability Theory and Stochastic Processes	3+0
	6.	Department Course	ECE251	Electronic Devices Lab	0+1
	7.	Department Course	ECE252	Digital Electronics & Logic Design Lab	0+1
	8.	ENV201	ENV201	Environment & Ecology	2+0 (**NC**)
	9.	**SEC Course**		**SEC-x**	**03**
	10.	**AEC Course**		**AEC-x**	**02**
				Total credits	**22**
	The students have to choose one course from each (SEC, and AEC)				

	Semester IV				
	S. No.	**Category**	**Course Code**	**Course Title**	**Credits**
Second Year	**1.**	Department Course	ECE206	Analog Circuits	3+0
	2.	Department Course	ECE207	Microprocessor & Microcontroller	4+0
	3.	Department Course	ECE208	Engineering Electromagnetics	4+0
	4.	Basic Science Course	EMAT201	Engineering Mathematics-III	3+0
	5.	Humanities and Social Sciences including Management Course	HSM201	Managerial Economics	3+0
	6.	Department Course	ECE256	Analog Circuits Lab	0+1
	7.	Department Course	ECE257	Microprocessor & Microcontroller Lab	0+1
	8.	Department Course	ECE258	Engineering Electromagnetics Lab	0+1
	9.	Department Course	ECEP201	Micro Project	0+2
	10.	**AEC Course**		**AEC-x**	**02**
				Total credits	**24**
	The students have to choose one course from AEC				

Third Year	Semester V				
	S. No.	**Category**	**Course Code**	**Course Title**	**Credits**
	1.	Department Course	ECE301	Computer Architecture & Organization	3+0
	2.	Department Course	ECE302	Control Systems	3+0
	3.	Department Course	ECE303	Digital Signal Processing	4+0
	4.	Department Course	ECE304	Analog and Digital Communication	3+0
	5.	Department Course	CSE304	Computer Network	4+0
	6.	Humanities and Social Sciences including Management Course	HSM301	Organization Behaviour	3+0
	7.	Department Course	ECE353	Digital Signal Processing Lab	0+1
	8.	Department Course	ECE354	Analog and Digital Communication Lab	0+1
	9.	Department Course	CSE354	Computer Network Lab	0+1
				Total credits	**23**

Third Year	Semester VI				
	S.No.	**Category**	**Course Code**	**Course Title**	**Credits**
	1.	Department Course	ECE305	Embedded Systems	3+0
	2.	Department Course	ECE306	Wireless and Mobile Communication	4+0
	3.	Department Course	ECE307	VLSI Design	4+0
	4.	Department Course	ECEL#	Department Elective Course-1	3+0
	5.	Department Elective Course	EOE*	Engineering Open Elective Course-1	3+0
	6.	Department Course	ECE355	Embedded Systems Lab	0+1
	7.	Department Course	ECE357	VLSI Design Lab	0+1
	8.	Department Course	ECEP301	Mini Project	0+3
				Total credits	**22**
	• *ECEL#: One course to be selected from the Department Elective Courses* • *EOE*: Only one Course is to be selected from the list of Engineering Open Elective Courses*				

	Semester VII				
	S. No.	**Category**	**Course Code**	**Course Title**	**Credits**
Fourth Year	**1.**	Department Elective Course	ECEL#	Department Elective Course-2	3+0
	2.	Department Elective Course	ECEL#	Department Elective Course-3	3+0
	3.	Department Elective Course	EOE*	Engineering Open Elective Course-2	3+0
	4.	Humanities and Social Sciences including Management Course	HSM401	Universal Human Values-II: Understanding Harmony and Ethical Human Conduct	3+0
	5.	Department Course	ECESI401	Seminar	0+2
	6.		ECESI402	Internship	0+2
				Total credits	**16**
	• *ECEL#: One course to be selected from the Department Elective Courses* • *EOE*: Only one Course is to be selected from the list of Engineering Open Elective Courses*				

	Semester VIII				
	S.No.	**Category**	**Course Code**	**Course Title**	**Credits**
Fourth Year	**1.**	Department Elective Course	ECEL#	Department Elective Course-4	3+0
	2.	Engineering Open Elective Course	EOE*	Engineering Open Elective Course-3	3+0
	3.	Engineering Open Elective Course	EOE*	Engineering Open Elective Course-4	3+0
	4.	Department Elective Course (Project)	ECEP401	Major Project	0+12
				Total credits	**21**
	• *ECEL#: One course to be selected from the Department Elective Courses* • *EOE*: Only one course to be selected from the list of Engineering Open Elective Courses*				

Note: Students who have joined the jobs can earn credits from MOOCS courses in the 7th and 8th semester. (*Subjects may vary according to the availability of courses. In case of any change, HoD and/or Coordinator will issue a separate list of subjects.)

Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credit	22	25	22	24	23	22	16	21	**175**

Detailed B. Tech ECE Curriculum Contents

Basic Electronics Engineering			
Course code	ECE101		
Category	Basic Engineering Course		
Course title	**Basic Electronics Engineering (Theory)**		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	**-**		
Course Objective: To introduce the basic concept of Electronics engineering to the students			
Unit-1	**PN junction diode:** Introduction of Semiconductor Materials, Semiconductor Diode, Depletion layer, V-I characteristics, ideal and practical, Transition and Diffusion Capacitance, Diodes breakdown mechanism (Zener and avalanche) Diode Application, Series and Parallel Diode Configuration, Half and Full Wave rectification, Clippers, Clampers, Zener diode as shunt regulator, Voltage-Multiplier Circuits, Light-Emitting Diodes, Liquid-Crystal Displays.		**09 (Lectures)**
Unit-2	**Bipolar Junction Transistors and Field Effect Transistor:** Bipolar Junction Transistor, Transistor Construction, Operation, Amplification action. Common Base, Common Emitter, Common Collector Configuration **DC Biasing BJTs:** Operating Point, Fixed-Bias, Emitter Bias, Voltage-Divider Bias Configuration. Collector Feedback, Emitter-Follower Configuration. Bias Stabilization, CE, CB, CC amplifiers. **Field Effect Transistor**, Construction and Characteristics of JFETs. **MOSFET** (Depletion and Enhancement) Type, Transfer Characteristics.		**09 (Lectures)**
Unit-3	**Operational Amplifiers**, Introduction and Block diagram of Op Amp, Ideal & Practical characteristics of Op-Amp, Differential amplifier circuits, Practical Op- Amp Circuits (Inverting Amplifier, Non inverting Amplifier, Unity Gain Amplifier, Summing Amplifier, Integrator, Differentiator).		**09 (Lectures)**
Unit-4	**Electronic Instrumentation and Measurements:** Digital Voltmeter, Basic Principle and Block Diagram of Oscilloscope, Simple CRO, Measurement of voltage, current phase and frequency using CRO. Introduction of Digital Storage Oscilloscope. **Fundamentals of Communication Engineering**, Elements of a Communication System, Need of Modulation, Electromagnetic spectrum and typical applications. Introduction of various analog modulation techniques.		**09 (Lectures)**

Text Books:

1. Robert L. Boylestand / Louis Nashelsky "Electronic Devices and Circuit Theory", Latest Edition, Pearson Education.
2. H S Kalsi, "Electronic Instrumentation", Latest Edition, TMH Publication,.
3. George Kennedy, "Electronic Communication Systems", Latest Edition, TMH,

Reference Books:

1. David A. Bell, "Electronic Devices and Circuits", Latest Edition, Oxford University Press.
2. Jacob Millman, C.C. Halkias, Staya brataJit, "Electronic Devices and Circuits", Latest Edition , TMH.
3. David A. Bell, Electronic Instrumentation and Measurements, Latest Edition, Oxford University Press India.

Basic Electronics Engineering Lab			
Course code	ECE151		
Category	Basic Engineering Course		
Course title	**Basic Electronics Engineering Lab (Laboratory)**		
Scheme and Credits	**Credits**	**0+1**	
Pre-requisites (if any)	**-**		

EXP No.	**Experiment**
EXP-1	Study of Power Supply, Active and Passive Components, and Bread Board.
EXP-2	Study of CRO, DSO, Multimeter, and Function generator.
EXP-3	Study of CRO, Multimeter, and function generator
EXP-4	To plot V-1 Characteristics of PN Junction Diode.
EXP-5	To plot V-I characteristics of the Zener diode.
EXP-6	To study the operation of a Half wave rectifier and Measurement of V_{rms}, V_{dc}, and ripple factor
EXP-7	To study the operation of a Full wave rectifier and Measurement of V_{rms}, V_{dc}, and ripple factor
EXP-8	To plot the Characteristics of a BJT in a Common Emitter Configuration.
EXP-9	To plot the Characteristics of a BJT in Common Base Configuration.
EXP-10	To study Drain Characteristics and Transfer Characteristics of a Junction Fiel Effect Transistor (JFET).
EXP-11	To study Operational Amplifier as Adder and Subtractor
EXP-12	To study clipping & clamping circuits.

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Basic Electrical Engineering			
Course code	ECE102		
Category	Basic Engineering Course		
Course title	**Basic Electrical Engineering (Theory)**		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	**-**		

Course Objective:

- To understand the electrical circuit fundamentals.
- Attain proficiency in analyzing single-phase AC circuits, exploring resonance phenomena, power factor concepts, and methods for power factor improvement.
- To understand how the power supply and load are balanced, and how to measure power.

Unit-1	**Electrical Circuit Analysis:** Introduction, Circuit Concepts, Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation, AC fundamentals, Sinusoidal, square and triangular waveforms, Average and effective values, Form and peak factors, Concept of phasors, phasor representation of sinusoidally varying voltage and current.	**09 (Lectures)**
Unit-2	**Network theorems (AC & DC with independent sources):** Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem (Simple numerical problems) **Steady-State Analysis of Single-phase AC circuits:** Analysis of series and parallel RLC Circuits, Concept of Resonance in series & parallel circuits, bandwidth and quality factor; Apparent, active & reactive powers, Power factor, Concept of power factor improvement and its improvement (Simple numerical problems).	**09 (Lectures)**
Unit-3	**Three-phase AC circuit:** Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, three-phase power, and its measurement. **Measuring instruments:** Types of instruments, Construction and working principles of PMMC and moving iron type voltmeters & ammeters, Single phase dynamometer wattmeter, Use of shunts and multipliers (Simple numerical problems on shunts and multipliers), Single phase energy meter.	**09 (Lectures)**
Unit-4	**Magnetic circuit:** Concept of magnetic circuit, circuit analogy between electric and magnetic circuit, B-H curve, hysteresis and eddy current losses, Magnetic circuit calculation(Series and Parallel). **Electrical Machines:** Principle of operation, Construction, EMF equation, Phasor diagram, Equivalent circuit, Power losses, Efficiency (Simple numerical problems) of DC Machine, Single phase Transformer, Three phase Transformer, Single Phase Induction Machine , Three Phase Induction machine and Alternator. **Power system:** Basic concepts of electrical power generation, ac and dc transmission concepts, Models and performance of transmission lines and cables, Symmetrical and unsymmetrical fault analysis, Circuit breakers	**09 (Lectures)**

Text/Reference Books

1. Franklin F. Kuo, "Network Analysis and Synthesis," Wiley India Education, 2nd Ed., 2006.
2. Van, Valkenburg, "Network analysis," Pearson, 2019.
3. Sudhakar, A., Shyammohan, S. P., "Circuits and Network," Tata McGraw-Hill NewDelhi, 1994.
4. A William Hayt, "Engineering Circuit Analysis," 8th Edition, McGraw-Hill Education.
5. A. Anand Kumar, "Network Analysis and Synthesis," PHI publication, 2019.

Course Outcomes:

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

CO1. Understand basics electrical circuits with nodal and mesh analysis.
CO2. Appreciate electrical network theorems.
CO3. Apply Laplace transform for steady-state and transient analysis.
CO4. Determine different network functions.
CO5. Appreciate the frequency domain techniques.

Basic Electrical Engineering Lab		
Course code	ECE152	
Category	Department Course	
Course title	**Basic Electrical Engineering Lab** (Laboratory)	
Scheme and Credits	**Credits**	**0+1**
Pre-requisites (if any)	-	

EXP No.	**Experiment**
EXP-1	Verification of Superposition theorem
EXP-2	Verification of Thevenin's Theorem and Maximum Power Transfer Theorem.
EXP-3	Measurement of power and power factor in a single-phase ac series inductive circuit and study improvement of power factor using capacitor
EXP-4	Study of phenomenon of resonance in RLC series circuit and obtain resonant frequency.
EXP-5	Connection and measurement of power consumption of a fluorescent lamp (tube light).
EXP-6	Measurement of power in 3- phase circuit by two wattmeter method and determination of its power factor for star as well as delta connected load.
EXP-7	Determination of parameters of ac single phase series RLC circuit
EXP-8	To observe the B-H loop of a ferromagnetic material in CRO.
EXP-9	Determination of (i) Voltage ratio (ii) polarity and (iii) efficiency by load test of a single-phase transformer
EXP-10	Determination of efficiency of a dc shunt motor by load test
EXP-11	To study running and speed reversal of a three-phase induction motor

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Electronics Devices		
Course code	ECE201	
Category	Department Course	
Course title	**Electronics Devices** (Theory)	
Scheme and Credits	**Credits**	**3+0**
Pre-requisites (if any)	-	

Course Objective:

- To introduce the concept of Basic crystal properties.
- To introduce the concept of semiconductor physics and its fundamentals.
- To introduce the concept of carrier transport in semiconductors and design resistors.
- To introduce semiconductor devices BJT, MOS capacitor and MOSFET, their characteristics, and operations.
- To analyze and interpret MOSFET circuits for small signal at low and high frequencies.
- To study the different types of optoelectronic devices.

Unit-1	Crystal Properties: Elemental and compound semiconductor materials, crystal lattice structure; Introduction to semiconductor physics: Review of quantum mechanics, electrons in periodic lattices, E-k diagrams.	**9 (Lectures)**
Unit-2	Energy bands in intrinsic and extrinsic silicon, carrier transport, diffusioncurrent, drift current, mobility and resistivity, sheet resistance, design of resistors.	**9(Lectures)**
Unit-3	Generation and recombination of carriers, Poisson and continuity equation P-N junction characteristics, I-V characteristics, and small signal switching models, Avalanche breakdown, Zener diode, Schottky diode, Photodiodes, solar cell, light emitting diodes, semiconductor lasers, light emitting materials.	**9(Lectures)**
Unit-4	**Transistors:** MOS capacitor: C-V characteristics; MOSFET: I-V characteristics, and small signal models of MOS transistor; Bipolar Junction Transistor: I-V characteristics, Ebers-Moll model.	**9 (Lectures)**

Text /Reference Books:

1. G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson,2014.
2. D. Neamen, D. Biswas, "Semiconductor Physics and Devices," McGraw-Hill Education.
3. S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices,” 3rd edition, John Wiley&Sons, 2006.
4. C.T. Sah, “Fundamentals of Solid State Electronics,” World Scientific Publishing Co. Inc,1991.
5. Y. Tsividis and M. Colin, “Operation and Modeling of the MOS Transistor,” Oxford univ.press, 2011.
6. Muhammad H. Rashid, “Electronic Devices and Circuits,” Cengage publication, 2014.

Course Outcomes:

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

CO1. Understand the principles of semiconductor Physics.
CO2. Understand and utilize the mathematical models of semiconductor junctions.
CO3. Understand carrier transport in semiconductors and design resistors.
CO4. Utilize the mathematical models of MOS transistors for circuits and systems.
CO5. Analyze and find application of special purpose devices.
CO6. Understand working of basic electronics lab equipment.
CO7. Understand working of Diode, BJT, FET, MOSFET and apply the concept in designing of amplifiers.

Electronics Devices Lab		
Course code	ECE251	
Category	Department Course	
Course title	**Electronics Devices Lab** (Laboratory)	
Scheme and Credits	**Credits**	**0+1**
Pre-requisites (if any)	-	

EXP No.	**Experiment**	**Virtual Lab Link**
EXP-12	**Study of Lab Equipment and Components:** CRO, multimeter, and function generator, power supply- active, passive components and bread board.	http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAE/exp1/index.html & https://be-iitkgp.vlabs.ac.in/List%20of%20experiments.html
EXP-13	To Determine Energy Band Gap of Semiconductor	https://bop-iitk.vlabs.ac.in/exp/energy-band-gap/
EXP-14	**P-N Junction diode:** To study the V-I Characteristics of a Diode	http://vlabs.iitkgp.ernet.in/be/exp5/index.html
EXP-15	**Applications of PN Junction diode:** Half wave rectifier-Measurement of V_{rms}, V_{dc}, and ripple factor.	http://vlabs.iitkgp.ernet.in/be/exp6/index.html
EXP-16	**Applications of PN Junction diode:** Full wave rectifier-Measurement of V_{rms}, V_{dc}, and ripple factor.	http://vlabs.iitkgp.ernet.in/be/exp7/index.html
EXP-17	**Characteristics of Zener diode:** V-I characteristics of Zener diode.	https://be-iitkgp.vlabs.ac.in/exp/voltage-regulator/
EXP-18	**Characteristics of Solar cell:** V-I characteristics of solar cell, graphical measurement of forward and reverse resistance.	https://vlab.amrita.edu/?sub=1&brch=195&sim=360&cnt=1
EXP-19	**Application of Zener diode:** Zener diode as voltage regulator.	https://be-iitkgp.vlabs.ac.in/exp/voltage-regulator/
EXP-20	To study the BJT Common Emitter Characteristics	http://vlabs.iitkgp.ernet.in/be/exp11/index.html
EXP-21	To study the BJT Common Base Characteristics	https://be-iitkgp.vlabs.ac.in/exp/common-base-characteristics/
EXP-22	Studies on BJT CE Amplifier	https://be-iitkgp.vlabs.ac.in/exp/ce-amplifier/
EXP-23	The aim of this experiment is to plot (i) the output characteristics and, (ii) the transfer characteristics of an n-channel and p-channel MOSFET.	https://vlsi-iitg.vlabs.ac.in/MOSFET_theory.html

***Note:** Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Digital Electronics & Logic Design		
Course code	ECE202	
Category	Department Course	
Course title	**Digital Electronics & Logic Design** (Theory)	
Scheme and Credits	**Credits**	**3+0**
Pre-requisites (if any)	**-**	

Course Objective:

- To introduce the concept of digital and binary systems
- To analyze and design MSI devices.
- To understand the different Logic families and semiconductor memories

Unit-1	Logic simplification and combinational logic design: Binary codes, code conversion, review of Boolean algebra and Demorgan's theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, tabulationmethod. MSI devices like comparators, multiplexers, encoder, decoder, driver & multiplexed display, half and full adders, subtractors, serial and paralleladders, BCD adder, barrel shifter and ALU.	**9 (Lectures)**
Unit-2	Sequential logic design: Building blocks like S-R, JK and Master-Slave JK FF, edge triggered FF, state diagram, state reduction, design of sequential circuits, ripple and synchronous counters, shift registers, finite state machines, design of synchronous FSM, algorithmic state machines charts. Designing synchronous circuits like pulse train generator, pseudo random binary sequence generator, clock generation.	**9(Lectures)**
Unit-3	Logic families and semiconductor memories: TTL NAND gate,specifications, noise margin, propagation delay, fan-in, fan-out, tristate TTL, ECL, CMOS families and their interfacing, memory elements, concept of programmable logic devices like FPGA, logic implementation using programmable devices.	**9(Lectures)**
Unit-4	**Digital-to-Analog converters (DAC):** Weighted resistor, R-2R ladder, resistor string etc. **analog-to-digital converters (ADC):** single slope, dual slope, successive approximation, flash etc. switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.	**9 (Lectures)**

Text/Reference Books:

1. R.P. Jain, "Modern Digital Electronics," Tata McGraw Hill, 4th edition, 2009.
2. A. Anand Kumar, "Fundamental of Digital Circuits," PHI 4th edition, 2018.
3. W.H. Gothmann, "Digital Electronics- An Introduction to Theory and Practice," PHI, 2nd edition, 2006.
4. D.V. Hall, "Digital Circuits and Systems," Tata McGraw Hill, 1989.
5. A. K. Singh, "Foundation of Digital Electronics & Logic Design," New Age Int.Publishers.
6. Subrata Ghosal, "Digital Electronics," Cengage publication, 2nd edition, 2018

Course outcomes:

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

CO1. Design and analyze combinational logic circuits.
CO2. Design and analyze modular combinational circuits with MUX / DEMUX, Decoder & Encoder
CO3. Design & analyze synchronous sequential logic circuits.
CO4. Analyze various logic families.
CO5. Design ADC and DAC and implement in amplifier, integrator, etc.
CO6. Design & build mini project using digital ICs.

Digital Electronics & Logic Design Lab			
Course code	ECE252		
Category	Department Course		
Course title	**Digital Electronics & Logic Design Lab** (Laboratory)		
Scheme and Credits	**Credits**	**0+1**	
Pre-requisites (if any)	-		

EXP No.	Experiment	Virtual Lab Link
EXP-1	Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates	https://de-iitr.vlabs.ac.in/exp/truth-table-gates/
EXP-2	Implementation of the given Boolean function using logic gates in both SOP and POS forms.	http://ebootathon.com/labs/beta/ec/DIGITAL_SYSTEM_DESIGN_LAB/exp1/simulation.html & https://www.iitg.ac.in/cseweb/vlab/Digital-System-Lab/login.php **(REQUIRES LOGIN)**
EXP-3	To Study and Verify Half and Full Subtractor	https://de-iitr.vlabs.ac.in/exp/half-full-subtractor/
EXP-4	Verification of state tables of RS, JK, T and D flip-flops using NAND & NOR gates.	https://de-iitr.vlabs.ac.in/exp/truth-tables-flip-flops/ &
EXP-5	Implementation and verification of Decoder using logic gates.	https://de-iitr.vlabs.ac.in/exp/decoder-demultiplexer-encoder/
EXP-6	Implementation and verification of Encoder using logic gates.	https://de-iitr.vlabs.ac.in/exp/decoder-demultiplexer-encoder/
EXP-7	Implementation of 4:1 multiplexer using logic gates.	https://de-iitr.vlabs.ac.in/exp/multiplexer-demultiplexer/theory.html
EXP-8	Implementation of 1:4 demultiplexer using logic gates.	https://de-iitr.vlabs.ac.in/exp/multiplexer-demultiplexer/theory.html
EXP-9	Implementation of 4-bit parallel adder using 7483 IC.	https://dld-iitb.vlabs.ac.in/exp/binary-adder-implementation/theory.html
EXP-10	Design, and verify the 4-bit synchronous counter.	https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter/theory.html
EXP-11	Design, and verify the 4-bit asynchronous counter.	https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter/theory.html
EXP-12	Implementation of Mini Project using digital integrated circuits and other components.	

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Signals and Systems			
Course code	ECE203		
Category	Department Course		
Course title	**Signals and Systems** (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:

- To introduce the basic concept of signal and systems.
- To analyze the systems in frequency and time domain.

Unit-1	**Signals:** Definition, types of signals and their representations: continuous-time/discrete-time, periodic/non-periodic, even/odd, energy/power, deterministic/ random, one dimensional/multidimensional; commonly used signals (in continuous-time as well as in discrete-time): unit impulse, unit step, unit ramp (and their interrelationships), exponential, rectangular pulse, sinusoidal; operations on continuous-time and discrete-time signals (including transformations of independent variables).	**9 (Lectures)**
Unit-2	**Laplace-Transform (LT):** One-sided LT of some common signals, important theorems and properties of LT, inverse LT, solutions of differential equations using LT, Bilateral LT, Regions of convergence (ROC). **Z-transform (ZT):** One sided and Bilateral Z-transforms, ZT of some common signals, ROC, Properties and theorems, solution of difference equations using one-sided ZT, s- to z-plane mapping. **Fourier Transforms (FT):** Definition, conditions of existence of FT, properties, magnitude and phase spectra, Some important FT theorems, Parseval's theorem, Inverse FT, relation between LT and FT. **Discrete time Fourier transform (DTFT):** Definition, properties, inverse DTFT, convergence, properties and theorems, Comparison between continuous time FT and DTFT.	**11(Lectures)**
Unit-3	**Systems:** Classification, linearity, time-invariance and causality, impulse response, characterization of linear time-invariant (LTI) systems, unit sample response, convolution summation, step response of discrete time systems, stability. convolution integral, signal energy and energy spectral density, signal power and power spectral density, properties of power spectral density, co-relations.	**9(Lectures)**
Unit-4	**Time and frequency domain analysis of systems:** Analysis of first order and second order systems (continuous-time & discrete-time), continuous-time (CT) system analysis using LT, Laplace Transfer Function- poles and zeros.	**7 (Lectures)**

Text/Reference books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems," Pearson, 2015.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete," 4th edition, Prentice Hall, 1998.
3. B.P. Lathi, "Signal Processing and Linear Systems," Oxford University Press, 1998.
4. Douglas K. Lindner, "Introduction to Signals and Systems," McGraw Hill InternationalEdition: 1999.
5. Simon Haykin, Barry van Veen, "Signals and Systems," John Wiley and Sons (Asia)Private Limited, 1998.
6. V. Krishnaveni, A. Rajeswari, “"Signals and Systems," Wiley India Private Limited,2012.
7. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems," John Wiley andSons, 1995.
8. M. J. Roberts, "Signals and Systems - Analysis using Transform methods andMATLAB," TMH, 2003.
9. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems," TMH New Delhi,2001.
10. Anand Kumar, “Signals and Systems,” PHI 3rd edition, 2018.
11. D. Ganesh Rao, K.N. Hari Bhat, K. Anitha Sheela, “Signal, Systems, and StochasticProcesses,” Cengage publication, 2018.

Course outcomes:

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

CO1. Analyze different types of signals.
CO2. Analyze linear time-invariant (LTI) systems.
CO3. Represent continuous and discrete systems in time and frequency domain.
CO4. Analyze discrete time signals in z-domain.
CO5. Find the stability of the system using pole-zero diagrams and block diagrams.

Network Analysis and Synthesis			
Course code	ECE204		
Category	Department Course		
Course title	**Network Analysis and Synthesis** (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:

- To understand the basic concept of electrical circuits.
- To analyze the Circuits in time and frequency domain
- To study network Topology, network Functions, two port network.
- To synthesize passive network by various methods.

Unit-1	Node and mesh analysis, matrix approach of network containing voltage & current sources and reactances, source transformation and duality. **Network Theorems:** Superposition, reciprocity, Thevenin's, Norton's, Maximum power transfer, compensation and Tellegan's theorem as applied to A.C. circuits.	**9 (Lectures)**
Unit-2	Review of Laplace transforms, poles and zeroes, initial and final value theorems, The transform circuit, the system function, step and impulse responses, the convolution integral. Amplitude and phase responses. Network functions, relation between port parameters, transfer functions using two port parameters, interconnection of two ports.	**9(Lectures)**
Unit-3	Hurwitz polynomials, positive real functions. Properties of real immittance functions, synthesis of LC driving point immittances, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances.	**9(Lectures)**
Unit-4	Concept of Poles and Zeroes on the stability, Properties of Open Circuit and Short Circuit Parameters, Zeroes of transmission, Synthesis of Y21 and Z21 with 1Ω terminations, Introduction to active network synthesis.	**9 (Lectures)**

Text/Reference Books

1. Franklin F. Kuo, "Network Analysis and Synthesis," Wiley India Education, 2nd Ed., 2006.
2. Van, Valkenburg, "Network analysis," Pearson, 2019.
3. Sudhakar, A., Shyammohan, S. P., "Circuits and Network," Tata McGraw-Hill NewDelhi, 1994.
4. A William Hayt, "Engineering Circuit Analysis," 8th Edition, McGraw-Hill Education.
5. A. Anand Kumar, "Network Analysis and Synthesis," PHI publication, 2019.

Course Outcomes:

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

CO1. Understand basics electrical circuits with nodal and mesh analysis.
CO2. Appreciate electrical network theorems.
CO3. Apply Laplace transform for steady-state and transient analysis.
CO4. Determine different network functions.
CO5. Appreciate the frequency domain techniques.

Probability Theory and Stochastic Processes			
Course code	ECE205		
Category	Department Course		
Course title	**Probability Theory and Stochastic Processes** (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	**-**		

Course Objective:

To understand the basic concept of Probability Theory and Stochastic Processes

Unit-1	Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models	**8 (Lectures)**
Unit-2	Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions; Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds.	**11 (Lectures)**
Unit-3	Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.	**9(Lectures)**
Unit-4	Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density.	**8 (Lectures)**

Text/Reference Books

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education
2. A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill.
3. K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International
4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability, UBS Publishers,
5. S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.F. Kuo, "Network

Course Outcomes:

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

CO1. Develop understanding of basics of probability theory.
CO2. Identify different distribution functions and their relevance.
CO3. Apply the concepts of probability theory to different problems.
CO4. Extract parameters of a stochastic process and use them for process characterization

Analog Circuits			
Course code	ECE206		
Category	Department Course		
Course title	Analog Circuits (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:

- To describe and analyze the Diode circuits and basic amplifier models
- To understand the various feedback topologies.
- To describe the concept of Oscillators and their types.
- To understand the basic topology and variants of Current mirror circuits.
- To understand the concept of differential amplifiers.
- To understand the basic concept of Op-Amp and its use in various applications.
- To design basic active filters.

Unit-1	Diode circuits, amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.	**9 (Lectures)**
Unit-2	High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier, various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues, feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.	**9(Lectures)**
Unit-3	Oscillators: Review of the basic concept, Barkhausen criterion, RCoscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators. Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (V_{ON}), maximum usable load, differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR	**9(Lectures)**
Unit-4	Op-Amp design: Design of differential amplifier for a given specification, design of gain stages and output stages, compensation. Op-Amp applications: Review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications, active filters: Low pass, high pass, band pass and band stop, design guidelines.	**9(Lectures)**

Text/Reference Books:

1. J.V. Wait, L.P. Huelsman and GA Korn, "Introduction to Operational Amplifier theoryand applications," Mc Graw Hill, 1992.
2. J. Millman and A. Grabel, "Microelectronics," 2nd edition, McGraw Hill, 1988.
3. P. Horowitz and W. Hill, "The Art of Electronics," 2nd edition, Cambridge University Press, 1989.
4. A.S. Sedra and K.C. Smith, "Microelectronic Circuits," Saunder's College11 Publishing,4th edition.
5. Paul R. Gray and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits,"John Wiley, 3rd edition.
6. Muhammad H. Rashid, "Electronic Devices and Circuits," Cengage publication, 2014.

Course Outcomes:

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

CO1. Understand the characteristics of diodes and transistors.
CO2. Design and analyze various rectifier and amplifier circuits.
CO3. Design sinusoidal and non-sinusoidal oscillators.
CO4. Understand the functioning of OP-AMP and design OP-AMP based circuits.
CO5. Design LPF, HPF, BPF, BSF.
CO6. Design ADC and DAC.

Analog Circuits Lab		
Course code	ECE256	
Category	Department Course	
Course title	Analog Circuits Lab (Laboratory)	
Scheme and Credits	**Credits**	**0+1**
Pre-requisites (if any)	-	

(i) Analog Circuits

EXP No.	Experiment	Virtual Lab Link
Exp-1.	BJT Common Emitter Characteristics	http://vlabs.iitkgp.ernet.in/be/exp11/index.html
Exp-2.	BJT Common Base Characteristics	http://vlabs.iitkgp.ernet.in/be/exp12/index.html
Exp-3.	Study of Frequency response of single stage RC coupled amplifier.	https://vlab.amrita.edu/?sub=3&brch=223&sim=983&cnt=1
Exp-4.	Study of Differentiator and Integrator using Operational Amplifier	http://vlabs.iitkgp.ernet.in/be/exp18/index.html
Exp-5.	Frequency Response of CS Amplifier	http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAE/exp6/index.html
Exp-6.	Design and simulate of RC oscillators for required frequency	https://vlab.amrita.edu/?sub=3&brch=225&sim=996&cnt=1
Exp-7.	Wien bridge oscillator using operational amplifier.	https://ae-iitr.vlabs.ac.in/exp/wein-bridge-oscillator/theory.html
Exp-8.	To design and construct a Hartley oscillator and to measure its output frequency.	https://vlab.amrita.edu/?sub=1&brch=201&sim=1137&cnt=3
Exp-9.	To construct a Colpitts oscillator and to measure its output frequency.	https://vlab.amrita.edu/?sub=1&brch=201&sim=1142&cnt=1
Exp-10.	Design and simulate analog to digital converter and digital to analog converter	https://he-coep.vlabs.ac.in/exp/digital-analog-converter/theory.html
Exp-11.	To analyse Function generator using operational amplifier (sine, triangular and square wave).	https://ae-iitr.vlabs.ac.in/exp/function-generator/
Exp-12.	To study the voltage comparator.	https://ae-iitr.vlabs.ac.in/exp/voltage-comparator/

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Microprocessor & Microcontroller			
Course code	ECE207		
Category	Department Course		
Course title	Microprocessor & Microcontroller (Theory)		
Scheme and Credits	**Credits**	**4+0**	
Pre-requisites (if any)	-		

Course Objective:
This subject deals about the basic 8-bit (8085), 16-bit (8086) microprocessors and an 8-bit (8051) microcontrollers, their architecture, internal organization and their functions, interfacing an external device with the processors/ controllers.

Unit-1	**8085 Microprocessor:** History and Evolution of Microprocessor and their Classification, Microprocessor architecture and its operations, Memory, Input & output devices, The 8085 MPU- architecture, Pins and signals, Address / Data Bus multiplexing and demultiplexing. Status and Control signal generation, Timing Diagrams, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O, 8085 Interrupts, Classification of instructions, addressing modes,.	**12 (Lectures)**
Unit-2	**16-bit Microprocessor (8086):** Architecture, Pin Description, Physical address, segmentation, memory organization, Addressing modes. **Peripheral Devices:** 8237 DMA Controller, 8255 programmable peripheral interface, 8253/8254 programmable timer/counter, 8259 programmable interrupt controller, 8251 USART and RS232C.	**12 (Lectures)**
Unit-3	**8051 Microcontroller Basics**: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM. 8051 Addressing Modes. Classification of instructions.	**12 (Lectures)**
Unit-4	Block diagram of Advanced Microprocessor, Memory Hierarchy, Cache memory, Virtual memory, Paging & segmentation, Pipe lining – Pipe line hazards. Features and comparison of 80286, 80386, 80486, Pentium IV.	**12 (Lectures)**

Text Book:

1. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Penram International Publication (India) Pvt. Ltd.,2009
2. D. V. Hall : Microprocessors Interfacing, TMH (2nd Edition),2006
3. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D., "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson, 2nd Edition,2006

Reference Books:

1. AK Roy & KM Bhurchandi, "Advance Microprocessor and Peripherals (Architecture,Programming & Interfacing)", Tata McGraw Hill Publication.
2. Kenneth L. Short, "Microprocessors and programmed Logic", 2nd Ed, Pearson Education Inc.,2003.
3. Barry B. Brey, "The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, PentiumPro Processor, PentiumII, PentiumIII, Pentium IV, Architecture, Programming & Interfacing", Eighth Edition, Pearson Prentice Hall, 2009.
4. Shah Satish, "8051 Microcontrollers MCS 51 Family and its variants", Oxford,2010
5. V. Udayashankara, M.S. Mallikajunaswamy, "8051 Microcontroller Hardware, Software and Applications", McGraw-Hill, 2017

Course Outcomes:
Students are able to

CO1. Recall and apply a basic concept of digital fundamentals to Microprocessor based personal computer system.
CO2. Identify a detailed s/w & h/w structure of the Microprocessor.
CO3. Illustrate how the different peripherals are interfaced with Microprocessor.
CO4. Distinguish and analyze the properties of Microprocessors & Microcontrollers.
CO5. Analyze the data transfer information through serial & parallel ports.

Microprocessor & Microcontroller Laboratory		
Course code	ECE257	
Category	Department Course	
Course title	**Microprocessor & Microcontroller Laboratory** (Lab)	
Scheme and Credits	**Credits**	**0+1**
Pre-requisites (if any)	-	

EXP No.	**Experiment**
Exp-1.	Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers.
Exp-2.	Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
Exp-3.	To perform multiplication and division of two 8 bit numbers using 8085.
Exp-4.	To find the largest and smallest number in an array of data using 8085 instruction set.
Exp-5.	To write a program to arrange an array of data in ascending and descending order.
Exp-6.	To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8085 instruction set.
Exp-7.	To write a program to initiate 8251 and to check the transmission and reception of character.
Exp-8.	To interface 8253 programmable interval timer to 8085 and verify the operation of 8253 in six different modes.
Exp-9.	To interface DAC with 8085 to demonstrate the generation of square, saw tooth and triangular wave.
Exp-10.	Serial communication between two 8085 through RS-232 C port.
Exp-11.	Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
Exp-12.	Write a program to generate 10 kHz square wave using 8051
Exp-13.	Write a program to show the use of INT0 and INT1 of 8051.
Exp-14.	Write a program for temperature & to display on intelligent LCD display.

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Engineering Electromagnetics			
Course code	ECE208		
Category	Department Course		
Course title	Engineering Electromagnetics (Theory)		
Scheme and Credits	**Credits**	**4+0**	
Pre-requisites (if any)	-		

Course Objective:

- To introduce the basic mathematical concepts related to electromagnetic fields.
- To impart knowledge on the concepts of electrostatics and its applications.
- To impart knowledge on the concepts of magnetostatics, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday's law, induced emf, Maxwell's equations, electromagnetic waves and Transmission lines.

Unit-1	Cartesian, Cylindrical, Spherical transformation, Vector calculus: Differential length, area and volume, line surface and volume integrals, Deloperator, Gradient, Divergence of a vector, Divergence theorem, Curl of a vector, Stokes's theorem, Laplacian of a scalar.	**12(Lectures)**
Unit-2	**Electrostatic fields and Magnetostatic fields**: Electric field intensity, Electric field due to charge distribution, Electric flux density, Continuity equation and relaxation time, boundary conditions, Magneto-static fields, Ampere's circuit law, Maxwell's equation, magnetic scalar and vector potential, Magnetic boundary conditions, Faraday's Law, transformer and motional electromotive forces, Displacement current, Maxwell's equation in final form.	**12(Lectures)**
Unit-3	**Waves and Applications:** Wave propagation in loss dielectrics, Plane waves in lossless dielectrics Plane wave in free space. Plain waves in good conductors, Power and the pointing vector, Reflection of a plain wave in a normal incidence & Oblique Incidence. Wave propagation in parallel plane waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide.	**12 (Lectures)**
Unit-4	**Transmission Lines:** Equations of Voltage and Current on TX line, Propagation constant and characteristic impedance, and reflection coefficient and VSWR, Impedance Transformation on Loss-less and Low loss Transmission line, Power transfer on TX line, Smith Chart, Applications of transmission lines: Impedance Matching, use transmission line sections as circuit elements.	**12 (Lectures)**

Text Book/ Reference Books:

1. MNO Sadiku, "Elements of Electromagnetic', Oxford University Press.
2. WH Hayt and JA Buck, "Engineering Electromagnetic", McGraw- Hill Education.
3. EC Jordan and KG Balmain - Electromagnetic Waves and Radiating Systems,PHI.
4. Kraus, John D, and Keith R. Carver. "Electromagnetics",McGraw-Hill.

Course Outcome:

CO1. Understand the basic mathematical concepts related to electromagnetic fields. .

CO2. Apply the principles of electrostatics to the solutions of problems relating to electric field, boundary conditions and electric energy density.

CO3. Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.

CO4. Understand the concepts related to Faraday's law, induced emf and Maxwell's equations.

CO5. Apply Maxwell's equations to solutions of problems relating to transmission lines and uniform plane wave propagation.

Engineering Electromagnetics Lab			
Course code	ECE258		
Category	Department Course		
Course title	Engineering Electromagnetics Lab (Laboratory)		
Scheme and Credits	**Credits**	**0+1**	
Pre-requisites (if any)	-		

EXP No.	**Experiment**
Exp-1.	1.1 Vector addition 1.2 Vector products
Exp-2.	2.1 Coordinate systems 2.2 Position vector and distance vector
Exp-3.	3.1 Curl of a vector field 3.2 Divergence of a vector field 3.3 Gradient of a scalar field
Exp-4.	4.1 Variation of electrostatic fields 4.2 Curl free static electric field
Exp-5.	5.1 Variation of electrostatic fields over multiple dielectrics 5.2 Electric flux density 5.3 Electron moving in different regions
Exp-6.	6.1 Force on a single current carrying conductor 6.2 Force between two current carrying conductors 6.3 Magnetic vector potential
Exp-7.	7.1 Variation of time varying fields
Exp-8.	8.1 Velocity of EM Waves 8.2 Visualization of $c = \omega/\beta$ 8.3 Transverse Nature of Fields 8.4 Skin effect in current carrying conductors 8.5 Proximity effect in current carrying conductors 8.6 Dispersion phenomenon 8.7 Polarization of waves 8.8 Normal Incidance in Medium Interface Air Dielectric
Exp-9.	9.1 Reflection phenomenon in transmission line 9.2 Voltage, current and power associated with a short-circuited line 9.3 Transmission line as circuit elements
Exp-10.	10.1 Transverse Electric Modes in a Rectangular Waveguide 10.2 Transverse Magnetic Modes in a Rectangular Waveguide 10.5. TM3 mode of parallel plate waveguide 10.6. Surface Current of Rectangular Waveguide (TE10) 10.7. Surface Current of Rectangular Waveguide (TE11) 10.8. Surface Current of Rectangular Waveguide (TE32)

Reference:

1. https://www.ee.iitb.ac.in/course/~vel/
2. http://www.iitk.ac.in/mimt_lab/vlab/index.php?pg=waveguide/theory&usr=mbgore&enc=ac1a9ee6c40236ce88204d211376cce6
3. https://nt7-mhe-complex-assets.mheducation.com/nt7-mhe-complex-assets/Upload-20190715/InspireScience6-8CA/CT05/index.html
4. http://eem-iitd.vlabs.ac.in/home.html
5. https://phet.colorado.edu/en/simulations/faraday
6. https://phet.colorado.edu/en/simulations/charges-and-fields
7. https://phet.colorado.edu/en/simulations/coulombs-law
8. https://phet.colorado.edu/en/simulations/vector-addition-equations

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Computer Architecture and Organization			
Course code	ECE301		
Category	Department Course		
Course title	Computer Architecture and Organization (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:

- Discuss the basic concepts and computer design methodology.
- Understand concepts of CPU organizations and Instruction sets.
- Explain different types of memory organization.

Unit-1	**Introduction to Design Methodology:** System Design – System representation, Design Process, the gate level, the register level components and PLD, register level design The Processor Level: Processor level components, Processor level design	**8(Lectures)**
Unit-2	**Processor basics:** CPU organization- Fundamentals, Additional features Data Representation - Basic formats, Fixed point numbers, Floating point numbers. Instruction sets - Formats, Types, Programming considerations.	**9(Lectures)**
Unit-3	**Data path Design:** Fixed point arithmetic - Addition and subtraction, Multiplication and Division, Floating point arithmetic, pipelining. **Control Design:** basic concepts - introduction, hardwired control, Micro programmed control -introduction, multiplier control unit, CPU control unit, Pipeline control- instruction pipelines, pipeline performance	**11 (Lectures)**
Unit-4	**Memory organization:** Multi level memories, Address translation, Memory allocation, Caches - Main features, Address mapping, structure vs performance, System Organization: Communication methods- basic concepts, bus control. Introduction to VHDL.	**8 (Lectures)**

Text Book:

1. John P Hayes "Computer Architecture and Organization", 3rd Edition McGraw Hill Publication. (2017)
2. M Morris Mano, "Computer System Architecture", 3rd Edition ,Pearson,. (2017)

Reference Books:

1. Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer Organization and Embedded Systems", McGraw Hill Publication. (2009)
2. David A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Elsevier Publication. (2007)

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

CO1. understand basic concepts of system design methodology and processor level design.
CO2. explain the basics of processor and basic formats of data representation.
CO3. understand basic concepts of control design and pipeline performance.
CO4. understand the architecture and functionality of central processing unit.

Control Systems			
Course code	ECE302		
Category	Department Course		
Course title	Control Systems (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:
To understand concepts of the mathematical modeling, feedback control and stability analysis in Time and Frequency domains

Unit-1	**Introduction to Control Systems:** Basics of a control system, Feedback type and its effect. Block diagrams Reduction technique and signal flow graphs, **Modeling of Physical systems:** Analysis of mechanical & electrical systems; analogous Systems. **Control hardware and their models**: Sensors and encoders, potentiometers, synchros, LVDT, DC and AC servomotors, Tacho-generators, **Actuators:** hydraulic & pneumatic actuators.	**9(Lectures)**
Unit-2	**Stability of Linear Control Systems:** Bounded-input bounded-output stability continuous data systems, zero-input and asymptotic stability of continuous data systems, Routh Hurwitz criterion, **Root-Locus Technique:** Introduction, Properties of the Root Loci, Design aspects of the Root Loci.	**7(Lectures)**
Unit-3	**Time domain Analysis of Control Systems:** Time response of continuous data systems, typical test signals for the time response of control systems, unit step response and time domain specifications, time response of a first order system, transient response of a prototype second order system, Steady-State error, Static and dynamic error coefficients, error analysis for different types of systems. **Frequency Domain Analysis:** Resonant peak and Resonant frequency, Bandwidth of the prototype Second order system, effects of adding a zero to the forward path, effects of adding a pole to the forward path, polar plot, Nyquist stability criterion, stability analysis with the Bode plot, relative stability: gain margin and phase margin.	**12 (Lectures)**
Unit-4	**State-Variable Analysis:** Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability. Introduction to Optimal control & Nonlinear control, Nonlinear system – Basic concept & analysis.	**8(Lectures)**

Text Book:

1. I. J. Nagrath & M. Gopal, "Control System Engineering", 6th Ed. New Age International Publishers, 2018
2. B.C. Kuo & Farid Golnaraghi, "Automatic Control Systems", 9th Edition, John Wiley India, 2008

Reference Books:

1. Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Control Systems", 3rd Edition, TMH, Special Indian Edition, 2010.
2. A. Anand Kumar, "Control Systems", Second Edition, PHI Learning private limited, 2014.
3. William A. Wolovich, "Automatic Control Systems", Oxford University Press, 2011.

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

CO1. Describe the basics of control systems along with different types of feedback and its effect.
CO2. To explain the techniques such as block diagrams reduction, signal flow graph and modelling of various physical systems along with modelling of DC servomotor.
CO3. Explain the concept of state variables for the representation of LTI system.
CO4. Interpret the time domain response analysis for various types of inputs along with the time domain specifications.
CO5. Distinguish the concepts of absolute and relative stability for continuous data systems along with different methods.
CO6. Interpret the concept of frequency domain response analysis and their specifications.

Digital Signal Processing		
Course code	ECE303	
Category	Department Course	
Course title	Digital Signal Processing (Theory)	
Scheme and Credits	**Credits**	**4+0**
Pre-requisites (if any)	-	

Course Objective:

- To describe signals mathematically and understand how to perform mathematical operations on signals.
- To provide knowledge of Digital filter.
- To discuss multi rate signal processing and application.

Unit-1	**Introduction to Digital Signal Processing:** Basic elements of digital signal processing, advantages and disadvantages of digital signal processing, Technology used for DSP. **Realization of Digital Systems:** Introduction, direct form realization of IIR systems, cascade realization of an IIR systems, parallel form realization of an IIR systems, Ladder structures: continued fraction expansion of H(z), example of continued fraction, realization of a ladder structure, example of a ladder realization.	**12 (Lectures)**
Unit-2	**Infinite Impulse Response Digital (IIR) Filter Design:** Introduction to Filters, Impulse Invariant Transformation, Bi-Linear Transformation, All- Pole Analog Filters: Butterworth and Chebyshev, Design of Digital Butterworth and Chebyshev Filters, Frequency Transformations. **Finite Impulse Response Filter (FIR) Design:** Windowing and the Rectangular Window, Gibb's phenomenon, Other Commonly Used Windows (Hamming, Hanning, Bartlett, Blackmann, Kaiser), Examples of Filter Designs Using Windows.	**12(Lectures)**
Unit-3	**Discrete Fourier Transforms:** Definitions, Properties of the DFT, Circular Convolution, Linear Convolution. **Fast Fourier Transform Algorithms:** Introduction, Decimation in Time (DIT) Algorithm, Computational Efficiency, Decimation in Frequency (DIF) Algorithm.	**12(Lectures)**
Unit-4	**Finite Word length effects in digital filters:** Coefficient quantization error, Quantization noise – truncation and rounding, Limit cycle oscillations-dead band effects. **Multirate Digital Signal Processing:** Introduction, Decimation, Interpolation, Sampling rate conversion: Single and Multistage, applications of MDSP- Subband Coding of Speech signals, Quadrature mirror filters, Advantages of MDSP.	**12(Lectures)**

Text Books:

1. John G Prokias, Dimitris G Manolakis, Digital Signal Processing. Pearson , 4th Edition, 2007
2. Johnny R. Johnson, Digital Signal Processing, PHI Learning Pvt Ltd., 2009.
3. S. Salivahanan, A. Vallavaraj, Digital Signal Processing, TMH, 4th Edition 2017.
4. Oppenheim & Schafer, Digital Signal Processing. Pearson Education 2015
5. S.K. Mitra, 'Digital Signal Processing–A Computer Based Approach, TMH, 4th Edition.

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

CO1. Design and describe different types of realizations of digital systems (IIR and FIR) and their utilities.
CO2. Select design parameters of analog IIR digital filters (Butterworth and Chebyshev filters) and implement various methods such as impulse invariant transformation and bilinear transformation of conversion of analog to digital filters.
CO3. Design FIR filter using various types of window functions.
CO4. Define the principle of discrete Fourier transform & its various properties and concept of circular and linear convolution. Also, students will be able to define and implement FFT i.e. a fast computation method of DFT.
CO5. Define the concept of decimation and interpolation. Also, they will be able to implement it in various practical applications.

Digital Signal Processing Lab			
Course code	ECE353		
Category	Department Course		
Course title	Digital Signal Processing Lab (Laboratory)		
Scheme and Credits	**Credits**	**0+1**	
Pre-requisites (if any)	-		

EXP No.	**Experiment**
Exp-1.	Introduction to MATLAB and or Open Source Software, Scilab
Exp-2.	Write a Program for the generation of basic signals such as unit impulse, unit step, ramp, exponential, sinusoidal and cosine.
Exp-3.	Implement IIR Butterworth analog Low Pass for a 5 KHz cut off frequency.
Exp-4.	Verify Hamming and Blackman windowing techniques.
Exp-5.	Evaluate 4-point DFT of and IDFT of $x(n) = 1, 0 \leq n \leq 3$; 0 elsewhere.
Exp-6.	Verify Linear convolution using FFT
Exp-7.	Verify Circular Convolution using FFT.
Exp-8.	To implement floating point arithmetic.
Exp-9.	To study about DSP Processors and architecture of TMS320C6713 DSP processor
Exp-10.	Study of Discrete Fourier Transform (DFT) and its inverse (***Through Virtual Lab)***.
Exp-11.	Study of FIR filter design using window method: Lowpass and highpass filter (***Through Virtual Lab)***.
Exp-12.	Study of FIR filter design using window method: Bandpass and Bandstop filter (***Through Virtual Lab)***.
Exp-13.	Study of Infinite Impulse Response (IIR) filter (Through Virtual Lab).
References: http://vlabs.iitkgp.ernet.in/dsp/	
Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*	

Analog and Digital Communication			
Course code	ECE304		
Category	Department Course		
Course title	Analog and Digital Communication (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:

- To understand the basic principle of a communication system
- To describe and analyze the mathematical techniques of generation, transmission and reception of amplitude modulation (AM), frequency modulation (FM) and phase modulation (PM) signals.
- To understand the behavior of a communication system in presence of noise
- To understand the basic concept of Probability and random process for communication applications.
- To convert analog signals to digital format and describe Pulse and Digital Modulation techniques.
- To understand the basics of digital modulation techniques.

Unit-1	Introduction: Overview of Communication system, communication channels, Need for modulation, Baseband and Passband signals, Amplitude Modulation: Double sideband with Carrier (DSB-C), Double sideband without Carrier, Single Side Band Modulation, DSB-SC, DSB-C, SSB Modulators and Demodulators, Vestigial Side Band (VSB), Quadrature Amplitude Modulator, Radio Transmitter and Receiver.	**9 (Lectures)**
Unit-2	Angle Modulation, Tone Modulated FM Signal, Arbitrary Modulated FM Signal, FM Modulators and Demodulators, Approximately Compatible SSB Systems, Stereophonic FM Broadcasting	**9(Lectures)**
Unit-3	Review of probability and random process, Gaussian and white noise characteristics, noise in amplitude modulation systems, noise in frequency modulation systems, pre-emphasis and de-emphasis, threshold effect in angle modulation.	**8(Lectures)**
Unit-4	Pulse modulation, sampling process, Pulse Amplitude, Pulse Width Modulation, Pulse Position Modulation, and pulse code modulation (PCM), differential pulse code modulation. Delta modulation, noise considerations in PCM, Frequency Division Multiplexing, time division multiplexing, digital multiplexers. Digital modulation schemes-phase shift keying, frequency shift keying, quadrature amplitude modulation, continuous phase modulation and minimum shift keying.	**10(Lectures)**

Text/Reference Books:

1. Haykin S., "Communications Systems," John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering," Pearson Education,2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems," Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., "Principles of Communication Engineering," JohnWiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., "Digital Communication," KluwerAcademic Publishers, 2004.
6. Proakis J.G., "Digital Communications',' 4th Edition, McGraw Hill, 2000.
7. Abhay Gandhi, "Analog and Digital Communication," Cengage publication, 2015.

Course Outcomes:

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

CO1. Analyze and compare different analog modulation schemes for their efficiency and bandwidth.
CO2. Analyze the behavior of a communication system in presence of noise.
CO3. Investigate pulsed modulation systems and analyze their system performance.
CO4. Investigate various multiplexing techniques.
CO5. Analyze different digital modulation schemes and compute the bit error performance.
CO6. Analyze and compare different analog modulation schemes for their modulation factor and power.

Analog and Digital Communication Lab			
Course code	ECE354		
Category	Department Course		
Course title	Analog and Digital Communication **Lab** (Laboratory)		
Scheme and Credits	**Credits**	**0+1**	
Pre-requisites (if any)	-		

EXP No.	**Experiment**
Exp-1.	To study DSB/ SSB amplitude modulation & determine its modulation factor & power in side bands.
Exp-2.	To study amplitude demodulation by linear diode detector.
Exp-3.	To study frequency modulation and determine its modulation factor.
Exp-4.	To study sampling and reconstruction of pulse amplitude modulation system.
Exp-5.	To study pulse amplitude modulation. **i.** Using switching method **ii.** By sample and hold circuit
Exp-6.	To demodulate the obtained PAM signal by 2nd order LPF.
Exp-7.	To study pulse width modulation and pulse position modulation.
Exp-8.	To study pulse code modulation and demodulation technique.
Exp-9.	To study delta modulation and demodulation technique.
Exp-10.	To construct a square wave with the help of fundamental frequency and its harmoniccomponent.
Exp-11.	Study of amplitude shift keying modulator and demodulator.
Exp-12.	Study of frequency shift keying modulator and demodulator.
Exp-13.	Study of phase shift keying modulator and demodulator.
Exp-14.	Study of single bit error detection and correction using hamming code.
Exp-15.	Study of quadrature phase shift keying modulator and demodulator.
Exp-16.	To simulate differential phase shift keying technique using MATLAB/SCILAB software.
Exp-17.	To simulate M-ary Phase shift keying technique using MATLAB/SCILAB software (8PSK,16PSK) and perform BER calculations.
Exp-18.	Design a front end BPSK modulator and demodulator.

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Embedded Systems			
Course code	ECE305		
Category	Department Course		
Course title	Embedded Systems (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	**-**		

Course Objective:
The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

Unit-1	**Introduction to Embedded Systems:** What is Embedded Systems? – the classification of Embedded Systems – the building blocks of the embedded systems - Structural units in Embedded System Different memory technologies - DMA - Memory management - Timer and Counter – Reset Circuit, Watchdog Timer, Real Time Clock - Simulators, In-Circuit Emulators (ICE), and Debuggers and their role in embedded firmware debugging	**9(Lectures)**
Unit-2	**Embedded Networking:** Introduction of I/O subsystem of the embedded system, Communication protocols - RS232 standard, RS422, RS485, Introduction of Controller Area Network (CAN), Serial Peripheral Interface (SPI), Inter-Integrated Circuits (I2C), UART, etc. **Embedded Firmware Development Environment:** Objective of Embedded Product Development Life Cycle (EDLC), Different phases of EDLC, Modelling of EDLC, Issues in Hardware-software Co-design, Data Flow Graph, Introduction of state machine model, Sequential Program Model, concurrent Model, and object-oriented Model.	**10(Lectures)**
Unit-3	**Real Time Operating System – Based Embedded System Design:** Introduction of RTOS, Task, Process & threads, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication, Shared memory, Message passing, Interrupt routines, Inter Process Communication, Task synchronization Introduction of different TROS: VxWorks, MicroC/OS-II, RT Linux.	**9(Lectures)**
Unit-4	**Embedded System Application Development:** Design issues and techniques Case Study of Washing Machine- Automotive Application- Smart card System Application.	**8(Lectures)**

Text Books:

1. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Education, Second edition, 2007.
2. Raj Kamal, “Embedded Systems: Architecture, Programming and Design”, Second Edition, The McGraw-Hill, 2008.
3. Shibu K V, “Introduction to Embedded Systems”, Second Edition, The Tata McGraw Hill Education (India), 2008.

Reference Books:

1. Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006.
2. Michael J. Pont, "Embedded C", Pearson Education, 2007.
3. Steve Heath, "Embedded System Design", Elsevier, 2005.

COURSE OUTCOME: *After completion of the course student will be able to:*

CO1: Understand the basics of embedded system and its structural units.
CO2: Analyze the embedded system specification and develop software programs.
CO3: Evaluate the requirements of the programming embedded systems, related softwarearchitecture.
CO4: Understand the RTOS based embedded system design.
CO5: Understand all the applications of the embedded system and designing issues.

Embedded Systems Lab			
Course code	ECE355		
Category	Department Course		
Course title	Embedded Systems Lab (Laboratory)		
Scheme and Credits	**Credits**	**0+1**	
Pre-requisites (if any)	**-**		

EXP No.	**Experiment**
Exp-1.	Digital FIR filter design and simulation
Exp-2.	Fixed point Implementation of Digital FIR Filter
Exp-3.	MCU-DAC interfacing and generation of ramp wave
Exp-4.	Interfacing of ADC and data trasnfer by software polling, study of aliasing
Exp-5.	ADC triggering through timer(On Chip Timer)
Exp-6.	Interrupt driven data transfer from ADC
Exp-7.	Implementation of Digital FIR Filter on 8051 Microcontroller
Exp-8.	LCD - MCU interfacing and displaying a string
Exp-9.	Keyboard-MCU interfacing take a input from keypad and display on LCD
Exp-10.	Stepper Motor Control Using ATMEGA-16 Microcontroller
Exp-11.	Interface a LED matrix and display a number on the matrix.
Exp-12.	Interfacing 4x4 switch matrix with the microcontroller
Exp-13.	Implementation of Hopfield network in C to recognize a simple ASCII character.
Exp-14.	Implementation of Hopfield Network on ATMEGA-16 microcontroller
Exp-15.	Serial Communication between micro controller and PC
Exp-16.	Temperature control using ATmega16

Note: *Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

Wireless and Mobile Communication			
Course code	ECE306		
Category	Department Course		
Course title	Wireless and Mobile Communication (Theory)		
Scheme and Credits	**Credits**	**4+0**	
Pre-requisites (if any)	-		
Course Objective: To expose the students to understand mobile communication principles and to study the recent trends adopted in cellular systems and wireless standards.			

Unit-1	**Wireless Communication Fundamentals:** Evolution of mobile radio communication fundamentals. General Model of Wireless Communication Link, Types of Signals, Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems, Channel Assignment, Frequency reuse, Channel Assignment strategies, Handoff Strategies Cellular Interferences, Sectorization; Wireless Channel and Radio Communication, Free Space Propagation Model, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing; Wireless Channel Modeling: AWGN Channel, Rayleigh Channel, Rician Fading Channel, Nakagami Fading Channel, Ocumura and Hata Path Loss Model; Channel Modeling: Stochastic, Flat Fading, Wideband Time-Dispersive Channel Modeling.	**12(Lectures)**
Unit-2	**Spread Spectrum and Diversity:** Theory of Vocoders, Types of Vocoders; Spread Spectrum Modulation, Pseudo-Noise Codes with Properties and Code Generation Mechanisms, DSSS and FHSS Systems, Time Hopping and Hybrid Spread Systems; Multicarrier Modulation Techniques, Zero Inter Symbol Interference Communication Techniques, Detection Strategies, Diversity Combining Techniques: Selection Combining, Threshold Combining, Equal Gain Combining, Maximum Ratio Combining; Spatial Diversity and Multiplexing in MIMO Systems, Channel Estimation.	**12(Lectures)**
Unit-3	**Equalization and Multiple Access:** Equalization Techniques: Transversal Filters, Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, and related algorithms; Multiplexing and Multiple Access: FDMA, TDMA, CDMA, OFDMA, SC- FDMA, IDMA Schemes and Hybrid Method of Multiple Access Schemes, RAKE Receiver; Multiple Access for Radio Packet Systems: Pure ALOHA, Slotted ALOHA, CSMA and their versions; Packet and Pooling Reservation Based Multiple Access Schemes.	**12(Lectures)**
Unit-4	**Cellular Networks:** GSM system for mobile Telecommunication, General Packet Radio Service, Edge Technology; CDMA Based Standards: IS 95 to CDMA 2000, Wireless Local Loop, IMT 2000 and UMTS, Long Term Evolution (LTE), Mobile Satellite Communication. **Other Wireless Networks:** Introduction to Mobile Adhoc Networks, Bluetooth, Wi-Fi Standards, WiMax Standards, Li-Fi Communication, Ultra-Wideband Communication, Mobile data networks, Wireless Standards IMT 2000, Introduction to 4G & 5G and concept of NGN.	**12(Lectures)**

Text Books:

1. T.S. Rappaport, "Wireless Communication-Principles and practice", Pearson Publications,Second Edition.
2. Upena Dalal, "Wireless Communication and Networks", Oxford Press Publications, first edition.
3. T L Singal, "Wireless Communications", McGraw Hill Publications, 2010.

Reference Books:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
2. S. Haykin & M. Moher, "Modern wireless communication", Pearson, 2005.

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

CO1. Express the basic knowledge of mobile radio & cellular communication fundamentals and their application to propagation mechanisms, path loss models and multi-path phenomenon.
CO2. Analyze the performance of various voice coding and diversity techniques.
CO3. Apply the knowledge of wireless transmission basics to understand the concepts of equalization and multiple access techniques.
CO4. Examine the performance of cellular systems being employed such as GSM, CDMA and LTE using various theoretical and mathematical aspects.
CO5. Express basic knowledge of Mobile Adhoc networks and the existing & upcoming data communication networks in wireless and mobile communication domain.

VLSI Design			
Course code	ECE307		
Category	Department Course		
Course title	VLSI Design (Theory)		
Scheme and Credits	**Credits**	**4+0**	
Pre-requisites (if any)	-		

Course Objective:
This is an advanced course of electronic devices and circuits which covers basic theories and techniques of CMOS VLSI design.

Unit-1	**Introduction:** Evolution of Complexity in Integrated Circuits, Advantages of Monolithic Integration, Moore's Law, Design Methodologies, VLSI Design Flow, Design Hierarchy, Design Abstraction Levels, Concept of Regularity, Modularity and Locality, VLSI Design Styles, Design Quality, Packaging Technology, Computer-Aided Design (CAD Technology. **MOS Transistor Basics**: The MOS Structure, The MOS System under External Bias, Structure, and operation of MOSFET, MOSFET I-V Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitances, Modeling of MOSFETs using SPICE.	**12 (Lectures)**
Unit-2	**CMOS Inverter Static Characteristics:** Introduction, Voltage Transfer Characteristics (VTC), Static CMOS Inverter DC Characteristics, Beta Ratio Effects, Noise Immunity and Noise Margins. **Delay:** Introduction, Delay-Time Definitions**,** Transient Response, RC Delay Model, Linear Delay Model, Logical Effort of Paths. **CMOS Inverter Dynamic Characteristics:** Introduction, Calculation of Delay Times, Inverter Design with Delay Constraints. **Power:** Introduction, Dynamic Power, Static Power and Energy-Delay Optimization. **Interconnect Modeling:** Resistance, Capacitance, Inductance, Skin Effect and Temperature Dependence.	**12(Lectures)**
Unit-3	**Combinational MOS Logic Circuits:** Introduction, CMOS Logic Circuits, Complex Logic Circuits and CMOS Transmission Gates (Pass Gates). **Sequential MOS Logic Circuits:** Introduction, Behavior of Bistable Elements, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge Triggered Flip-Flop. **Dynamic CMOS Design:** Introduction, Basic Principles of Pass Transistor Circuits, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High-Performance Dynamic CMOS Circuits.	**12(Lectures)**
Unit-4	**Semiconductor Memories:** Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Nonvolatile Memory, Flash Memory, **Design For Testability:** Introduction, Fault Types and Models, Controllability and Observability, Ad Hoc Testable Design Techniques, Scan-Based Techniques, Built-In Self-Test (BIST) Techniques and Current Monitoring I_{DDQ} Test	**12(Lectures)**

Text Book:

1. Sung-Mo Kang & Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis & Design",Mcgraw Hill, 4th Edition.
2. Neil H.E.Weste, David Money Harris, "CMOS VLSI Design – A circuits and Systems Perspective" Pearson, 4th Edition.
3. D. A. Pucknell and K. Eshraghian, "Basic VLSI Design: Systems and Circuits", PHI, 3rd Ed.,1994.

Reference Books:

1. R. J. Baker, H. W. Li, and D. E. Boyce , " CMOS circuit design, layout, and simulation", Wiley-IEEE Press,2007.
2. J. Rabaey, A. Chandrakasan, and B. Nikolic, "Digital integrated circuits- A design perspective". Prentice Hall
3. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design" , Jaico Publishing House.

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

1. Express the concept of VLSI design MOS Transistors and CMOS circuits
2. Analyze mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits and delay study.
3. Design and analyze various combinational & sequential circuits based on CMOS technology.
4. Examine different semiconductor memories used in present days technology.
5. Interpret faults in digital circuits, Fault Models and various Testing Methodologies.

VLSI Design Lab			
Course code	ECE357		
Category	Department Course		
Course title	VLSI Design Lab		
Scheme and Credits	**Credits**	**0+2**	
Pre-requisites (if any)	-		

Note: A minimum of ten experiments from the following should be performed

Part-A (PSPICE Experiments)

Transistor Modeling and Circuits

Exp-1. SPICE parameters for MOSFET transistors.
Exp-2. Transient Analysis of CMOS inverter
Exp-3. DC Analysis (VTC) of CMOS inverter
Exp-4. Transient & DC Analysis of NAND Gate using CMOS inverter.
Exp-5. Transient Analysis of NOR Gate inverter and implementation of XOR gate using NOR gate.
Exp-6. To design and perform transient analysis of D latch using CMOS inverter.
Exp-7. To design and perform the transient analysis of SR latch circuit using CMOS inverter.
Exp-8. Analysis of frequency response of Common Source amplifiers.
Exp-9. Analysis of frequency response of Source Follower amplifiers Timing
Exp-10. MOSFET based Ring oscillators
Exp-11. MOSFET based Voltage-controlled oscillators

Part B : HDL (using VHDL program module & verilog Module)

Exp-12. Design and Simulation of Full Adder using VHDL program module
Exp-13. Design and Simulation of 4x1 MUX using VHDL program module
Exp-14. Design and Simulation of BCD to Excess-3 code using VHDL program module
Exp-15. Design and Simulation of 3 to 8 decoder using VHDL program module
Exp-16. Design and Simulation of JK Flip-flop using VHDL program module
Exp-17. Design and Simulation of CMOS Inverter using Verilog Module

Note: ***Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.***

Micro Project			
Course code	ECEP201		
Category	Department Course		
Course title	Micro Project		
Scheme and Credits	**Credits**	**0+2**	
Pre-requisites (if any)	-		

Guidelines:

The micro-project is a team activity having 3-4 students in a team. This is electronic circuit building and testing for developing real life small electronic applications. The microproject may be complete hardware or hardware with a small programming aspect. It should encompass electronics components, devices, analog or digital ICs, micro controller etc. Micro Project should cater to a small system required in laboratory or real-life application. Based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of Micro-project.

Course Outcomes:

At the end of the micro project, students will demonstrate the ability to:

CO1. Identify and define a problem statement from the requirements raised from literature survey /need analysis.
CO2. Build and Test electronic circuits/prototype for developing real life small electronic applications.
CO3. Work in teams, write comprehensive report and effective presentation of the project work.
CO4. Rapid prototyping which will lead them towards entrepreneurship.

Mini Project			
Course code	ECEP301		
Category	Department Course		
Course title	Mini Project		
Scheme and Credits	**Credits**	**0+3**	
Pre-requisites (if any)	-		

The mini project is a team activity having 3-4 students in a team. This is electronic product design work with a focus on electronic circuit design. The mini project may be complete hardware or a combination of hardware and software. Mini Project should cater to a small system required in laboratory or real life. It should encompass components, devices, analog or digital ICs, micro controllers with which functional familiarity is introduced. Based on comprehensive literature survey/ Industry requirements analysis, the student shall identify the title and define the aim and objectives of the mini project.

Students are expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within the first week of the semester. The student is expected to exert on design, development, and testing of the proposed work as per the schedule.

The layout should be made using CAD based PCB simulation software. Due consideration should be given for power requirements of the system, mechanical aspects for enclosure and control panel design. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester

Major Project			
Course code	ECEP401		
Category	Department Course		
Course title	Major Project		
Scheme and Credits	**Credits**	**0+12**	
Pre-requisites (if any)	-		

The object of Major Project work is to enable the student to extend further the investigative study taken up under ECEP401, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including teamwork;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.

ECE Department Elective Courses
Detailed Syllabus

<table>
<tr><th colspan="4">Information Theory and Coding</th></tr>
<tr><td colspan="2">Course code</td><td colspan="2">ECEL301</td></tr>
<tr><td colspan="2">Category</td><td colspan="2">Department Elective Course</td></tr>
<tr><td colspan="2">Course title</td><td colspan="2">Information Theory and Coding (Theory)</td></tr>
<tr><td colspan="2">Scheme and Credits</td><td colspan="2">Credits   3+0</td></tr>
<tr><td colspan="2">Pre-requisites (if any)</td><td colspan="2">-</td></tr>
<tr><td colspan="4">Course Objective:
To provide an insight into the concept of information theory and coding in the context of communication theory and its significance in the design of communication receivers.</td></tr>
<tr><td>Unit-1</td><td colspan="2">Basics of information theory; Entropy: Entropy, Joint Entropy & Conditional Entropy, Relative Entropy & Mutual Information and their relationship, Chain Rules for Entropy, Introduction and applications of Jensen’s Inequality, Log Sum Inequality, Data-Processing Inequality, Fano’s Inequality. Asymptotic Equipartition Property (AEP) Theorem.</td><td>8(Lectures)</td></tr>
<tr><td>Unit-2</td><td colspan="2">Consequences of the AEP: Data Compression techniques, High-Probability Sets and the Set Data Compression: types of Codes, Optimal Codes and Optimal Code Length, Kraft Inequality: Basics and its use in Uniquely Decodable Codes, Huffman Codes and its Optimality, Shannon–Fano–Elias Coding technique.</td><td>9(Lectures)</td></tr>
<tr><td>Unit-3</td><td colspan="2">Channel Capacity: Properties, Channel Capacity for Various Binary Channels, Symmetric Channels, Channel Coding Theorem, Channel capacity Theorem, Jointly Typical Sequences.
Block Codes: Introduction, Single-parity check codes, Product codes, Repetition codes, Hamming codes, Minimum distance of block codes, Soft-decision decoding, Automatic-repeat-request schemes.</td><td>10 (Lectures)</td></tr>
<tr><td>Unit-4</td><td colspan="2">Linear Block codes: Definition of linear Block Codes, Generator matrices, Standard array, Parity-check matrices, Error detection and correction.
Convolution codes: Encoding convolutional codes, Generator matrices for convolutional codes, Generator polynomials for convolutional codes, Graphical representation of convolutional codes, Viterbi Algorithm, Binary Cycle Codes, BCH codes. RS codes, Golay codes.</td><td>9(Lectures)</td></tr>
</table>

Text Books:

1. Bose, Information Theory, Coding and Cryptography, McGraw-Hill Education, 3rd Edition, (2016).
2. Joy A. Thomas, Thomas M. Cover, “Elements of information theory”, Wiley-Interscience; 2nd edition (July 18, 2006).
3. S. Gravano, “Introduction to Error Control Codes” OUP Oxford (24 May 2001).
4. Robert B. Ash, “Information Theory”, Dover Publications (November 1, 1990).
5. Todd k Moon, “Error Correction Coding: Mathematical Methods and Algorithms ” Wiley, 2005.

Reference Books:

1. Simon Haykin, “Digital communication”, John Wiley.
2. Ranjan Bose, “ITC and Cryptography”, Tata McGraw-Hill.
3. Roberto Togneri, Christopher J.S deSilva, “Fundamentals of Information Theory and Coding Design”, CRC Press.

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

CO1. Explain each block involved in digital communication thoroughly with applications.
CO2. Apply the knowledge of basic concepts of probability and entropies to analyze the behavior of a communication system.
CO3. Analyze the use of source coding and evaluating all the techniques of source coding.
CO4. Examine the significance of channel coding and evaluating all available techniques of channel coding and decoding with challenges.
CO5. Examine various error control coding techniques.

VLSI Technology			
Course code	ECEL302		
Category	Department Elective Course		
Course title	VLSI Technology (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:

- To introduce the fundamental concepts relevant to VLSI fabrication.
- To enable the students to understand the various VLSI fabrication techniques.

Unit-1	**Introduction To IC Technology:** SSI, MSI, LSI, VLSI Integrated Circuits. Crystal Growth and Wafer Preparation: Electronic Grade Silicon, Czochralski Crystal Growth, Silicon Shaping, Processing Considerations. Wafer Cleaning Technology - Basic Concepts, Wet cleaning, Dry cleaning	**8(Lectures)**
Unit-2	**Epitaxy:** Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation. **Oxidation:** Growth Kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxides Properties	**9(Lectures)**
Unit-3	Optical Lithography, Electron beam lithography, Photo masks, Wet Chemical Etching, Deposition Processes of Polysilicon, Silicon Dioxide, Silicon Nitride; Models of diffusion in solids, Fick's 1-Dimensional diffusion equation, Diffusion of Impurities in Silicon and Silicon Dioxide, Diffusion Equations, Diffusion Profiles, Diffusion Furnace, Solid, Liquid and Gaseous Sources, Ion-Implantation: Ion-Implantation Technique, Range Theory, Implantation Equipment.	**11 (Lectures)**
Unit-4	**Metallization:** Metallization Application, Metallization Choices, Physical Vapor Deposition, Vacuum Deposition, Sputtering Apparatus. **Packaging of VLSI devices:** Package Types, Packaging Design Consideration, VLSI Assembly Technologies, Package Fabrication Technologies, CMOS fabrication steps.	**08(Lectures)**

Text Books:

1. S. M. Sze, "VLSI Technology", McGraw Hill Publication, 2nd Edition 2017
2. S.K. Ghandhi, "VLSI Fabrication Principles", Willy-India Pvt. Ltd, 2008

Reference Books:

1. J. D. Plummer, M. D. Deal and Peter B. Griffin, "Silicon VLSI Technology: Fundamentals, Practice and Modeling", Pearson Education Publication, 2009
2. Stephen A. Campbell, "Fabrication Engineering at the Micro and Nano scale", Oxford University Press, 2013

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

CO1. Interpret the basics of crystal growth, wafer preparation and wafer cleaning.
CO2. Evaluate the process of Epitaxy and oxidation.
CO3. Differentiate the lithography, etching and deposition process.
CO4. Analyze the process of diffusion and ion implantation.
CO5. Express the basic process involved in metallization and packaging.

Nano Electronics		
Course code	ECEL401	
Category	Department Elective Course	
Course title	Nano Electronics (Theory)	
Scheme and Credits	**Credits**	**3+0**
Pre-requisites (if any)	-	

Course Objective:
To provide students with knowledge and understanding of physical background and applications of nanoelectronics.

Unit-1	Overview: Nano devices, Nano materials, Nano characterization. Introduction to nano-electronics, CMOS technology scaling issues, Design techniques for nanoscale transistors	**9(Lectures)**
Unit-2	Materials for nanoelectronics: Semiconductors, Crystal lattices: bonding in crystals, Electron energy bands, Semiconductor heterostructures, Lattice-matched and pseudomorphic heterostructures, Inorganic nanowires, Organic semiconductors , Carbon nanomaterials: nanotubes and fullerenes.	**9(Lectures)**
Unit-3	Shrink-down approaches: Introduction, CMOS Scaling, MOS Electrical characterization, Non classical MOSFETs: overview and carrier transport in NanoMOSFETs, Silicon on Insulator (SOI) MOSFET, FINFETs, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.)	**9(Lectures)**
Unit-4	Resonant Tunneling Diode, Coulomb dots, Quantum blockade, Single electron transistors, 2D semiconductors and electronic devices, Graphene, atomistic simulation	**9(Lectures)**

Text/ Reference Books:

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced ElectronicMaterial and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge UniversityPress, 1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003.
6. Introduction to Nano Science and Technology by S.M. Lindsay.
7. Supriyo Dutta -Lessons from Nanoscience: A Lecture Note Series, World Scientific (2012).
8. Supriyo Dutta --Quantum Transport- Atom to Transistor, Cambridge University Press (2005).
9. Introduction to Nanoelectronics : Science, Nanotechnology, Engineering & Applications by Vladimir.V.Mitin.
10. **NPTEL Link:** https://nptel.ac.in/courses/117108047

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

CO1. Understand various aspects of nano-technology and the processes involved in makingnano components and material.
CO2. Leverage advantages of the nano-materials and appropriate use in solving practicalproblems.
CO3. Understand various aspects of nano-technology and the processes involved in makingnano components and material.
CO4. Leverage advantages of the nano-materials and appropriate use in solving practical problems.

Speech Processing			
Course code	ECEL402		
Category	Department Elective Course		
Course title	Speech Processing (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:
The course provides an introduction to speech processing oriented to human-computer interaction.

Unit-1	**Digital models for speech signals**: speech signal production mechanism, acoustic phonetics, acoustic theory to produce speech signals, lossless tubemodels, and digital models for speech signals.	**6(Lectures)**
Unit-2	**Time domain methods of speech sampling**: Time dependent processing of speech, short time energy and average magnitude, short time average zero crossing rate, discrimination between speech & silence, pitch period estimation using parallel processing, short time autocorrelation function & AMDF, pitch period estimation using autocorrelation function.	**10(Lectures)**
Unit-3	**Short time Fourier analysis**: Definition and properties, design of filter banks, implementation of filter bank summation method using FFT, spectrographic displays, pitch detection, analysis by synthesis phase, vocoder. **Homomorphic speech processing**: Homomorphic system for convolution,complex cepstrum of speech, pitch detection using Homomorphic processing, formant estimation, Homomorphic vocoder.	**10 (Lectures)**
Unit-4	**Linear predictive coding of speech**: Basic principles of linear predictive analysis, the autocorrelation method, computation of the gain for the model, solution of LPC equations for auto correlation method, prediction error and normalized mean square error, frequency domain interpretation of mean squared prediction error relation of linear predictive analysis to lossless tube models, relation between various speech parameters, synthesis of speech from linear predictive parameters, application of LPC parameters.	**10(Lectures)**

Text Book:

1. R. L. Rabiner & R.W. Schafer, "Digital Processing of speech signals", Pearson Education, 2004.
2. B. Gold and Nelson Morgon, "Speech and audio signal processing", Wiley India Edition, 2006.

Reference Books:

1. D O Shaughnessy, "Speech Communication: Human and Machine" May 29, 2012.
2. J L Flanagan, "Speech Analysis, Synthesis and Perception" October 11, 2012.
3. John Coleman, "Digital Speech Processing: Synthesis, and Recognition" by Sadaoki Furui, "Introducing Speech and Language Processing" 2nd edition, November 17, 2000.

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

CO1. Describe the mechanism of speech production & acoustic phonetics, the acoustic theory of speech production, lossless tube models.

CO2. Explain time dependent processing of speech, short time energy and average magnitude, short time average zero crossing rate.

CO3. Design filter banks, implement filter banks and perform summation method using FFT.

CO4. Evaluate homomorphic system for convolution, complex cepstrum of speech, pitch detection using Homomorphic processing.

CO5. Interpret the basic principles of linear predictive analysis, the autocorrelation method, computation of the gain for the model, solution of LPC equations.

Satellite Communication			
Course code	ECEL406		
Category	Department Elective Course		
Course title	Satellite Communication (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:
To introduce various aspects in the design of systems for satellite communication.

Unit-1	**Introduction to Satellite Communication:** History, Overview of Satellite Communication, Types of Satellite, Types of Orbit, Satellite services, Advantages & Applications of Satellite communication, Satellite Life phases, Space Debris, Introduction to Geo-synchronous and Geo-stationary satellites.	**9(Lectures)**
Unit-2	**Orbital Mechanics:** Orbital Mechanics, Kepler's Three laws of Planetary Motion, Developing the Equations of the orbit, Look Angle Determination, Earth Stations, Orbital Perturbations, Orbital effects in Communication system performance. **Satellite Sub-systems:** Seven segments of Satellite communication, Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system.	**9(Lectures)**
Unit-3	**Satellite Link Design:** Basic transmission theory, System noise temperature and G/T ratio, Design of down link and uplink, Design of satellite links for specified C/N. **Introduction to Various Satellite Systems:** VSAT, Direct broadcast satellite television and radio, Satellite navigation and the Global positioning systems, GPS position location principle, GPS receivers and codes, Satellite Signal Acquisition, GPS navigation Message, GPS Signal Levels, Timing Accuracy, GPS Receiver Operation.	**9(Lectures)**
Unit-4	**Launchers & Advanced Technologies:** Mechanism of Satellite launching, Launch Vehicles, Advanced launching tech like Space X, Intelligent Testing, Control and Decision making for Space, Inter Satellite Link. **Indian Satellite Systems:** History and Overview of Indian Satellite System, Achievements, GSLV, PSLV, Advanced Technology Vehicle.	**9(Lectures)**

Text Books:

1. B.Pratt, A.Bostian, "Satellite Communications", Wiley India, 2^{nd} Edition,2006.
2. D. Roddy, "Satellite Communications", TMH, 4^{th} Edition, 2001.
3. Digital Satellite Communications/ Tri T. Ha./ McGraw-Hill, 2^{nd} Edition
4. D.C. Agrawal, Satellite communication, Khanna Publishers; 7^{th} Edition.

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

CO1. Define and list the benefits of satellite communication.
CO2. Demonstrate orbital mechanics principles of satellite communication systems and solve problems related to it.
CO3. Describe a satellite link and identify ways to improve the link performance.
CO4. Classify new technologies of satellite communication systems as per given specifications.
CO5. Examine advanced technologies of satellite launching and describe the Indian satellite system.

Antennas and Wave Propagation			
Course code	ECEL407		
Category	Department Elective Course		
Course title	Antennas and Wave Propagation (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:
To introduce the student to antennas, covering their principles of radiation, their basic parameters, their general types, and those commonly used in wireless systems.

Unit-1	**Antennas Basics:** Introduction, Basic Antenna Parameters, Patterns, Beam Area (or Beam Solid Angle) QA, Radiation Intensity, Beam Efficiency, Directivity D and Gain G, Directivity and Resolution, Antenna Apertures, Effective Height, The radio Communication link, Fields from Oscillating Dipole, Single-to-Noise Ratio(SNR), Antenna Temperature, Antenna Impedance.	**8(Lectures)**
Unit-2	**Point Sources and Their Arrays:** Introduction, Point Source, Power Theorem and its Application to an Isotropic Source, Radiation Intensity, Arrays of Two Isotropic Point Sources, Non-isotropic but Similar Point Sources and the Principle of Pattern Multiplication, Pattern Synthesis by Pattern Multiplication, Linear Arrays of n Isotropic Point Sources of Equal Amplitude and Spacing, Linear Broadside Arrays with Non-uniform Amplitude Distributions. General Considerations. **Electric Dipoles, Thin Liner Antennas and Arrays of Dipoles and Apertures:** The Short Electric Dipole, The Fields of a Short Dipole, Radiation Resistance of Short Electric Dipole, Thin Linear Antenna, Radiation Resistance of $\lambda/2$ Antenna, Array of Two Driven $\lambda/2$ Elements: Broadside Case and End-Fire Case, Horizontal Antennas Above a Plane Ground, Vertical Antennas Above a Plane Ground, Yagi-Uda Antenna Design, Long-Wire Antennas, folded Dipole Antennas.	**10(Lectures)**
Unit-3	**The Loop Antenna:** Design and its Characteristic Properties, Application of Loop Antennas, Far Field Patterns of Circular Loop Antennas with Uniform Current, Slot Antennas, Horn Antennas, Helical Antennas, The Log-Periodic Antenna, Micro strip Antennas. **Reflector Antennas:** Flat Sheet Reflectors, Corner Reflectors, The Parabola-General Properties, A Comparison Between Parabolic and Corner Reflectors, The Paraboloidal Reflector, Patterns of Large Circular Apertures with Uniform Illumination, Reflector Types (summarized), Feed Methods for Parabolic Reflectors.	**9(Lectures)**
Unit-4	**Ground Wave Propagation: Plane** Earth Reflection, Space Wave and SurfaceWave. **Space Wave Propagation: Introduction,** Field Strength Relation, Effects ofImperfect Earth, Effects of Curvature of Earth. **Sky wave Propagation:** Introduction structural Details of the ionosphere, Wave Propagation Mechanism, Refraction and Reflection of Sky Waves by ionosphere, Ray Path, Critical Frequency, MUF, LUF, OF, Virtual Height and Skip Distance, Relation Between MUF and the Skip Distance, Multi-Hop Propagation, Wave Characteristics.	**9(Lectures)**

Text Book:

1. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, "Antennas and Wave Propagation",Tata McGraw Hill Publication.

Reference Books:

1. A. R. Harish, M. Sachidananda, "Antennas and Wave Propogation", Oxford University Press.
2. Edward Conrad Jordan and Keith George Balmain, "Electromagnetic Waves and RadiatingSystems", PHI Publication.
3. A. Das, Sisir K. Das, "Microwave Engineering", Tata McGraw Hill Publication.
4. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
5. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
6. R.C. Johnson and H. Jasik, Antenna Engineering Handbook, McGraw ill, 1984.
7. I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House, 1980.
8. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill, 2005

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
CO1. Understand the properties and various types of antennas.
CO2. Analyze the properties of different types of antennas and their design.

Wireless Sensor Networks			
Course code	ECEL411		
Category	Department Elective Course		
Course title	Wireless Sensor Networks (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:
This course covers the challenges and the latest research results related to the design and management of wireless sensor networks (WSNs).

Unit-1	Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks. Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies forWireless Sensor Networks. Issues and challenges in wireless sensor networks	**10(Lectures)**
Unit-2	Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MACprotocol, IEEE 802.15.4 standard and ZigBee, Dissemination protocol for large sensor network. Data dissemination, data gathering, and datafusion; Quality of a sensor network; Real-time traffic support and security protocols.	**10(Lectures)**
Unit-3	Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication.	**8(Lectures)**
Unit-4	Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.	**8(Lectures)**

Text/Reference Books:

1. Waltenegus Dargie , Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks Theory And Practice", By John Wiley & Sons Publications ,2011
2. Sabrie Soloman, "Sensors Handbook" by McGraw Hill publication. 2009
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", Elsevier Publications,2004
4. Kazem Sohrby, Daniel Minoli, "Wireless Sensor Networks": Technology, Protocols andApplications, Wiley-Inter science
5. Philip Levis, And David Gay "TinyOS Programming" by Cambridge University Press2009

Course Outcomes:

At the end of the course the students will be able to

CO1. Design wireless sensor networks for a given application
CO2. Understand emerging research areas in the field of sensor networks
CO3. Understand MAC protocols used for different communication standards used in WSN
CO4. Explore new protocols for WSN.

High Speed Electronics			
Course code	ECEL412		
Category	Department Elective Course		
Course title	High Speed Electronics (Theory)		
Scheme and Credits	**Credits**	**3+0**	
Pre-requisites (if any)	-		

Course Objective:

- The course deals with the theory and design of high speed electronic systems and interconnects in both the digital and analogue domain.

Unit-1	Transmission line theory (basics) crosstalk and nonideal effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency power delivery, methodologies for design of high speed buses; radiated emissions and minimizing system noise; Noise Analysis: Sources, Noise Figure, Gain compression, Harmonic distortion, Intermodulation, Cross-modulation, Dynamic range	**10(Lectures)**
Unit-2	Devices: Passive and active, Lumped passive devices (models), Active (models, low vs high frequency) RF Amplifier Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed) Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages	**9(Lectures)**
Unit-3	Mixers –Upconversion, Downconversion, Conversion gain and spurious response. Oscillators Principles. PLL Transceiver architectures	**8(Lectures)**
Unit-4	Printed Circuit Board Anatomy, CAD tools for PCB design, Standard fabrication, Microvia Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.	**9(Lectures)**

Text/Reference Books:

1. Stephen H. Hall, Garrett W. Hall, James A. McCall " High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", August 2000, Wiley-IEEE Press
2. Thomas H. Lee, " The Design of CMOS Radio-Frequency Integrated Circuits", CambridgeUniversity Press, 2004, ISBN 0521835399.
3. Behzad Razavi, " RF Microelectronics", Prentice-Hall 1998, ISBN 0-13-887571-5.
4. Guillermo Gonzalez, " Microwave Transistor Amplifiers", 2nd Edition, Prentice Hall.
5. Kai Chang, "RF and Microwave Wireless systems", Wiley.
6. R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011

Course Outcomes:

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

CO1. Understand significance and the areas of application of high-speed electronics circuits.
CO2. Understand the properties of various components used in high speed electronics
CO3. Design High-speed electronic system using appropriate components.

ECE Open Elective Courses
Detailed Syllabus

Introduction to Microcontrollers and Embedded Systems	
Course Code	**ECOE01**
Course Title	**Introduction to Microcontrollers and Embedded Systems**
Number of Credits	**3+0**
Prerequisites	**NONE**

Course learning Objective: To impart knowledge on basics of Microcontrollers and Embedded Systems and their applications.

Unit	Topics	Lectures
I	**Basic Terms in Embedded system:** Introduction to Microcontrollers and Microprocessors, embedded versus external memory devices, CISC and RISC processors, Harvard and Von Neumann Architecture, 8051 microcontrollers-Assembly language, Architecture of 8051, Registers, Addressing Modes, Instruction Set. **8051 internal architecture and programming:** I/O ports, memory organization, Programs showing use of I/O Pins, Interrupts, Interrupt Programming, Timer and counters, Serial Communication, Programming of serial communication.	**9**
II	**Introduction to advanced concept in embedded system:** Introduction: Embedded System, Application of Embedded System, Embedded operating system, Design Parameters of embedded and its Significance, Design life cycle, Hardware fundamentals, Digital circuit parameter, O.C and Tristate outputs, I/O sink and Source, Custom single purpose processor Optimization, FSMD, data path & FSM , General purpose Processor and ASIP'S	**9**
III	**Introduction to operating system and basics of higher embedded system:** Introduction to RTOS, Tasks, Data, Semaphores and shared data, Operating system services, Message queues, Mailboxes, Advanced processor (Only architecture), 80386, 80486, ARM (References)	**9**
IV	**Communication basics and interfacing of various devices the microcontroller:** Microprocessor interfacing I/O addressing, direct memory access (DMA), Arbitration, multilevel bus architecture, serial protocol, parallel protocols and wireless protocol, Real world interfacing: LCD, Stepping motor, ADC, DAC, LED, Pushbuttons, Keyboard, Latch connection, PPI.	**9**

Text Books

1. Embedded system Design-Frank Vahid/ Tony Givargis. John Willey
2. Microcontroller (Theory and applications) Ajay V Deshmukh, Tata , McGraw-Hill
3. An Embedded Software Primer-David E.Simon, Pearson Education

Reference Books:

4. The 8051 Microcontroller and embedded systems-Muhammad Ali Mazidi and Janice Gillispie.
5. Microcontrollers (Architecture, Implementation & Programming) Kenneth Hinz, DanielTabak,Tata McGraw-Hill
6. 8051 Microcontrollers & Embedded Systems 2nd edition Sampath Kr. Katson books

Course outcomes

At the end of the course student will be able

CO-1. Understand various Embedded system related concepts, Memory classification, 8051 architecture and its Instructions.
CO-2. Demonstrate the programming of I/O, Timers, Serial communication and Interrupt of 8051.
CO-3. Differentiate types of embedded processor and their use in embedded system.
CO-4. Remember the application of RTOS and its various services in embedded systems such as Semaphores, Mailbox. Architecture of high-end processor.
CO-5. Learn various Communication protocol and demonstrate interfacing of
CO-6. microcontroller with various components such as LCD, motor, stepper motor and pushbuttons.

Introduction To MEMs	
Course Code	**ECOE02**
Course Title	**Introduction To MEMs**
Number of Credits	**3+0**
Prerequisites	**NONE**

Course learning Objective:

1. Understand the Basic concept of MEMS, Mechanics of Beam and Diaphragm Structures, Air Damping and Electrostatic Actuation.
2. Know the knowledge of Thermal Effects and the Applications of MEMS in RF.

Unit	Topics	Lectures
I	**Introduction to MEMS:** MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes for Micromachining, Characteristics, Sensors/Transducers, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor. **Mechanics of Beam and Diaphragm Structures:** Stress and Strain, Hooke's Law. Stress and Strain of Beam Structures: Stress, Strain in a Bent Beam, Bending Moment and the Moment of Inertia, Displacement of Beam Structures Under Weight, Bending of Cantilever Beam Under Weight.	9
II	**Air Damping:** Drag Effect of a Fluid: Viscosity of a Fluid, Viscous Flow of a Fluid, Drag Force Damping, The Effects of Air Damping on Micro-Dynamics. Squeeze-film Air Damping: Reynolds' Equations for Squeeze-film Air Damping, Damping of Perforated Thick Plates. Slide-film Air Damping: Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model.	9
III	**Electrostatic Actuation:** Electrostatic Forces, Normal Force, Tangential Force, Fringe Effects, Electrostatic Driving of Mechanical Actuators: Parallel-plate Actuator, Capacitive sensors. Step and Alternative Voltage Driving: Step Voltage Driving, Negative Spring Effect and Vibration Frequency.	9
IV	**Thermal Effects:** Temperature coefficient of resistance, Thermo-electricity, Thermocouples, Thermal and temperature sensors. **Applications of MEMS in RF:** MEMS Resonator Design Considerations, One-Port Micromechanical Resonator Modeling Vertical Displacement Two-Port Microresonator Modeling, Micromechanical Resonator Limitations.	9

Text Books

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat and V. K. Atre, "Micro and smart systems", Wiley India, 2010.
2. S.M. Sze, "Semiconductor Sensors", John Wiley & Sons Inc., Wiley Interscience Pub.
3. M.J. Usher, "Sensors and Transducers", McMillian Hampshire.
4. RS Muller, Howe, Senturia and Smith, "Micro sensors", IEEE Press

Course outcomes

At the end of the course student will be able

- **CO1.** Understand the Basic concept of MEMS Fabrication Technologies, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor.
- **CO2.** Explain Mechanics of Beam and Diaphragm Structures.
- **CO3.** CO3: Understand the Basic concept of Air Damping and Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model.
- **CO4.** Know the concept of Electrostatic Actuation. CO5: Understand the applications of MEMS in RF

Digital VLSI Design	
Course Code	**ECOE03**
Course Title	**Digital VLSI Design**
Number of Credits	**3+0**
Prerequisites	**NONE**

Course Learning Objective
To impart knowledge on basics of VLSI Design and Digital Integrated Circuits.

Unit	Topics	Lectures
I	**Introduction:** VLSI Design flow, general design methodologies; critical path and worst case timing analysis, overview of design hierarchy, layers of abstraction, integration density and Moore's law, VLSI design styles, packaging, CMOS Logic, Propagation Delay definitions, sheet resistance **Interconnect Parameters:** Resistance, Inductance, and Capacitance, skin effect and its influence , lumped RC Model, the distributed RC Model, transient Response, RC delay model, Linear Delay Model, Logical Effort of Paths, Scaling.	9
II	**Dynamic CMOS design:** steady-state behavior of dynamic gate circuits, noise considerations in dynamic design, charge sharing, cascading dynamic gates, domino logic, np-CMOS logic, problems in single-phase clocking, two phase non-overlapping clocking scheme, Sequential CMOS Logic Circuits, Layout design	9
III	**Semiconductor Memories:** Dynamic Random Access Memories (DRAM), Static RAM, non-volatile memories, flash memories, Pipeline Architecture. Low – Power CMOS Logic Circuits: Introduction, Overview of Power Consumption, Low – Power Design through voltage scaling,	9
IV	**Introduction to Testing:** Faults in digital circuits. Modeling of faults, Functional Modeling at the Logic Level, Functional Modeling at the Register, Structural Model and Level of Modeling. Design for Testability, Ad Hoc Design for Testability Techniques, Controllability and Observability, Introduction to Built-in-self-test (BIST) Concept.	9

Text Book:

1. Sung-Mo Kang & Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis & Design",Mcgraw Hill, 4th Edition.
2. Neil H.E.Weste, David Money Harris, "CMOS VLSI Design – A circuits and Systems Perspective" Pearson, 4th Edition.
3. D. A. Pucknell and K. Eshraghian, "Basic VLSI Design: Systems and Circuits", PHI, 3rd Ed.,1994.

Reference Books:

1. R. J. Baker, H. W. Li, and D. E. Boyce , " CMOS circuit design, layout, and simulation", Wiley-IEEE Press,2007.
2. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design" , Jaico Publishing House.

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

- **CO1.** Express the concept of VLSI design and CMOS circuits and delay study.
- **CO2.** Analyze mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits.
- **CO3.** Design and analyze various combinational & sequential circuits based on CMOS technology.
- **CO4.** Examine power logic circuits and different semiconductor memories used in present day technology.
- **CO5.** Interpret faults in digital circuits, Fault Models and various Testing Methodologies.

Wireless Communication and Networks	
Course Code	**ECOE04**
Course Title	**Wireless Communication and Networks**
Number of Credits	**3+0**
Prerequisites	**NONE**
Course Learning Objective To impart knowledge on basics of Wireless Communication and Networks.	

Unit	Topics	Lectures
I	**Cellular concepts**- Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G 3G, 4G and 5G cellular mobile standards.	**9**
II	**Signal propagation**- Propagation mechanism, reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small-scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.	**9**
III	**Antennas:** antennas for mobile terminal, monopole antennas, PIFA, base station antennas and arrays. **Multiple access schemes**-FDMA, TDMA, CDMA and SDMA. Modulation schemes-BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM. Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity Altamonte scheme.	**9**
IV	MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff. Performance measures- Outage, average snr, average symbol/bit error rate. System examples-GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA, 3G, 4G and 5G mobile communications.	**9**

Text Books

1. Erik Dahlman , 4G, LTE-Advanced Pro and The Road to 5G

2. Sassan Ahmadi, 5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards Hardcover – 1 June 2019

3. Vijay K. Garg, "Wireless Communication and Networking", Elsevier, Morgan Kaufmann,

4. Reprinted 2012.

5. Vijay K. Garg, J.E. Wilkes, "Principle and Application of GSM", Pearson Education, Fifth Impression 2008

6. T.S. Rappaport, "Wireless Communications Principles and Practice", PHI, II Edition, 2006.

7. William Lee," Mobile Cellular Telecommunications: Analog and Digital Systems", McGraw Hill Education

Course outcomes

At the end of the course student will be able

CO1. Understand cellular concepts and signal propagation in mobile communication.

CO2. Perform small simulations and plot results on modulation techniques.

CO3. Analysis performance of different generations of mobile communications.

CO4. Solve numerical problems on different multi-access and modulation schemes of mobile communications.