ECE Department

UG Curriculum

(2020-21 Session Onwards)

A. SEMESTER WISE UG SCHEME TO BE IMPLEMENTED W.E.F. 2020-21 SESSION

Semester wise UG Scheme to be implemented w.e.f. 2020-21 session

SEMESTER-I		
S.No.		**Credits**
1	Orientation (including Introduction to Discipline course-1 credit 14 hours)	2
2	BSC-I (Mathematics)	4
3	BSC-II/ BSC-IV (Physics/ Chemistry)	4
4	GSC-I & GSC-II/ ESC-I	4
5	HSM-I/ ESC-II	3
6	ESC-III/ ESC-IV	3 / 2
	TOTAL	**20 / 19**

SEMESTER-II		
S.No.		**Credits**
1	BSC-III (Mathematics)	4
2	BSC-IV/ BSC-II (Chemistry/ Physics)	4
3	ESC-I/ GSC-I & GSC-II	4
4	ESC-II/ HSM-I	3
5	ESC-IV/ ESC-III	2 / 3
6	ESC-V/ ESC-VI	2
	TOTAL	**19/ 20**

SEMESTER-III		
S.No.		**Credits**
1	ESC-VII/ HSM-II	3
2	Deptt Core Courses (DCC)	12
3	OE-I	4
4	Industrial Tour	2
	TOTAL	**21**

SEMESTER-IV		
S.No.		**Credits**
1	HSM-II/ ESC-VII	3
2	Deptt Core Courses (DCC)	12
3	OE-II	4
4	Proficiency-I	2
	TOTAL	**21**

SEMESTER-V		
S.No.		**Credits**
1	DEC-I	4
2	Deptt Core Courses (DCC)	12
3	DEC-II	4
4	Minor Project	3
	TOTAL	**23**

SEMESTER-VI		
S.No.		**Credits**
1	**Internship Training (Optional)**	12
	Students opting for course work will do Deptt. Elective (4 credits), Open Elective (4 credits) and Project Work (4 credits)	
	TOTAL	**12**

SEMESTER-VII		
S.No.		**Credits**
1	HSM-III	3
2	DEC-III	4
3	DEC-IV	4
4	OE-III	4
5	OE-IV	4
6	Major Project-I	2
	TOTAL	**21**

SEMESTER-VIII		
S.No.		**Credits**
1	HSM-IV	3
2	DEC-V	4
3	OE-V	4
4	OE-VI	4
5	Discipline	2
6	Proficiency-II	2
7	Major Project-II	4
	TOTAL	**23**

ABBREVIATIONS	
Basic Science Course	BSC
Engineering Science Course	ESC
General Science Course	GSC
Humanities, Social Sciences & Mgmt.	HSM

ABBREVIATIONS	
Department Core Course	DCC
Department Elective Course	DEC
Open Elective Course	OE

Total Credits = 160 without Honours

Total Credits = 160 + 16 with Honours

Note: *Minor Specialization will be given to a student who earns 16 credits from the basket of Open Elective courses offered by any one department (outside the parent department). Major Specialization will be given to a student who earns 16 credits in any one domain of Department Elective courses offered by parent department. To get Honours, the student will have to complete additional 16 credits of discipline Electives.*

ESC-I	Introduction to Computing
ESC-II	Engineering Drawing with CAD Software
ESC-III	Introduction to Mechatronics
ESC-IV	Introduction to Electronics & electrical Engineering
ESC-V	Introduction to Manufacturing
ESC-IV	Strength of Materials
ESC-VII	Artificial Intelligence & Machine Learning
ESC-VII and HSM-II (in 3rd and 4th semesters) are common to all branches.	

B. COURSES / CREDITS DISTRIBUTION

I. Institute Core Courses (ICC) – 37 Credits
   a. Basic Science Courses (BSC) – 16 Credits
   b. Engineering Science Courses (ESC) – 17 Credits
   c. General Science Courses (GSC) – 4 Credits

II. Humanities, Communication and Management Elective Courses (HSSMEC) – 12 Credits

III. Departmental Core Courses (DCC)- 39 Credits Including 3 credits for Minor Project

IV. Departmental Elective Courses (DEC) – 20 Credits

V. Institute Open Elective Courses – 30 Credits
   a. Open Elective Courses – 24 Credits
   b. Project (Compulsory Major Project) – Interdisciplinary – 6 Credits

VI. Internship (Optional) / Course Work – 12 Credits
(Students Opting for course work will do department elective (4 credits), open elective (4 credits) and Project Work (4 Credits)

VII. Non-Academic Courses (NAC) – 10 Credits

Total Credits (without Honours): 160
Honours: 16 Credits
Total Credits (with Honours): 160 + 16 = 176

- *Major Specialization:*

  Major Specialization will be given to a student who earns 16 credits (within 160 credits) in any one specialized domain of Department Elective Courses (DEC) offered by the ECE department.

- *Minor Specialization:*

  Minor Specialization in ECE will be given to a student of outside the ECE department who earns 16 credits (within 160 credits) from the basket of Open Elective Courses offered by the ECE department as Minor Specialization Courses (MSC).

- *Honours:*

  To get Honours in ECE, the student will have to complete additional 16 credits (over and above 160 credits) of Department Elective Courses (DEC) of ECE department.

I. List of Institute Core Courses (ICC) – 37 credits

a. Basic Science Courses (BSC) – 16 Credits
b. Engineering Science Courses (ESC) – 17 Credits
c. General Science Courses (GSC) – 4 Credits

Basic Science Courses (BSC) – 16 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							
1.	MA1101	Calculus and Ordinary Differential Equations	3	1	0	4	BSC-I
2.	CH1101	Applied Chemistry-I	3	0	2	4	BSC-IV
Semester II							
3.	PY1201	Electromagnetic Theory and Quantum Physics	3	0	2	4	BSC-II
4.	MA1201	Linear Algebra, vector Calculus, and partial differential equations	3	1	0	4	BSC-III
					Total Credits	16	

Engineering Science Courses (ESC) – 17 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							
1.	ES1101	Introduction to Computing*	3	0	2	4	ESC-I
2.	ES1201	Engineering Drawing with CAD Software	2	0	2	3	ESC-II
3.	ES1301	Introduction to Mechatronics	2	0	2	3	ESC-III
Semester II							
4.	ES1401	Introduction to Electronics & Electrical Engineering	2	0	0	2	ESC-IV
5.	ES1501	Introduction to Manufacturing	2	0	0	2	ESC-V
Semester III							
6.	ES1701	Artificial Intelligence and Machine Learning*	2	0	2	3	ESC-VII
					Total Credits	17	

*Common to All Branches

General Science Courses (GSC) – 4 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester II							
1.	GS1101 & GS1201	Introduction to Environmental Sciences – I Introduction to Environmental Sciences - II	2 1	0 0	0 2	2 2	GSC I & GSC II
					Total Credits	4	

II. List of HSM Courses – 12 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester II							
1.	HS1101	Communication Skills & Ethics	2	0	2	3	HSM-I
Semester IV							
2.	HS2301 / HS2302 / HS2303 / HS2304	Basics of Economics / French- Basic / General Psychology / Sociology	2 2 2 2	1 1 1 1	0 0 0 0	3	HSM-II
Semester VII							
3.	HS2701 / HS2702 / HS2703 / HS2704 / HS2705 / HS2706 / HS2707 / HS2708	Anthropology / Appreciation of Art / English Literature / History / Introduction to Art History / Philosophy- an Introduction / Political Science / Public Administration	2 3 2 3 3 3 2 2	1 0 1 0 0 0 1 1	0 0 0 0 0 0 0 0	3	HSM-III
Semester VIII							
4.	HS2801 / HS2802 / HS2803	Business Environment and Business Laws / Entrepreneurship and Project Management / Financial Management	2 2 2	1 1 1	0 0 0	3	HSM-IV
				Total Credits		12	

Semester Wise Courses Detail

SEMESTER-I			
S.NO.			CREDITS
1	Orientation (including Introduction to Discipline course-1 credit 14 hours)		2
2	BSC-I (Mathematics):	Math-I	4
3	BSC-II/BSC-IV (Physics/Chemistry) :	Chem-I	4
4	GSC-I & GSC-II/ESC-I :	ESC-I	4
5	HSM-I/ESC-II :	ESC-II	3
6	ESC-III/ESC-IV :	ESC-III	3
	TOTAL		20

SEMESTER-II			
S.NO.			CREDITS
1	BSC-III(Mathematics) :	(Math-II) (Linear Algebra, vector calculus and partial differential equations)	4
2	BSC-IV/BSC-II (Chemistry/Physics) :	BSC-II (Phy)	4
3	ESC-I/GSC-I & GSC-II :	GSC-I & GSC-II	4
4	ESC-II/HSM-I :	HSM-I	3
5	ESC-IV/ESC-II :	ESC-IV (ES1401)	2
6	ESC-V/ESC-VI :	ESC-V	2
	TOTAL		19

SEMESTER-III		
S.NO.		CREDITS
1	ESC-VII/HSM-II	3
2	Digital Logic Design (DCC)	4
3	Electronic Devices and Circuits (DCC)	4
4	Circuit Theory (DCC)	4
5	OE-I	4
6	Industrial Tour	2
	TOTAL	21

SEMESTER-IV		
S.NO.		CREDITS
1	HSM-II/ ESC-VII	3
2	Analog Electronics (DCC)	4
3	Probability and Random Processes (DCC)	4
4	Signals and Systems (DCC)	4
5	OE-II	4
6	Proficiency-I	2
	TOTAL	21

SEMESTER-V		
S.NO.		CREDITS
1	DEC-I	4
2	Analog and Digital Communication (DCC)	4
3	Control Systems (DCC)	4
4	Microwave Engineering (DCC)	4
5	DEC-II	4
6	Minor Project	3
	TOTAL	23

SEMESTER-VI		
S.NO.		CREDITS
1	Internship Training(Optional)	
	Students opting for course work will do Dept. Elective (4 Credits), Open Elective (4 credits) and Project Work (4 Credits)	12
	TOTAL	12

SEMESTER-VII		
S.NO.		CREDITS
1	HSM III	3
2	DEC-III	4
3	DEC-IV	4
4	OE-III	4
5	OE-IV	4
6	Major Project-I	2
	TOTAL	21

SEMESTER-VIII		
S.NO.		CREDITS
1	HSM-IV	3
2	DEC-V	4
3	OE-V	4
3	OE-VI	4
4	Discipline	2
5	Proficiency-II	2
6	Major Project-II	4
	TOTAL	23

Scheme for B.Tech. (ECE) – List of Departmental Core Courses

COURSE NAME	L-T-P
Semester-3	
Digital Logic Design (EC1231)	3-0-2
Electronic Devices and Circuits (EC1232)	3-0-2
Circuit Theory (EC1233)	3-1-0
Semester-4	
Analog Electronics (EC1241)	3-0-2
Probability and Random Processes (EC1242)	3-1-0
Signals and Systems (EC1243)	3 -1-0
Semester-5	
Analog and Digital Communication (EC1351)	3-0-2
Control Systems (EC1352)	3-1-0
Microwave Engineering (EC1353)	3-0-2

CODE- EC:range:year:semester:course number

List of Dept. Elective Courses With Specialized Domains (Credit: 20)

	Communication Engineering	VLSI Design	Embedded Systems
DEC 1/ DEC 2	Information Theory and Coding (3-1-0) (EC2211)	Electronics Devices Fabrication (3-0-2) (EC2231)	Microprocessor and Microcontroller (3-0-2) (EC2221)
	Computer Communication Networks (3-1-0) (EC2212)	HDL based System Design (3-0-2) (EC2232)	Industrial Automation (3-1-0) (EC2222)
	Digital Image Processing (3-1-0) (EC2213)	Power Electronics (3-1-0)(DEC2) (EC2233)	Embedded System Design (3-0-2) (EC2223)
	Digital Signal Processing (3-0-2) (DEC2) (EC2214)	Digital VLSI Design (3-0-2)(DEC2) (EC2234)	IoT with ARDUINO and Raspberry Pi (3-02) (EC2224)
DEC 3/ DEC 4	Antenna and Wave Propagation (3-1-0) (EC2311)	PCB Circuit Design (3-0-2) (EC2331)	Neural Networks and Fuzzy System (3-1-0) (EC2321)
	Satellite Communication (3-1-0) (EC2312)	Foundations of VLSI CAD (3-1-0) (EC2332)	Computer Architecture (3-1-0) (EC2322)
	Optical Communication (3-0-2)(EC2313)	Analog VLSI Design (3-0-2) (EC2333)	Multimedia technology (3-1-0) (EC2323)
	Wireless Communication (3-0-2) (EC2314)	FPGA & ASICs (3-1-0) (EC2334)	Digital Image Processing (3-1-0) (EC2324)
DEC 5	Advanced digital communication (3-1-0) (EC2411)	Nanotechnology (3-1-0) (EC2431)	Advanced Sensing technology (3-1-0) (EC2421)
	Mobile and Cellular Communication(3-0-2) (EC2412)	MEMS & Microsystems (3-1-0) (EC2432)	Robotics (3-1-0) (EC2422)
	MIMO Wireless Communication (3-1-0) (EC2413)	Low Power VLSI Devices (3-1-0) (EC2433)	PLC Designing (3-1-0) (EC2423)
		Advanced VLSI Devices (3-1-0) (EC2434)	

CODE-EC:range:year:pool(alphabetical):course number

List of Open Elective Courses (Credit: 20)

1	Communication Systems*(3-1-0) (EC6011/EC5001)
2	Digital Image Processing*$ (3-1-0) (EC6012/EC5003)
3	Computer Networks (3-1-0) (EC6013)
4	Advanced Communication Systems (3-1-0) (EC6014)
5	Mobile and Cellular Communication (3-0-2) (EC6015)
6	Digital Signal Processing*$ (3-1-0) (EC6106/EC5004)
7	Analog and Digital Electronics * (3-1-0) (EC6021/EC5002)
8	Introduction to Printed Circuit Board (3-0-2) (EC6022)
9	Electronic Measurements and Instrumentation (3-1-0) (EC6023)
10	MEMS and Microsystems (3-1-0) (EC6024)
11	Electronics Device Fabrication (3-0-2) (EC6025)
12	Nano Electronics Devices (3-0-2) (EC6026)
13	PLC designing (3-1-0) (EC6031)
14	ARDUINO Programming and Raspberry Pi (3-1-0) (EC6032)
15	Sensing Technology (3-1-0) (EC6033)
16	Multimedia Technology (3-1-0) (EC6034)
17	Microcontrollers and their Applications*# (3-1-0) (EC6035/EC5005)
18	Microprocessor and Microcontroller*# (3-1-0) (EC6036/EC5006)

Code- range:range:different_pool:course number

*** Fixed for Minor Specialisation; $/# : any one subject**

(code- range: range: range: course number)

Minor Specialization Courses (16 Credits)

Minor Specialization Courses (MSC)					
	Course name	L	T	P	Credits
1.	Analog and Digital Electronics	3	1	0	4
2.	Communication Systems	3	1	0	4
3.	Digital Signal Processing/ Digital Image Processing	3	1	0	4
4.	Microprocessor and Microcontroller/ Microcontroller and its applications	3	1	0	4

Detailed syllabus of Dept. Core courses

Course Name	**:**	**DIGITAL LOGIC DESIGN**
Course Code	**:**	**EC1231**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:

At the end of this course, the student should be able to design and analyze various combinational and sequential logic circuits and compare various A/D and D/A Converters, Logic families and their characteristics.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**DIGITAL FUNDAMENTALS** Binary Codes, Binary Logic, Complements, Theorems of Boolean algebra, Sum of Products and Products of Sum forms, Boolean function minimization, logic gates, Universal building blocks- NAND and NOR gates,	5
2	**COMBINATIONAL LOGIC** Half adder, full adder, Half subtractor, Full Subtractor, Parallel binary adder, Combined adder subtractor, BCD adder, binary multiplier, magnitude comparator, code converter, encoder decoder, multiplexer, demultiplexer, parity detector and generator, three state gate Introduction to HDL- Structural, Dataflow and Behavioral modeling, Combinational circuit design using HDL	10
3	**SYNCHRONOUS SEQUENTIAL LOGIC** Introduction, Flip Flops, Analysis of clocked sequential circuits, Design of synchronous sequential circuits, Mealy and Moore finite state machines, Counters, Shift Registers	9
4	**ASYNCHRONOUS SEQUENTIAL CIRCUITS** Analysis Procedure, Circuits with latches; Design Procedure, Reduction of state and flow table; Race free state ASM assignment; Hazards; chart; Design examples	5
5	**DIGITAL MEMORIES & PROGRAMMABLE LOGIC** ROM, RAM (static and dynamic), PROMS, PLA and PAL	4
6	**A/D AND D/A CONVERTERS** Various types of A/D and D/A Converters, Performance Parameters (Resolution, Accuracy etc.)	4
7	**LOGIC FAMILIES** Characteristics of logic families, RTL, TTL, ECL, CMOS logic families.	5

List of Experiments:		**Number of Turns**
1	To Study the data sheets of various logic families	**1**
3	To simulate and implement a logic function using logic gates.	**1**
4	To simulate and implement Adder and Subtractor circuits.	**1**
5	To simulate and implement code converters.	**2**
6	To simulate and implement combinational circuits using Multiplexers.	**1**
7	To simulate and implement Flip-flops using NAND and NOR Gates.	**1**
8	To study the operation of shift register.	**1**
9	To study the operation of counter ICs.	**2**
10	To simulate and implement the synchronous sequential circuits.	**2**
11	To simulate and implement an application based on digital circuits.	**2**

Course Outcomes:	
1	Design the combinational circuits using logic gates making use of various Boolean laws and minimization techniques.
2	Design and analyze combinational circuits with MUX, DEMUX,Encoder, Decoder ,PLDs etc.
3	Design and analyze various sequential circuits.
4	Compare the different logic families, memories and A/D-D/A converters.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Digital Design by Morris Mano, PHI, 4th edition	2008
2	Digital principles and Applications, by Malvino Leach, TMH	2011
3	Digital System Principles and Applications, by R J Tocci (PHI)	2009
4	Modern Digital Electronics, by R P Jain, TMH	2006
5	Digital Integrated Electronics, by Taub Schilling, TMH	2004

Course Name	**:**	**ELECTRONIC DEVICES AND CIRCUITS**
Course Code	**:**	**EC1232**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives: **Total No. of Lectures – 42**

At the end of this course, the student should be able to identify active and passive components and to solve simple electronic circuits. The student should also be able to explain construction, operation, characteristics and biasing of diodes, BJTs and FETs. The student should also be able to analyze the mathematical models of transistor amplifier circuits analyze the frequency response of amplifiers and describe the operation of power amplifiers.

Lecture wise breakup	**No. of Lectures**

1	**Semiconductor physics** Electron affinity, work function, quasi-states, fermi level, Equilibrium Carrier concentration, Temperature dependence on Carrier concentration, Drift, Diffusion, Recombination-generation	(6)
2.	**PN Junction diode and diode circuits** Space charge at a junction, electrostatic analysis of junction at different bias conditions, band diagrams, Depletion and Diffusion Capacitances, Switching Characteristics, and Breakdown Mechanisms, Rectifier circuits, Clippers, Clampers, Special purpose diodes, Metal-Semiconductor Junctions: Schottky barrier, Rectifying and Ohmic Contacts	(8)
3	**Bipolar Junction Transistors** Transistor operation, Carrier Distribution, Transit Time, Transistor configurations, , characteristics of CB, CE and CC configuration, Transistor as an amplifier, Load line and Operating point, Bias stability, various biasing circuits, Thermal Runaway, Thermal stability	(5)
4.	**Metal Oxide Field Effect Transistors:** Basic Operation, Ideal MOS Capacitor, Electrostatic analysis, Effects of real surfaces, Threshold Voltage, Body effect, C-V and I-V Characteristics	(8)
5.	**Amplifiers** Small-Signal Equivalent Circuits: FET/MOSFET; Biasing and Design of FET/MOSFET (CS, CG, and CD) Amplifiers, Frequency Response of Amplifiers, High Frequency Device Models, Gain bandwidth product	(8)
6.	**Other Semiconductor devices:** Compound semiconductor based electronic, optoelectronic, and photonic devices and integrated circuits, CCD and imaging devices	(7)

ELECTRONIC DEVICE AND CIRCUITS (LAB)

List of Experiments		**No. of turns**
1.	To study electronic components and various testing and measuring equipment.	2
3.	To study the V-I characteristics of p-n junction diode and determine static resistance and dynamic resistance.	1
4.	To simulate and implement clipper and clamper circuits.	2
5.	To simulate and implement half wave and full wave rectifier.	1
6.	To study the characteristics of BJT in different configurations.	2
7.	To study the characteristics of MOSFET	1
8.	To simulate and verify the operation of BJT/MOSFET as an amplifier and draw the frequency response.	2

Course Outcomes:

At the end of this course, the student will be able to

1. Analyse simple electronic circuits based on the knowledge of devices such as diodes and transistors (BJT and FET) with special focus on designing amplifiers with discrete components
2. Design and analyse bias circuits for BJTs for the basic categories (CE, CC, CB)
3. Analyse the modelling of transistor and formulate the performance parameters of the amplifier.
4. Perform design of Amplifiers and frequency analysis based on BJTs using small signal model.
5. Demonstrate basic skills on using electronic devices simulation programs and on applying them in homework and laboratory exercises functioning effectively as a team.

Text Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
2	D. A. Neamen and D. Biswas, *Semiconductor Physics and Devices*, 4th edition. Tata McGraw-Hill, 2012.	**2012**
3	R. F. Pierret, *Semiconductor Device Fundamentals*. Pearson, 2006.	**Latest edition**
5	B. Razavi, *Fundamentals of Microelectronics*, 2nd edition. Wiley-India, 2014.	**2014**

Suggested Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	B. G. Streetman and S. K. Banerjee, *Solid State Electronic Devices*, 7th edition. Pearson, 2015.	**2015**
2	A. S. Sedra and K. C. Smith, *Microelectronic Circuits: Theory and Applications*, 7th edition. Oxford, 2017.	**2017**
3	Millman & Halkias, *Electronic devices and circuits*, **TMH**	**Latest Edition**
4	Sedra, A. S., Smith, K. C., and Chandorkar, A. N., (2013), Microelectronic Circuits: International Version, 6th Edition, Oxford University Press	**2013**

Course Name	**:**	**CIRCUIT THEORY**
Course Code	**:**	**EC1233**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The main aim of this course is to make students learn the fundamentals of network analysis using matrices, two-port and multi-port networks, and network synthesis and filter circuits.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SINUSOIDAL STEADY STATE ANALYSIS:** Sinusoids, Phasors, Impedance and admittance, kirchhoff's law in frequency domain, impedance combinations, steady state analysis: nodal and mesh analysis, dependent, independent voltage and current sources, source transformation, thevenin and norton equivalent. AC power analysis: instantaneous and average power, max average power transfer, RMS value, apparent power and power factor, complex power, conservation of AC power. Three phase circuits: types of load and source connections, power in balanced three phase circuits, star delta transformations. Network theorems: compensation, superposition, reciprocity, millman's and tellegen's theorem.	**8**
2	**TRANSIENT NETWORK ANALYSIS:** Complex frequency and Laplace transforms, circuits analysis in S domain, poles, zeros, transfer Functions and driving point impedances and convolution. Step and impulse response of RL, RC, LC, RLC circuits, initial and final conditions.	**8**
3	**TWO PORT NETWORKS :** short circuit admittance parameter, open circuit impedance parameters, hybrid and transmission parameters, series parallel and tandem connection of two port networks, multi port networks, multi terminal networks, indefinite admittance matrix and its properties, relationships among different network parameters	**10**
4.	**Network Synthesis** Elements of realizability theory: causality and stability, hurwitz polynomials, positive real functions, elementary synthesis procedure, synthesis of one port network with two kind of element: L-C driving point immittances, synthesis of R-L, L-C functions.	**6**
4	**GRAPH THEORY:** Introduction, Linear graph of a network, Tie-set and cut-set schedule, incidence matrix, Analysis of resistive network using cut-set and tie-set, Dual of a network.	**5**
5	**FILTERS:** Series and parallel resonance, single and double tuned circuits. Passive filters: lowpass, highpass, bandpass and bandstop filters, difference between actual and ideal frequency response	**5**

Course Outcomes: By the end of the course, the student must be able to:	
1	Acquire knowledge of the fundamentals of network analysis using matrices, two-port and multi-port networks, network synthesis and filter circuits..
2	Analyze DC and AC (single and three phase) circuits making use of various circuit techniques.
3	Analyze the magnetic circuits.
4	Analyze various types of two port networks and their inter connection.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Network Analysis, M.E Van Valkenburg, PHI 3rd edition	1980
2	Fundamentals of Electric Circuits, C K Alexander & Matthew N O Sadiku, Mc Graw Hill, 2nd edition.	2003
3	Circuit Theory Analysis and Synthesis, A. Chakrabarty, Dhanpat Rai Publishing Company (P) Limited,	2008
4	Engineering Circuit Analysis, W H Hayt, J E Kemmerly & S M Durbin, Tata McGrawHill Education,	2005

Course Name	**:**	**ANALOG ELECTRONICS**
Course Code	**:**	**EC1241**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:

By the end of this course, the students should be able to design and analyze feedback amplifier and oscillator circuits, explain basic building blocks of operational amplifier, their functioning and demonstrate its various applications in analog systems. The students should also be able to classify various filters and their design and describe the working of multivibrators and operating principle of Phase locked loop.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1.	**POWER AMPLIFIERS** Class A, B, AB stages, output stages, short circuit protection, power transistors and thermal design considerations	(6)
2.	**FEEDBACK AMPLIFIERS AND OSCILLATORS** Concept of feedback, Negative feedback, Gain Desensitization, Bandwidth modification, Modification of I/O impedances, sense and Return techniques, VCCS, VCVS, CCVS, CCCS, Stability in feedback systems, Basic principles of sinusoidal oscillators, tuned collector, tuned base, Hartley oscillator, Colpitt's Oscillator, Phase Shift Oscillator, Wein Bridge Oscillator, Crystal Oscillator, Frequency stability of Oscillator.	(8)
3.	**DIFFERENTIAL AMPLIFIERS** MOS differential pair's large signal analysis, small signal analysis of differential pairs, cascode differential amplifiers, common-mode rejection, and differential amplifiers with active load	(6)
4.	**OPERATIONAL AMPLIFIERS** Op-Amp characteristics and specifications, concept of virtual ground, Inverting and non-inverting amplifiers, op-amp applications including voltage summer, integrator, differentiator, instrumentation amplifiers, Zero crossing detector, Schmitt trigger	(10)
5.	**ACTIVE FILTERS** Filter specifications, design of low pass, high pass, band pass and band reject filters using operational amplifiers; Design of Butterworth and Chebyshev filters, higher order filters; State variable filters.	(7)
6.	**MULTIVIBRATORS** Multivibrators-Monostable, Bistable, Astable, Unsymmetrical/symmetrical triggering, 555 timer-block diagram and working, 555 timer as monostable, astable and bistable multivibrator, phase-locked loop (PLL), voltage regulators	(5)

List of Experiments:		**No. of turns**
1.	To simulate feedback amplifiers and oscillator circuits.	2
2.	To study the working of RC oscillator.	1
3.	To study the working of Opamp as summing and difference amplifier.	1
4.	To study the working of Opamp as integrator & differentiator.	1
5.	To study the working of low pass filter and observe the frequency response.	2
6.	To study the working of high pass filter and observe the frequency response.	2
7.	To study the working of Astable, monostable and bistable multivibrator using 555 timer	2

Course Outcomes: By the end of this course, the students will be able to	
1.	Describe the fundamentals of feedback amplifiers and oscillators.
2.	Draw outputs of the wave shaping circuits and explain operational amplifier along with its applications.
3.	Identify the multivibrator circuits and explain the basic principle of phase locked loop.
4.	Demonstrate the working behavior of devices and circuits and their applications.

Suggested Books:		
Sr. No.	**Name of Book/Authors/Publisher**	**Year of Publication /Reprint**
1.	Sedra, A. S., Smith, K. C., and Chandorkar, A. N., (2013), Microelectronic Circuits: International Version, 6th Edition, Oxford University Press	**2013**
2.	Op-amps and linear integrated circuits by Ramakant A Gayakward Prentice hall 4th edition	2000
3.	Electronics Devices & Circuit Theory, RL Boylestead & L Nashelsky, PHI	2008
4.	Microelectronic Circuits, AS Sedra & KC Smith, OXFORD	2003
5.	Electronics Circuit Analysis and Design, Donald A. Neamen, Tata McGraw Hill	2009
6.	B. Razavi, *Fundamentals of Microelectronics*, 2nd edition. Wiley-India, 2014.	**2014**
7.	Millman, Halkias, Integrated Electronics, TMH	**Latest edition**

Course Name	**:**	**PROBABILITY AND RANDOM PROCESSES**
Course Code	**:**	**EC1242**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, the students should be able to define a random variable and a random processes, get comfortable in working with discrete and continuous random variables and different random processes, i.e., Markov, Bernoulli and Poisson, understand the notion of convergence of random variable and can deduce inequalities frequently used in the probabilistic modeling, appreciate the applications of random variables and processes in communication engineering.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO PROBABILITY** Definitions of probability (Axiomatic and relative frequency), Axioms of probability, Events as sets, Conditional Probability, Independence, Concept of random variables	4
2	**DISCRETE RANDOM VARIABLES** Some examples of discrete distributions, Probability mass functions, Independence, Expectation, Indicators and their usage, Conditional distributions and conditional expectations, Sum of random variables, Simple random walk	6
3	**CONTINUOUS RANDOM VARIABLES** Some examples of continuous distributions, Probability density functions, Independence, Expectation, Conditional distributions and conditional expectations, Functions of random variables, Introduction to order statistics	9
4	**CONVERGENCE OF RANDOM VARAIBLES AND DIFFERENT INEQUALITIES** Central limit theorem, Law of large numbers, zero-one law, Borel-Cantelli Lemma, Markov inequality, Chebyshev inequality, Chernoff Bounds	7
5	**RANDOM PROCESSES** Definition of random processes, Gaussian processes, Stationary processes, Markov Processes (MP), Classification of states in MP, Stationary distributions in MP, Bernoulli Processes, Poisson processes, Combining and splitting of Poisson processes.	12
6	**APPLICATIONS OF PROBABILITY AND RANDOM PROCESS IN COMMUNICATIONS** Self -Information and entropy, Probability of error calculation using MAP and ML Detector, Characterizing wireless channel using random variables, Wireless networks and stochastic geometry, Markov state modeling of a communication channel.	4

Course Outcomes: By the end of this course, the students will be able to	
1	Describe the concept of random variables and get comfortable with axiomatic definition of probability.
2	Work with different discrete and continuous random variables and their functions.
3	Get familiarized with convergence of random variables and different inequalities frequently used in probabilistic modeling.
4	Describe the concept of random processes, and work with different stochastic processes like Markov, Bernoulli and Poisson processes.
5	Appreciate the importance of probability in the study of communication engineering

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Athanasios Papoulis and S. Unnikrishna Pillai, “Probability, Random variables and Stochastic processes”, TMH, 4th edition,	2002
2	Robert G. Gallager, “Stochastic Processes: Theory for Applications”, CUP, 1st edition	2013
3	Geoffrey Grimmett and David Stirzaker, “Probability and Random Processes”, OUP, 3rd edition	2001
4	J. Proakis , “Digital communications”, MGH , 5th Edition	2008
5	Andrea Goldsmith, "Wireless Communications." CUP, 1st edition	2005

Course Name	**SIGNALS AND SYSTEMS**
Course Code	**EC1243**
Credits	**4**
L T P	**3-1-0**

Course Objectives:

At the end of this course, students should be able to Analyze continuous and discrete time signals and systems. Analyze communication systems in time and frequency domain. Comprehend signals based on Fourier transform and study the impulse response of RC &RL networks, pulse response of RL, RC networks.

Lecture wise breakup (Total no. of Lectures=42)		**Number of Lectures**
1	**INTRODUCTION:** Signals and their classification, Basic operations on signals, elementary CT/DT signals, properties and classification of systems, Systems viewed as Interconnection of Operations	08
2	**TIME DOMAIN REPRESENTATION OF LINEAR TIME INVARIANT SYSTEMS:** Introduction, The Convolution Sum and evaluation procedure, The convolution Integral and Evaluation Procedure, Interconnection of LTI procedures, Relation between LTI system properties and impulse response, Differential and Difference Equations representation, Block Diagram Representation, State Variable Description	11
3.	**FOURIER REPRESENTATIONS OF SIGNALS:** Introduction, Complex Sinusoids and Frequency Response of LTI Systems, Fourier representation of Discrete time and Continuous time Periodic Signals, Fourier representation of Discrete time and Continuous time Nonperiodic Signals, Properties of Fourier Representations, correlation, auto-correlation and cross-correlation and their properties, energy spectral density, power spectral density	10
4.	**REPRESENTING SIGNALS BY USING CONTINUOUS TIME COMPLEX EXPONENTIALS: the LAPLACE TRANSFORM** Introduction, Unilateral and Bilateral laplace transform, their inversion and properties, properties of the region of convergence, transfer function, causality and stability, Laplace transform methods in circuit analysis	06
5	**REPRESENTING SIGNALS BY USING DISCRETE TIME COMPLEX EXPONENTIALS: THE Z- TRANSFORM:** Z-Transform and its properties, Region of convergence and its properties, inverse z transform, transfer function, causality and stability. Computational structure for implementing discrete time LTI systems, Unilateral Z-Transforms.	07

Course Outcome: By the end of this course student will be able to:

1. Explain in detail continuous and discrete signals and systems and solve problems based on them
2. Represent continuous and discrete systems in time and frequency domain using different transforms.
3. Analyze and Characterize the CT systems through Fourier Transform and Laplace Transform
4. Analyze and Characterize the DT systems through DTFT and z-Transform
5. Apply the knowledge of signals and systems to various field of electronics and communication
6. Analyze the response of linear, time-invariant dynamic systems to various input signals

Textbook & Related Course materials Books

1. Signals and systems by A.V. Oppenheim & A.S. willisky, 2nd edition, Pearson education (Latest Edition)
2. Simon Haykin and Barry van Veen " Signal and Systems", Latest edition, Wiley India Pvt. Ltd.
3. Modern Digital & Analog Communication Systems by B.P. Lathi, pub. Oxford Univ. Press, 3rd Edition (2009)
4. Signals And Systems by A. Anand Kumar, Third Edition, Prentice Hall Publication.
5. Introduction to Communication Theory by P.D. Sharma (Latest Edition)
6. Circuits and Networks (Analysis and synthesis):- Sudhakar, Shyammohan (Latest Edition)

Course Name	**:**	**ANALOG AND DIGITAL COMMUNICATION**
Course Code	**:**	**EC1351**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
By the end of this course, the students should be able to describe explain various analog modulation techniques, i.e., amplitude and angle modulation schemes, their generation and detection, and enlist the various functional blocks in analog communication receiver and transmitter. The students should also be able to describe sampling theorem and various pulse modulation schemes. The student should also be able to list the advantages of digital communication system over analog communication systems and appreciate the mathematics involved in designing digital communication systems and understand different digital modulation schemes, and have an introductory idea of information theory.

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO COMMUNICATION SYSTEMS:** Principles of Communication, Signal to Noise Ratio, Channel Bandwidth, Rate of Communication, Modulation.	2
2	**AMPLITUDE MODULATION:** Base band and carrier communication, Amplitude modulation: Double side Band (DSB), Single Side Band (SSB), Vestigial Sideband (VSB), AM Receiver.	7
3	**ANGLE MODULATION:** Concept of Instantaneous Frequency, Bandwidth of Angle Modulation, Generation of FM wave, Demodulation of FM, Interference of Angle Modulated Systems, FM Receivers.	7
4	**DIGITAL TRANSMISSION SCHEMES:** Sampling theorem, Analog to digital conversion schemes: Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation, Pulse Code Modulation (PCM), Differential PCM, Delta Modulation, Adaptive Delta Modulation.	5
5	**INTRODUCTION TO DIGITAL COMMUNICATION SYSTEMS:** Advantages of digital communication over analog communication, Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms.	6
6	**DIGITAL MODULATION TECHNIQUES:** Pulse amplitude modulation (binary and M-ary, Quadrature Amplitude Modulation (QAM)), Pulse position modulation (binary and M-ary), Carrier modulation (M-ary Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), Frequency Shift Keying (FSK), Differential Phase Shift Keying (DPSK)), Continuous phase modulation (Quadrature Phase Shift Keying (QPSK) and variants, Minimum Shift Keying (MSK), Gaussian Minimum Shift Keying (GMSK)).	10
7	**INFORMATION THEORY AND CODING:** Concept of information, Entropy, Mutual information, Source encoding, channel encoding, channel capacity	5

List of Simulations & Experiments:		**Number of Turns**
1	To perform modulation and demodulation of Double sideband modulation with carrier and double sideband modulation- suppressed carrier (DSB-SC)	1
2	To perform single-sideband modulation (SSB) and demodulation	1
3	To perform phase and frequency modulation and demodulation	1
4	To study the operation of phase lock loop (PLL)	2

5	To perform verification of sampling theorem	1
6	To perform modulation and demodulation of pulse amplitude modulation (PAM), pulse width modulation (PWM), and pulse position modulation (PPM)	2
7	To perform delta modulation and adaptive delta modulation	2
8	To perform modulation of amplitude shift keying (ASK), frequency shift keying (FSK)	2
9	To perform modulation of differential phase shift keying modulation (DPSK), minimum shift keying (MSK)	2

Course Outcomes: By the end of this course, the students will be able to	
1.	Explain the working of different analog communication modulation techniques and can describe their modulation and demodulation.
2.	Understand Sampling theorem, and can understand various analog to digital conversion schemes, i.e., Pulse Amplitude Modulation, Pulse Code Modulation (PCM), Differential PCM, and various delta modulation schemes, i.e., Delta Modulation, and Adaptive Delta Modulation.
3.	Appreciate the mathematical foundations of digital communication systems and can explain various digital modulation schemes.
4.	Have a basic idea about information theory.
5.	Perform various analog and digital modulation schemes using MATLAB.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1.	Electronic Communication Systems by G. Kennedy And B. Davis, Mc Graw Hill, 4th Edition	2006
2.	Digital Communication by John G. Proakis and Masoud Salehi, Fifth edition, McGraw-Hill Higher education	2008
3.	Modern Digital & Analog Communication Systems by B.P. Lathi, Oxford University Press,4th Edition	2009
4.	Principles of Communication Systems by Taub and Schilling Tata McGraw-Hill Education, 3rd edition	2008
5.	Elements of Information Theory, by Thomas Cover and Joy Thomas, 2nd edition, Wiley -Interscience	2006

Course Name	**:**	**CONTROL SYSTEMS**
Course Code	**:**	**EC1352**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, the students should be able to model a control system using different approaches, analyse the system in time domain and frequency domain and investigate the stability. The student should also be able to design lead, lag, lag lead compensators for the specified requirements.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** Basic components of a control system, classification of control system, Servomechanism, Regulator and process control, Feedback control Systems- Characteristics and Performance	4
2	**MODELLING A CONTROL SYSTEM:** Transfer function approach, Block Diagram Representation, Signal flow graphs, Error Analysis	6
3	**TIME RESPONSE ANALYSIS:** Time response of first order systems, second order systems, steady state errors and error constants, Sensitivity, Concept of Stability, Conditions of Stability ,Root Locus Technique	7
4	**FREQUENCY RESPONSE ANALYSIS:** Correlation between time and frequency response, Polar Plots, Bode Plot, stability margins on Bode plots, Nyquist criteria, Assessment of stability using Nyquist criteria, Design problem, preliminary considerations of classical design, realization of basic compensators, lead compensator, Lag compensator, Lag Lead Compensator	14
5	**CONTROL ACTIONS AND CONTROLLER CHARACTERISTICS:** Proportional, Integral and Derivative Control Actions, Proportional plus integral control action, proportional plus derivative control action, PID controller	3
6	**SAMPLED DATA CONTROL SYSTEMS:** Sample and Hold operations, frequency domain considerations, Transform Analysis of sampled data systems, Linear difference equations, Z-transform, block diagram analysis of sampled data systems,	4
7	**STATE SPACE ANALYSIS OF CONTROL SYSTEMS:** State Space representation, Transfer Matrix, State Transition Matrix, Single Input Single output system, multiple input multiple output system, Controllability and Observability	4

Course Outcomes: By the end of this course, the students will be able to	
1	Determine the transfer function of the system using different approaches.
2	Determine the time response of the system and investigate the stability.
3	Determine the frequency response of the system and investigate the stability.
3	Design lead, lag, lag lead compensators and PID Controller for the specified requirements.
4	Develop the state space representation of the system and calculate the response to the input.
5	Analyse the sampled data control systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Control Systems Engineering By Nagrath and Gopal, New Age International,4th Ed	2006
2	Digital Control Engineering by M Gopal, New Age International	2003
3	Automatic Control Systems, Kuo, B.C, 9th Ed., Wiley India	2009
4	Modern Control Engineering, Ogata, K., 5th Ed., Pearson Education. 2008	2009
5	Modern Control Systems, Dorf, R.C. and Bishop, R.H., 12th Ed., Prentice-Hall of India.	2010
6	Control Systems Engineering, Nise, N. S., 6th Ed., Wiley India	2010

Course Name	**:**	**MICROWAVE ENGINEERING**
Course Code	**:**	**EC1353**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:

By the end of this course the student should be able to understand the basics of microwave measurements and characteristics and working of microwave sources, generators and amplifiers, components and devices. The student should also be able to understand microwave propagation in transmission lines and waveguides, and microwave radiation through antennas and the microwave propagation. The student should also be able to describe the radar systems , scanning and tracking techniques used in radar systems. They should also be able to practically analyse various microwave devices, their characteristics and microwave measurements using test bench.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**TRANSMISSION LINES AND WAVEGUIDES** Concept of Distributed elements, Equations of Voltage and Current, Types of Transmission lines, Standing Waves and Impedance Transformation, Lossless and Low loss Transmission lines, Power transfer on a transmission line, Transmission line calculations using Smith Chart ,Applications of transmission lines Rectangular Waveguides, Field analysis and characteristics of TE and TM modes, Losses inwaveguides, Circular waveguides	**8**
2	**MICROWAVE COMPONENTS** Introduction to microwave engineering, Attenuators and phase shifters, Bends, Corners, Twists, Flanges, Shorts, Matched loads, Tees (e-plane h plane & hybrid), Rat-race, Directional Couplers, Scattering matrix. Ferrite devices (isolator, circulator, gyrator), Cavity resonators. Power and impedance measurement, Measurement of SWR, Frequency and wavelength.	**8**
3	**MICROWAVE SOURCES AND DETECTORS** Limitations of conventional solid state devices at microwave frequencies, Transistors (MESFET, HEMT), Diodes (tunnel, varactor, pin), transferred electron devices (GUNN), Avalanche transit time devices (IMPATT AND TRAPATT), Limitations of conventional tubes at microwave frequencies, Klystron amplifier, Reflex klystron, Magnetron, TWT, BWO, CFA'S. Microwave detectors	**8**
4	**ANTENNAS AND WAVE PROPOGATION:** The Potential Functions, Elemental Dipole Antennas (The Electric (Hertzian) Dipole, Magnetic Dipole (Loop), Antenna Characteristics, The Long Dipole and Monopole Antennas, Antenna Arrays, Antenna Directivity and Gain, Antenna Coupling, The Friis Transmission Equation, Effect of Ground Reflections on Signal Transmission, Introduction to wave propogation.	8
5	**INTRODUCTION TO RADAR SYSTEMS** Basic principal block diagram and operation of radar, Radar range equation, PRF's, Rangeambiguities. Applications of radars. Doppler determination of velocity, CW radar and its limitations, FM-CW radar, Basic principle and Operation of MTI radar, Delay line cancellers, Blind speeds and staggered PRF. Various scanning techniques (horizontal, vertical, spiral, palmer, raster, nodding), Angle tracking system (lobe switching, conical scan, monopulse), Range tracking systems, Doppler(velocity) tracking systems.	**10**

List of Simulations & Experiments:		Number of Turns
1	Study of various microwave components	1
2	Measure the insertion loss and isolation of a circulator.	2
3	Draw the V-I characteristics of Reflex Klystron.	1
4	Plot the power output v/s frequency characteristics of a Gunn source.	1
5	Design a Schottky diode at S Band frequencies structure using software.	2
6	Design a GaN MOSFET at K band using Software.	1
7	Plot the radiation characteristics of the horn antenna.	1
8	Simulation of Microstrip antenna for k-band application	1
9	Fabrication of Micro Strip antenna for k-band application	2
10	Design an antenna and calculate Gain, directivity, antenna efficiency, bandwidth and 3 dB beam width using empirical formulas. Compare the simulated results obtained by softwareand theoretical results and Observe the effect of feed location on center frequency, return loss and bandwidth.	2

Course Outcomes: By the end of this course the student will be able to	
1	Understand a wide range of microwave generators, components, tubes and their characteristics.
2	Get a basic idea about microwave measurements.
3	Describe radar systems, and the scanning and tracking techniques used in radar systems.
4	Understand microwave propagation through waveguides and transmission lines.
5	Describe radiation of microwaves through antenna and the propagation of radiated microwaves in the environment.
6	Characterize microwave devices in terms of the directionality of communication.
7	Use a microwave test bench in analyzing various types of microwave measurements.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Microwave devices and circuits (3rd Edition) by Samuel Liao, Pearson Publications	2013
2	Introduction to Radar systems (2nd Edition) by Merill I Skolnik,McGraw Hill Publications	2003
3	Microwave devices and Radar Engineering (3rd Edition) by Kulkarni,Umesh Publications	2003
4	Foundation of Microwave Engineering (2nd Edition) by RE Collin; McGraw Hill Publications	2001
5	Sonar for Practicing Engineers (3rd edition), by A.D. Waite, Wiley Publications	2002

DEPARTMENT ELECTIVE POOLS (Specialized Domains)

	Communication Engineering	**VLSI Design**	**Embedded Systems**
DEC 1/ DEC 2	Information Theory and Coding (3-1-0)	Electronics Devices Fabrication (3-0-2)	Microprocessor and Microcontroller (3-0-2)
	Computer Communication Networks (3-1-0)	HDL based System Design (3-0-2) (DEC2)	Industrial Automation (3-1-0)
	Digital Image Processing (3-1-0)	Power Electronics (3-1-0)	Embedded System Design (3-0-2)
	Digital Signal Processing (3-0-2) (DEC2)	Digital VLSI Design (3-0-2) (DEC2)	IoT with ARDUINO and Raspberry Pi (3-02)
DEC 3/ DEC 4	Antenna and Wave Propagation (3-1-0)	PCB Circuit Design (3-0-2)	Neural Networks and Fuzzy System (3-1-0)
	Satellite Communication (3-1-0)	Foundations of VLSI CAD (3-1-0)	Computer Architecture (3-1-0)
	Optical Communication (3-0-2)	Analog VLSI Design (3-0-2)	Multimedia technology (3-1-0)
	Wireless Communication (3-0-2)	FPGA & ASICs (3-1-0)	Digital Image Processing (3-1-0)
DEC 5	Advanced digital communication (3-1-0)	Nanotechnology (3-1-0)	Advanced Sensing technology (3-1-0)
	Mobile and Cellular Communication (3-0-2)	MEMS & Microsystems (3-1-0)	Robotics (3-1-0)
	MIMO Wireless Communication (3-1-0)	Low Power VLSI Devices (3-1-0)	PLC Designing (3-1-0)
		Advanced VLSI Devices (3-1-0)	

The list of department elective subjects could be changed as per requirements.

Communication Engineering Pool

Course Name	**:**	**INFORMATION THEORY AND CODING**
Course Code	**:**	**EC2211**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to appreciate the concept of information, entropy and entropy rates, get familiarized with asymptotic equipartition property theorem. The student should also be able to understand various data compression schemes and evaluate the capacity for discrete memoryless channels. The student should also be able to understand the encoding and decoding of different linear block and convolution codes.

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO THE CONCEPT OF INFORMATION:** Shannon measure of information, Self-information and entropy, Joint and conditional entropy, Kullback–Leibler distance and Mutual information, Chain Rules for Entropy, Various inequalities useful in information theory (Jensen's Inequality, Log Sum Inequality, Data-Processing Inequality, Fano's inequality), Markov processes and Entropy rates	8
2	**ASYMPTOTIC EQUIPARTITION PROPERTY AND DATA COMPRESSION**: Asymptotic equipartition property (AEP) theorem, Consequences of the AEP: Data Compression, High-probability sets and the typical set, Examples of source codes, Kraft Inequality, Optimal Codes, Bounds on the optimal code length, Kraft inequality for uniquely decodable codes, Huffman codes, Shannon–Fano–Elias coding	12
3	**CHANNEL CAPACITY** Capacity evaluation of various binary channels, capacity evaluation of symmetric channels (Strongly and Weakly symmetric discrete memoryless channels), Channel coding theorem and the promise of the existence of block codes, Source–channel separation theorem.	8
4	**LINEAR BLOCK CODES**: Linear codes and vector spaces, Generator matrix and parity check matrix, Weights and distance for linear block codes, Hamming codes, Syndrome decoding, Weight distribution polynomial, Bounds on minimum distance of linear block codes (Singleton and Hamming Bound), Cyclic codes, Encoding of cyclic codes, Decoding of cyclic codes using *Meggitt* Decoder	8
5	**CONVOLUTIONAL CODES:** Structure of convolutional codes (trellis representation), Encoding of convolutional codes, Transfer function of convolutional codes, Decoding of convolutional codes using Viterbi algorithm.	6

Course Outcomes: By the end of this course, the students will be able to:	
1	Describe the concepts of information, entropy and entropy rates.
2	Get familiarized with asymptotic equipartition property theorem and its applications in data compression.
3	Understand various data compression schemes.
4	Evaluate the capacity for discrete memoryless channels and get an understanding of channel coding theorem and source–channel separation theorem.
5	Understand coding and decoding of linear block codes and convolutional codes

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Elements of Information Theory, by Thomas Cover and Joy Thomas, 2nd edition, Wiley –Interscience	2006
2	A Course in Error Correcting Codes, by Jorn Justesen and Tom Hoholdt, 1st edition, Hindustan Book Agency.	2012
3	Digital Communications, by John Proakis & Masoud Salehi, 5th edition, McGraw-Hill,	2008

Course Name	**:**	**COMPUTER COMMUNICATION NETWORKS**
Course Code	**:**	**EC2212**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

By the end of this course, the students should be able to define the basic concepts of Data communication with different models, classify and compare the physical layer, Data Link Layer, Network Layer and Transport Layer and their functions. The students should also be able to summarize the Queueing concept, switching concept, its different types and explain the working of various types of wireless networks and their protocol.

Total No. of Lectures: 42		
Lecture wise breakup		**No. of Lectures**
1.	**OVERVIEW OF DATA COMMUNICATION AND NETWORKING**: Data communications, Networks, The Internet, Protocols and standards, Layered tasks, OSI model, TCP /IP protocol Architecture Overview (Physical, Data link, Network, Transport, Application Layer), History of the computer network	(5)
2.	**PHYSICAL LAYER AND SWITCHING** Data rate limit, Transmission impairments, Line coding, Block coding, FDM, WDM, TDM, Guided media, Unguided media; Circuit Switching, Packet Switching	(5)
3.	**POINT-TO- POINT PROTOCOLS** Error Detection and correction, Flow and error control, Stop and wait ARQ, go back n ARQ, Selective repeat ARQ, Framing and standard Data Link Control protocol - HDLC.	(6)
4.	**MULTIACCESS COMMUNICATION AND MULTIPLE ACCESS PROTOCOLS**: Queuing models in communication networks: Little's Theorem, M/M/1 Queueing System, M/M/m, M/M/m/m queueing systems Random access (ALOHA, slotted ALOHA, CSMA, CSMD/CD) Performance modelling and analysis., Controlled access (Reservation, Polling, Token Passing), Channelization (FDMA,TDMA, CDMA), Local Area Networks, Traditional Ethernet, Fast Ethernet, Gigabit Ethernet	(10)
5.	**INTERNETWORKING DEVICES AND ROUTING PROTOCOLS** Repeaters, Bridges, Type of Bridges, Routers, Routing concepts, Gateways, Internetworks, ARP, IP, ICMP, IPV6, Unicast routing, Unicast routing protocol, Multicast routing, Multicast routing protocols, introduction to Security, Cryptography, and SSL, Security - firewalls, DoS, etc.	(7)
6.	**TRANSPORT LAYER PROTOCOLS** Process to process delivery, User datagram protocol (UDP) , Connection less transport (UDP), Principles of reliable data transfer, Transmission control protocol (TCP), Data traffic, Congestion, Congestion control, Quality of service	(5)
7.	**APPLICATION LAYER PROTOCOLS** DNS, Electronics mail architecture and services, message formats and transfers, WWW architectural overview, static and dynamic web pages, HTTP, Digital audio and video	(4)

Course Outcomes: By the end of this course, the students will be able to	
1.	Describe the computer network system and its communication.
2.	Identify and compare the various layers of a computer network model, their role and characteristics.
3.	Explain various routing algorithms and switching concepts.
4.	Identify the various wireless network models.

Suggested Books:		
Sr. No.	**Name of Book/Authors/Publisher**	**Year Of Publication /Reprint**
1.	Introduction to Data Communication & Networking by Behrouz Forouzan, Tata McGraw Hill Edition	2012
2.	Data and Computer Communications by William Stallings PHI 8th Edition.	2007
3.	Data Communication and Distributed Networks, Ulylers D. Black, PHI 3rd ed.	1999
4.	Computer Networks, Andrew S.Tanenbaum, , PHI 2nd ed.	2000

Course Name	**:**	**DIGITAL IMAGE PROCESSING**
Course Code	**:**	**EC2213**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to learn and understand the fundamentals of image processing, transformation techniques, design & applications of image processing. The students should also be able to provide a useful skill base that would allow them to carry out further study should they be interested and to work in the field.

Total No. of Lectures-42

Lecture wise breakup		**No. of Lectures**
1	**FUNDAMENTALS OF IMAGE PROCESSING:** Introduction,Human visual system,Steps in image processing systems, Image acquisition, Sampling and Quantization, Pixel relationships,Light, brightness adaption and discrimination, Color fundamentals and models, File formats, Image operations, Arithmetic, Geometric and Morphological.	**9**
2	**IMAGE ENHANCEMENT:** Basic of intensity transform and spatial domain, Gray level Transformations, Contrast stretching, Thresholding, Image negative, Log transformation, Power-low transformation, Intensity level slicing and Bit-plane slicing, Histogram processing, Histogram equalisation process, Spatial filtering smoothing and sharpening, Filtering in frequency domain, Fourier transform of sampled function, DFT, FFT, DCT, Image smoothing and sharpening filters – Homomorphic Filtering.	**9**
3	**IMAGE SEGMENTATION AND FEATURE ANALYSIS:** Fundamentals,Detection of Discontinuities, Edge operators, Edge linking and Boundary Detection, Thresholding, Edge based segmentation, Region based segmentation,Region split and merge techniques, Morphological Watersheds,Motion Segmentation, spatial techniques and frequency domain techniques, feature analysis and extraction .	**8**
4	**MULTI RESOLUTION ANALYSIS AND COMPRESSIONS:** Multi Resolution Analysis: Image Pyramids, Multi resolution expansion, Wavelet Transforms, Image compression:Fundamentals, Image compression models, Elements of Information Theory , Error free compression , Lossy Compression, Image formats, and Compression Standards, Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, JPEG compression standard.	**8**
5	**APPLICATION OF IMAGE PROCESSING:** Image classification, Image recognition, Image fusion, Steganography, Colour Image Processing, Color models, Pseudo-colour image processing, Pattern recognition.	**8**

Course Outcomes: By the end of this course, the students will be able to:	
1	Acquire the fundamental concepts of a digital image processing system.
2	Design and implement with Matlab algorithms for digital image processing.
3	Utilize the skill base necessary to further explore advanced topics of Digital Image Processing.

S.No.	**Name of Book/Authors/Publisher**	**Year of Publication/ Reprint**
1	Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education	2001
2	Milan Sonka, ValclavHalavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd Edition, Thomson Learning	1998
3	Anil K. Jain, "Fundamentals of Digital Image Processing". Pearson Education,	1989
4	S Jayaraman, S Esakkirajan, T Veerakumar, "Digital Image Processing", Tata McGraw Hill Publication	2009
5	Rafael C. Gonzalez, Richard E. Woods & S L Eddins, "Digital Image Processing using MATLAB", Prentice hall.	2003

Course Name	**:**	**DIGITAL SIGNAL PROCESSING**
Course Code	**:**	**EC 2214 Pre-requisite: Signal and systems**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
To provide concepts and principles of DSP, its implementation and applications of DSP algorithms.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Review of discrete signals and systems analysis, sampling, quantization and reconstruction processes, Typical applications of DSP	**2**
2	**TRANSFORMATION OF DISCRETE SIGNALS** Discrete Fourier Transform (DFT) and its properties, IDFT, circular convolution using DFT, Fast Fourier Transform (FFT), Decimation in time and decimation in frequency algorithms, IFFT, K L transform, DCT, JPEG and MPEG coding standards, Applications of DFT in speech and audio coding	**12**
3	**DIGITAL FILTERS** Recursive and non-recursive systems, Frequency domain representation of discrete time systems, systems function, Ideal low pass filter	**2**
4	**DESIGN OF IIR FILTERS** Impulse invariance transformation technique, Bilinear transformation, Design of IIR Filters using Butterworth, chebyshev and elliptic filter , Digital frequency transformation	**6**
5	**DESIGN OF FIR FILTERS** Design of FIR filters using Window technique, frequency sampling technique, Equiripple Approx. technique, comparison of IIR and FIR filters	**6**
6	**REALIZATION OF DIGITAL SYSTEMS** Block diagrams and signal flow graphs for FIR and IIR systems, Direct form, cascade and parallel form realization of FIR and IIR systems.	**4**
7	**MULTIRATE DSP & APPLICATIONS** Fundamentals of Multirate systems and its applications, Decimation, Interpolation, Sampling Rate Conversion, filter banks, introduction to wavelet transform	**8**
8	**ADAPTIVE WEINER FILTER** Adaptive Weiner filter & its application in echo cancellation and equalization	**2**

List of Experiments:		**Number of Turns**
1	Hands on Experience on MATLAB and generation of digital signals	1
2	Write a Program for Discrete Convolution, Impulse Response of finite and infinite signals	1
3	Determine and plot Fourier Transform (magnitude and phase) for the infinite duration sequence.	1
4	Compute DFT and IDFT for the given signal.	1
5	Compute DCT of any given signal.	1
6	Determine impulse response and unit step response of the given system.	1
7	Determine and plot frequency response of any LTI system.	1
8	Determine DTFT of the given sequence and plot magnitude and phase response.	1

9	Design an FIR low pass filter for the given specifications and plot frequency response of the filter.	1
10	Design a LP Butterworth filter for the given specifications and plot frequency response of the filter.	1
11	Write a program to obtain decimated and interpolated output of any given input signal	1
12	Compute FFT of a real time speech and audio signal	2

Course Outcomes: By the end of this course, the students will be able to:	
1	Understand concepts of various transformation techniques such as DFT ,FFT, DCT etc..
2	Understand various design techniques of IIR and FIR digital filters.
3	Understand principles and applications of multirate systems.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	Mitra, S.K., "Digital Signal Processing-A Computer Based Appraoach", 3 Ed., TMH	2010
2	Digital Signal Processing by A.V Oppenheim and R.W.Schafer, Pearson Education	2006
3	Digital Signal Processing by S Salivahanan, A Vallavraj, C Gyanapriya, TMH	2011
4	Proakis, J.G. and Manolakis, D.G., "Digital Signal Processing: Principles, Algorithm	2006
5	Vaidyanathan, P.P., "Multirate Systems and Filter Banks", Pearson Education.	2003
6	Ifeachor, E.C. and Jervis, B.W., "Digital Signal Processing: A Practical Approach	2001

Course Name	**:**	**ANTENNA AND WAVE PROPAGATION**
Course Code	**:**	**EC2311**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Total No. of Lectures – 42

Course Objective:

By the end of this course the students should be able to describe the evolution and basics of antenna and wave propagation technology. Students should also be able to design different type of antennas and analyze antenna's performance.

Lecture wise breakup		No. of Lectures
1	**BASIC PRINCIPLES AND DEFINITIONS:** Retarded vector and scalar potentials. Radiation and induction fields. Radiation from elementary dipole (Hertzian dipole, short dipole, linear current distribution), half wave dipole, Antenna parameters: Radiation resistance, Radiation pattern, Beam width, Gain, Directivity, Effective height, Effective aperture, Bandwidth and Antenna Temperature.	12
2	**RADIATING WIRE STRUCTURES AND ANTENNA ARRAYS:** Folded dipole, Monopole, Biconical Antenna, Loop Antenna, Helical Antenna. Principle of pattern multiplication, Broadside arrays, Endfire arrays, Array pattern synthesis, Uniform Array, Binomial Array, Chebyshev Array, Antennas for receiving and transmitting TV Signals e.g. Yagi-Uda and Turnstile Antennas.	10
3	**APERTURE TYPE ANTENNAS:** Radiation from rectangular aperture, E-plane Horns, H-plane Horns, Pyramidal Horn, Lens Antenna, Reflector Antennas, Broadband and frequency independent antennas, The frequency independent concept: Rumsey's principle, Frequency independent planar log spiral antenna, Frequency independent conical spiral antenna and Log periodic antenna.	10
4	**PROPAGATION OF RADIO WAVES:** Different modes of propagation, Ground waves, Space waves, Surface waves and Tropospheric waves, Ionosphere, Wave propagation in the ionosphere, critical frequency, Maximum Usable Frequency (MUF), Skip distance, Virtual height, Radio noise of terrestrial and extraterrestrial origin. Multipath fading of radio waves.	10

Course Outcomes: By the end of this course the student will be able to

1. Analyze a complete radio system comprising of transmitter and receiver with reference to antenna.
2. Quantify the fields radiated by various types of antennas.
3. Design different types of antennas.
4. Analyze antenna measurements to assess antenna's performance.
5. Relate the concept of radio wave propagation.

Suggested Books:		Year of Publication/ Reprint
1	Antenna & Wave Propagation by Robert E.Collin, McGraw Hill	1985
2.	Antenna Theory, Analysis and Design by Balanis A Constantine. 2nd edition Wiley, New York	1997
3.	Antenna and Wave Propagation by Prasad KD, 3rd edition, Satya Prakashan, New Delhi	1996
4.	Antennas (2nd Edition) by John D. Kraus, McGraw Hill	1997
5.	Electromagnetic Waves and Radiating Systems (2nd Edition) byE.C.Jordan and K.G.Balmain, PHI	1995

Course Name:	**SATELLITE COMMUNICATION**
Course Code:	**EC2312**
Credits:	**4**
L T P:	**3 1 0**

COURSE OBJECTIVES:
In this course the students will get the basic technical knowledge of orbital dynamics, subsystems used in space segment and ground segment, power and bandwidth requirement, effect of the transmission medium, other impairments and techniques to mitigate them, small satellites and navigational aspects.

S No	Lecture wise breakup	No. of lectures
1.	**ORBIT MECHANICS** A Brief History and Overview of Satellite Communications, Achieving a Stable Orbit, Describing the Orbit of a Satellite (GEO, MEO and LEO satellite systems), Locating the Satellite, Look Angle Determination, Orbital Perturbations, Orbit Determination, Placing Satellites into Geostationary Orbit, Orbital Effects in Communications Systems Performance.	8
2.	**SPACECRAFT SYSTEMS AND LINK DESIGN** Attitude and orbit control system, telemetry, tracking and command (TT&C), communications subsystems, transponders, spacecraft antennas. LINK DESIN: Basic transmission theory, noise figure and noise temperature, G/T ratio, CNR, CIR, ACI, IMI, Down link design, Up link design.	9
3.	**TRANSMISSION ASPECTS** Probability of Error in Digital Transmission, Digital Transmission of Analog Signals, Time Division Multiplexing, Packets, Frames and Protocols, Error Detection and Correction, Digital Modulation, BPSK ,QPSK, QAM and Multiple Access, FDMA, TDMA, DAMA, CDMA.	8
4.	**PROPAGATION EFFECTS** Propagation Phenomena, Propagation Impairment Attenuation and Depolarization, Counter measures, Rain and Ice Effects, Rain Attenuation, Prediction, Figure of merit, total system performance	6
5.	**VSAT SYSTEMS** Use of Small Satellites, Low Throughput Mobile Communications Satellite Systems, VSAT Systems, Signal Formats, NGSO Satellite Systems, Packets and Protocols for NGSO Systems, Orbital Coverage and Frequency Considerations, Direct Broadcast Satellite Television and Radio, Home Satellite TV, Digital DBS-TV.	6
6.	**SATELLITE INTERNET AND NAVIGATIONAL ASPECTS** Geostationary Satellite Internet Access, Radio and Satellite Navigation, GPS Position Location Principles, GPS Codes and Frequencies, Satellite Signal Acquisition, GPS Signal Levels.	5

Course Outcomes: By the end of this course the students will be able to	
1.	Identify the communication satellite mechanics
2.	Explain the satellite internal sub systems for communication applications
3.	Explain the transmission errors and modulation techniques.
4.	Design the power budget for satellite links
5.	Describe various constellations of satellite and their applications

Suggested Books:		
Sr.No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1.	Satellite communication (3rd Edition) by Timothy Pratt, Charles W. Bostian, John Wiley & Sons Publication	2020
2.	Satellite Communication, P. Banerjee, PHI	2017
3.	Satellite Communications Systems Engineering (2ndEdition) by Wilbur Pritchard, HenriSuyderhoud, Pearson Education	2007
4.	Communication satellite systems by J. Martin, PHI publication	2001

Course Name	**:**	**OPTICAL COMMUNICATION**
Course Code	**:**	**EC2313**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, the students should be able to name the basic elements of optical fiber transmission link, describe fiber modes and different types of fibers. The student should also be able to summarize the various causes of signal degradation in optical fibers, explain the working of optical amplifiers and important parts at the transmitter (Semiconductor lasers/LEDs, modulators etc) as well as at the receiver sides (optical detector etc.) of the optical communications system, analyze and calculate the link power budget, describe the optical networks (FDDI,SONET/SDH) and operational principles of advanced multiplexing strategies.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**OVERVIEW OF OPTICAL FIBER COMMUNICATIONS:** Block Diagram of Optical Communication System, advantages of optical fiber communication, basic structure of optical fiber waveguide, ray theory transmission, optical fiber modes and configuration, step index & graded index fiber, single mode fiber, multi-Mode fiber, fiber materials , fiber fabrication.	6
2	**SIGNAL DEGRADATION IN OPTICAL FIBER TRANSMISSION:** Introduction, attenuation, intrinsic & extrinsic absorption losses, linear & nonlinear scattering losses, bending losses, distortion in optical wave guide, intramodal and intermodal dispersion. Power launching and coupling Source to fiber power launching, power calculation, lensing schemes, fiber to fiber joints, fiber splicing technique, fiber connectors.	6
3	**OPTICAL TRANSMITTERS:** Basic Concepts, Light Emitting Diodes, Semi-Conductor Lasers, DFB Lasers, Coupled Cavity semiconductor Lasers, Tunable Semiconductor Lasers, Vertical Cavity Semiconductor Lasers, Laser Characteristics, Transmitter design.	6
4	**OPTICAL RECEIVERS:** Basic concepts, p-n Photo Diodes, p-i-n Photo Diodes, Avalanche Photo Diode, MSM Photo detector, Receiver Design, Receiver Noise; Noise mechanism, Receiver sensitivity; Bit error rate, Minimum Receiver Power, Sensitivity Degradation, Receiver Performance	5
5	**OPTICAL COMMUNICATION SYSTEM DESIGN:** Point to point links, system considerations, link power budget, rise time budget.	3
6	**NONLINEAR EFFECTS IN FIBER OPTIC LINKS:** Concept of self-phase modulation, cross phase modulation, Raman scattering, Brillouin scattering ,four wave mixing, group velocity dispersion and soliton based communication , wavelength converters	4
7	**OPTICAL AMPLIFIERS:** Semiconductor optical amplifiers, EDFA, Raman amplifier.	4
8	**OPTICAL NETWORKS:** Optical multiplexing techniques-WDM, DWDM, CWDM & CDMA, Network Topologies, FDDI Networks: - Frame and Token formats, Network operation, SONET/SDH, SONET frame structure, SONET layers, operational principles of WDM - Broadcast and Select WDM networks, Single hop networks, Wavelength routed networks, Introduction to Optical Computing & Photonics.	6

List of experiments	No. of turns
1. To calculate the numerical aperture of a single mode fiber.	1
2. To determine the loss occurring in optical fiber link due to macro-bending.	
3. To study the length dependence of attenuation in the given optical fibre at different wavelengths.	1
4. To determine insertion loss and return loss of several connectors and return loss of PC and APC terminations.	2
5. Measurement of insertion loss, directivity and back reflection/ return loss for a series of fibre optic components (i.e. coupler, WDM, isolator, circulator, DWDM Mux/Demux devices).	2
6. Determination of isolation/ extinction ratios in various optical components.	1
7. Examination of narrowband wavelength responses of a number of optical components.	1
8. Investigation of temperature tuning of a Bragg grating.	1
9. Measurement of light, voltage and current (LVI) characteristics of a DFB laser with operating temperature.	1
10. To characterize Optical Add Drop Multiplexer in a WDM link.	1
11. To calculate the attenuation-limited fibre length based on the power budget equation.	1
12. Design and simulate a fibre optic system using a dispersion compensating fibre to reduce chromatic dispersion.	1
13. To perform the Eye Diagram and BER analysis of the WDM system to observe the channel crosstalk.	1

Course Outcomes: By the end of this course, the students will be able to	
1	Classify the structures of Optical fiber and types.
2	Discuss the channel impairments like losses , dispersion and non linear effects
3	Classify the Optical sources and detectors and to discuss their principle.
4	Explain various sections of optical transmitters and receivers and optical amplifiers
4	Perform fiber-optic communication system engineering calculations, identify system tradeoffs, and apply this knowledge to modern fiber optic systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Optical Fiber Communication, McGraw -Hill ,3rdEditionl,byGerd Keiser	2006
2	Fiber Optic Communication Systems by G.P. Agrawal, (4/e), Wiley, 2002.	2010
3	Optical Networks A practical perspective by Rajiv Ramaswami, Kumar N. Sivaranjan, 3rd edition, Elsevier,	2009
4	Fiber-Optic Communications Technology by .Djafar K. Mynbaev, Lowell L. Scheiner, Pearson Education	2000
5	Optical Fiber Communications, Principles and Practice, Senior, PHI – 2nd Edition.	2001

Course Name	**:**	**WIRELESS COMMUNICATIONS (DEC)**
Course Code	**:**	**EC2314**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
By the end of this course, students should be able to have a broad overview of wireless communication technology, identify and explain path loss, shadowing and fading phenomena in wireless communication systems, evaluate capacity of wireless communication channel, can compare various diversity achieving schemes, and understand the contemporary technologies used in wireless communications like Orthogonal Frequency-Division Multiplexing (OFDM) and Spread spectrum techniques.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO WIRELESS COMMUNICATIONS:** History of Wireless Communications, Wireless Vision, Technical Issues, Current Wireless Systems, Cellular Telephone Systems, Cordless Phones, Wireless Local Area Networks, Wide Area Wireless Data Services, Broadband Wireless Access, Satellite Networks, Low-Cost, Low-Power Radios: Bluetooth and ZigBee, Wireless Spectrum, Methods for Spectrum Allocation, Spectrum Allocations for Existing Systems	4
2	**PATH LOSS AND SHADOWING IN WIRELESS COMMUNICATIONS:** Radio Wave Propagation, Free-space path loss and path loss models, Shadow Fading, Log-normal model for shadowing.	6
3	**STATISTICAL MULTIPATH CHANNEL MODEL:** Small-Scale Multipath Propagation, Doppler Shift, Impulse Response Model of a Multipath Channel, Time Dispersion Parameters and Coherence Bandwidth, Doppler Spread and Coherence Time, Flat fading, Frequency Selective Fading, Fast Fading, Slow Fading, Rayleigh and Ricean Distributions, Clarke's Model for Flat Fading, Spectral Shape Due to Doppler Spread in Clarke's Model, Transforms for autocorrelation and scattering functions	10
4	**CAPACITY OF WIRELESS CHANNELS:** Capacity in additive white Gaussian noise, Capacity of Flat Fading Channels: Channel and System Model, Channel Side Information at Receiver, Channel Side Information at Transmitter and Receiver, Capacity with Receiver Diversity, Capacity Comparisons.	8
5	**DIVERSITY:** Realization of Independent Fading Paths, Receiver Diversity: Selection Combining, Threshold Combining, Maximal-Ratio Combining, Equal-Gain Combining, Transmitter Diversity: Channel Known at Transmitter, Channel Unknown at Transmitter –Alamouti Scheme.	7
6	**MULTICARRIER MODULATION (OFDM):** Data transmission using multiple carriers, multicarrier modulation with overlapping subchannels, Coding with interleaving over time and frequency, Discrete implementation of multicarrier modulation: Orthogonal Frequency-Division Multiplexing (OFDM), Review of Discrete Fourier Transform (DFT) and its implementation, and Cyclic prefix, Peak-to-average power ratio, Frequency and timing offset in multicarrier systems.	4
7	**SPREAD SPECTRUM TECHNIQUES:** Spread-spectrum principles, Direct-sequence spread spectrum (DSSS), DSSS System Model, RAKE Receivers, Frequency-hopping spread spectrum (FHSS)	3

List of Simulations & Experiments:		Number of Turns
1	Study of Log-normal distribution model	2
2	Simulation of Rayleigh and Ricean fading models	2
3	Visualize effects of frequency-selective fading	2
4	Implementing water-filling algorithm for calculating the capacity of a wireless channel	2
5	Implementing Alamouti space-time block code.	2
6	Implementing Direct-sequence spread spectrum (DSSS)	2
7	Implementing Frequency-hopping spread spectrum (FHSS)	2

Course Outcomes: By the end of this course the students will be able to	
1	Have a broad overview of wireless communication systems, i.e., hierarchy of wireless networks, methods of spectrum allocation.
2	Understand the concept of shadowing and fading in wireless communications.
3	Mathematically model wireless communication systems for different fading characteristics, i.e., Flat, Frequency Selective, Fast, and Slow fading characteristics.
4	Derive the capacity of a flat-faded wireless channel under the assumptions of channel side information at the receiver/transmitter.
5	Appreciate various schemes of achieving diversity and get an introduction to space time block coding, i.e., Alamouti Scheme.
6	Understand contemporary and widely used wireless communication techniques like Orthogonal Frequency-Division Multiplexing (OFDM) and Spread spectrum.
7	Comfortably use MATLAB for designing models and implementing different techniques used in wireless communications.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Wireless communications, Andrea Goldsmith, 1st edition, Cambridge University press	2009
2	Wireless communication, Principles and Practice, T.S Rappaport. 2nd Edition, Pearson	2010
3	Principles of Mobile Communication, Gordon L. Stüber, 4th edition, Springer	2017

Course Name	**:**	**ADVANCED DIGITAL COMMUNICATION**
Course Code	**:**	**EC2411**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

By the end of this course the students should be able to understand the principles that underlie the analysis and design of digital communication systems. The objective of this course is to introduce the students to advanced topics in digital communication such and optimal receiver design for AWGN channels and bandlimited channels, probability of error analysis for different digital modulation schemes, carrier and symbol synchronization, and equalization.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CHARACTERIZATION OF COMMUNICATION SIGNALS AND SYSTEMS** Elements of digital communication system, Representation of Band pass and Low pass Signals, Energy considerations, Low pass representations of Band pass Systems, Representation of Band pass Stationary Stochastic Processes, Signal Space Representation, Orthogonal Expansions of signals (Gram-Schmidt Procedure), Memory less Digital Modulation Schemes, Power Spectral density of Linearly Modulated Signals.	**10**
2	**OPTIMUM RECEIVERS FOR ADDITIVE WHITE GAUSSIAN NOISE CHANNEL** Implementation of the optimal receiver for AWGN channels (Correlation and Matched- Filter receiver), Probability of error of maximum likelihood detection, Optimal detection and error probability for bandlimited signaling (for ASK, PAM, PSK and QAM) , Probability of Error for M-ary Orthogonal Signals, Probability of Error for Simplex Signals, Optimal detection in presence of Uncertainty: Noncoherent detection.	**12**
3	**CARRIER AND SYMBOL SYNCHRONIZATION** Signal Parameter estimation: The Likelihood Function, Carrier recovery and Symbol synchronization in signal demodulation; Carrier Phase Estimation: Maximum-likelihood carrier phase estimation, the phase locked loop, Effect of additive noise on the phase estimate: Symbol timing estimation: Maximum-likelihood timing estimation, non-decision-directed timing estimation	**10**
4	**DIGITAL COMMUNICATION THROUGH BANDLIMITED CHANNELS WITH EQUALIZATION** Characterization of band-limited channels, Signal design for band limited channels: Bandlimited signal design for no Intersymbol Interference(Nyquist Criterion) and with controlled ISI; Optimum receiver for channels with ISI and AWGN; Linear Equalization: Peak distortion criterion, Mean-square error (MSE) criterion, Performance characterization of the MSE Equalizer.	**10**

Course Outcomes: By the end of this course the student will be able to	
1	Explain digital communication system and digital modulation techniques.
2	Analyze the representation of lowpass and bandpass signals and systems.
3	Design the optimal receiver for AWGN channels and bandlimited channels.
4	Analyze the probability of error for different digital modulation techniques.
5	Explain various synchronization and equalization techniques used in digital communication.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Digital communications (5th Edition) by J. Proakis,MGH	2008
2	Digital Communications Fundamentals and Applications (2nd Edition) by Bernard Sklar, Pearson Education.	2001
3	Multi-carrier Digital Communications:TheoryandApplications of OFDM (2nd Edition) by A. R. S. Bahai, B. R. Saltzberg, M.Ergen, Springer	2004
4	Digital Communication (3rdEdition) by Edward A Lee & David G Messerschmitt, Kluwer Academic Publishers	2003
5	Modern Wireless Communications by Simon Haykin and Michael Moher, Person	2004

Course Name	**:**	**MOBILE AND CELLULAR COMMUNICATIONS (DEC)**
Course Code	**:**	**EC2412**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

By the end of this course, students should be able to familiarize with the evolution and basics of wireless communication technology, identify and explain the cellular concepts, like, frequency reuse, co-channel interference, cell splitting, and in-depth knowledge about the concept of handoff. The student should have an introduction to very-small-aperture terminal satellites and its applications in mobile communications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO CELLULAR SYSTEMS:** A basic cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular system, planning a cellular system, analog& digital cellular systems.	3
2	**CELLULAR WIRELESS COMMUNICATION SYSTEM:** Second generation cellular systems: GSM specification and air interface- specification of various units, GSM Architecture, 2.5 G systems: GPRS/EDGE specifications and features, 3G systems: UMTS & CDMA 2000 standards and specifications.	5
3	**ELEMENTS OF CELLULAR RADIO SYSTEMS DESIGN:** General description of the problem, Concept of frequency reuse channels, co-channel interference reduction factor, desired carrier to interference ratio (C/I) for an omni-directional antenna system, cell splitting, consideration of the components of cellular systems.	7
4	**INTERFERENCE:** Introduction to co-channel Interference, real time co-channel interference, co-channel measurement design of antenna system, antenna parameter and their effects, diversity receiver in co-channel interference, Equalization, Equalization in Communication Receiver, RAKE Receiver.	6
5	**CELL COVERAGE FOR SIGNAL & TRAFFIC**: General introduction, Obtaining the mobile point to point model, propagation over water or flat open area, foliage loss, propagation near in distance, long distance propagation, point to point prediction model characteristics, cell site, antenna heights and signal coverage cells, mobile to mobile propagation.	6
6	**FREQUENCY MANAGEMENT AND CHANNEL ASSIGNMENT:** Frequency Management, Frequency spectrum utilization, Channel Assignment definition and its types, i.e., fixed channel assignment, non-fixed channel assignment, traffic and channel assignment.	5
7	**HANDOFFS, DROPPED CALLS**: Need of handoffs, types of handoffs, i.e., based on signal strength and carrier to interference ratio (C/I), Initiation, delay and queuing of handoffs, Intersystem handoffs, dropped call rates & their evaluation.	4
8	**EARTH STATION AND VERY-SMALL-APERTURE TERMINAL SATELLITES (VSATS):** Spacecraft Structure, Primary Power, Various Subsystem of a Satellite, Transmitter, Receivers, Components of Earth Station, VSAT- type, VSTA uses in Mobile Communications.	6

Serial Number	List of Experiments	No. of Turns
1	To study GSM Architecture and network topologies	1
2	To study and estimate call flow (Voice and Data)	1
3	To comprehend the intra-circle roaming functionality	1
4	To estimate, calculate and design link budget.	1
5	To do frequency planning of the network along with neighbor definition	1
6	To estimate and design concept of frequency reuse	1
7	Create a scenario to study the bottleneck of the transmission rate of a link	2
8	To study optimization strategies to improve grade of service	2
9	To estimate various types of interference.	2
10	To study the effect of fading and measure the fading margin of a received signal on spectrum analyzer	2

Course Outcomes: By the end of this course the students will be able to	
1	Explain the fundamental concepts and evolution of mobile communication systems.
2	Learn cellular system design basics and frequency management techniques, especially the concept of frequency reuse, co-channel interference, cell splitting.
3	Understand co-channel interference and describe interference reduction strategies, i.e., equalization.
4	Determine the cell coverage area for different natural and man-made terrains
5	Appreciate the concept of handoffs in mobile communication systems.
6	Understand the working and design of very-small-aperture terminal satellites and their applications in mobile communications

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Mobile Cellular Telecommunications; William, by C Y Lee. 2nd Edition McGraw Hill	2006
2	Wireless Digital Communications : Modulation and Spread Spectrum Applications , by Dr. Kamilo Feher. 2nd Edition, PHI	2015
3	Wireless communication, Principles &Practice, by T.S Rappaport. 1st Edition, Pearson	2010
4	Digital Satellite Communication, by Tri T. Ha. 2nd Edition, McGraw Hill	2017

Course Name	**:**	**MIMO WIRELESS COMMUNICATION (DEC)**
Course Code	**:**	**EC2413**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, students should be able to familiarize with the concept of space-time diversity and its need, explain the advantages offered by Multiple-Input Multiple-Output (MIMO) wireless systems over single input single output (SISO) wireless systems, evaluate the capacity and error performance of a MIMO wireless system, and get familiar with the concept of receiver and transmitter diversity and space-time block codes (STBC)

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**REVIEW OF MATRIX ALGEBRA:** Traces and determinants, Moore–Penrose pseudo-inverse, Kronecker Product, Singular value decomposition and Eigen value decomposition of matrices, Hadamard Inequality,	6
2	**INTRODUCTION TO SPACE-TIME DIVERSITY:** Space-time diversity and its need, Diversity analysis in one transmit antenna and two receive antenna and two transmit antenna and one receive antenna, 2 ×2 (Multiple-Input Multiple-Output) MIMO example over a flat fading channel.	4
3	**CAPACITY OF MULTIPLE-INPUT MULTIPLE-OUTPUT (MIMO) WIRELESS CHANNELS**: Additive White Gaussian Noise (AWGN) Channel Capacity, Resources of the AWGN Channel (Power and Bandwidth), Capacity of linear time-invariant Gaussian channels (Single Input Multiple Output (SIMO) Channel, Multiple Input Single Output (MISO) Channel), Capacity of the MIMO channel (Water-filling algorithm), Concept of Ergodic and Outage Capacity.	10
4	**ERROR PROBABILITY ANALYSIS OF MIMO:** Different types of detectors (Maximum Likelihood, Minimum Mean Square Error, Zero-Forcing), Error Probability Analysis for SISO Channels, Error Probability Analysis for MIMO Channels, Pairwise Error Probability and Union Bound, Coherent Maximum-Likelihood Detection, Detection with Imperfect Channel Knowledge, Joint ML Estimation/Detection	12
5	**RECEIVE AND TRANSMIT DIVERSITY AND INTRODUCTION TO SPACE-TIME CODING:** Receiver diversity over flat fading channels, Optimal Beamforming with Channel Known at Transmitter, Achieving Transmit Diversity, The ML Detector, Minimizing the Conditional Error Probability, Minimizing the Average Error Probability, Space-Time Coding, Alamouti's Space-Time Code, Space-Time Block Coding, Linear Space-Time Block Codes (STBC)	10

Course Outcomes: By the end of this course the students will be able to	
1	Appreciate the matrix analysis forming the foundations of Multiple-Input Multiple- Output (MIMO) wireless communication systems.
2	Understand the concept of Space-Time diversity and its need for MIMO wireless communication systems.
3	Evaluate the capacity of Single Input Multiple Output (SIMO), Multiple Input Single Output (MISO), MIMO wireless communication systems and understand the concept of ergodic and outage capacity.
4	Understand the working principle of different types of detectors and evaluate the probability of error for MIMO wireless communication systems.

5	Familiarize with notions of receive and transmit diversity and have a basic idea about Space-Time Block Coding

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Space Time Block Coding for Wireless Communications by Erik G. Larsson and Petre Stoica, 1st edition, Cambridge University Press	2013
2	Fundamentals of Wireless Communication, by David Tse and Pramod Viswanath, Cambridge University Press	2005
3	Foundations of MIMO Communication, by Robert W. Heath Jr. and Austin Angel Lozano, 1st edition, Cambridge University Press	2018

VLSI Design Pool

Course Name	**:**	**Electronic Devices Fabrication**
Course Code	**:**	**EC2231**
Credits	**:**	**4**
LTP	**:**	**3 0 2**

Course Objective:

To provide knowledge of device physics/operation, technologies and issues in nanoscale CMOS, other emerging devices and futuristic material-based interconnects. Students earn the basic understanding of nano electronics and followed by the advanced understanding of the nano-micro fabrication techniques.

Total number of Lectures - 42

Lecture wise breakup		**Number of Lecture**
1	**EMERGING NANOSCALE DEVICES and INTERCONNECTS** History of semiconductor devices, Moore's law, feature size and minimum feature size trend. Si and hetero-structure nanowire MOSFETs, carbon nanotube MOSFETs, Tunnel FET, quantum wells, quantum wires and quantum dots, Resonant tunnelling devices, Single electron transistors, Junction-less transistors, Spintronics devices. Optical interconnects, Superconducting interconnects, Nanotechnology interconnects, Silicon nanowires, Carbon nanotube (CNT) and Graphene nanoribbon (GNR) interconnects, performance comparison of CNTs, GNRs and copper interconnects.	**8**
2	**Material Preparation** Material properties, crystal structure, lattice, basis, planes, directions, angle between different planes, phase diagram and solid solubility, Crystal growth techniques, Epitaxy, Clean room and safety requirements. Oxidation: wet and dry oxidation, Deal-Grove model, Diffusion process, Ion implantation, modelling of Ion implantation, statistics of ion implantation, rapid thermal annealing, SIMS.	**10**
3	**NANO-FABRICATION** Epitaxy and Thin Film Deposition, Film growth: PVD Processes Evaporation (Thermal and e-beam), Chemical Growth Fundamentals of CVD growth Processes, Modern variants: MOCVD, PECVD and ALD Spin Coating.	**7**
4	**LITHOGRAPHY AND ETCHING TECHNIQUES** Optical lithography, resolution and depth of focus, resist processing methods and resolution enhancement, advanced lithography techniques for nanoscale patterning, Wet etching, selectivity, isotropy and etch bias, common wet etchants, orientation dependent etching effects; Introduction to plasma technology, plasma etch mechanisms, selectivity and profile control plasma etch chemistries for various films, plasma etch systems.	**10**

5	**CHARACTERISATION TECHNIQUES** Morphological characterisation: Raman, XRD, SEM, AFM; Electrical Characterisation: Electrical measurement techniques, two probe and four probe measurement technique; RF characterisation	**7**

List of Experiments:		**Number of Turns**
1	Thin film metal deposition using E-beam Evaporation System	**2**
2	Forming Electrode pattern using E-beam/thermal vaporization technique	**2**
3	Material synthesis and composites formation	**2**
4	Nanomaterial synthesis using hydrothermal technique	**2**
5	Deposition of compound metal oxides using sol-gel/spin coating technique	**2**
6	Measurement of Electrical properties of thin film electronic device	**2**
7	Measurement of junction characteristics of fabricated thin film semiconducting diodes such as PN, Schottky, etc.	**3**

Course Outcomes: Upon successful completion of this course, the enrolled students will be gaining the following knowledge, skills and competences:	
1	An in-depth knowledge of CMOS Scaling
2	Futuristic material-based interconnects such GNRs, CNTs
3	An in-depth knowledge of thin film deposition techniques
4	Understand operation of different fabrication tools and etching techniques
5	Characterize and study the properties of material

Suggested Books :

Sr.No.	**Title of Book/Name of Author(s)/Publisher**	**Year of Publication/Reprint**
1	Sze, S.M., “VLSI Technology”, 4th Ed., Tata McGraw-Hill	1999
2	Chang, C.Y. and Sze, S.M., “ULSI Technology”, McGraw-Hill	1996
3	Nano: The Essentials: Understanding Nanoscience and Nanotechnology by T. Pradeep,McGraw Hill Professional	2008
4	Gandhi, S. K., “VLSI Fabrication Principles: Silicon and Gallium Arsenide”, John Wiley and Sons	2003

Course Name	**:**	**HDL BASED SYSTEM DESIGN**
Course Code	**:**	**EC2232**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:

By the end of this course, the students should be able to demonstrate the designing of asynchronous logic design and FSMs, identify and define the syntax and various constructs of Verilog HDL language and programming using Verilog HDL. The student should also be able to design the digital logic using various programmable logic devices.

		Total No. of Lectures: 42
Lecture wise breakup		**No. of Lectures**
1.	**BASIC VERILOG ELEMENTS:** Lexical Conventions, Modules, Instances, Design Blocks, Stimulus Blocks, Data Types, Compiler Directives, Ports, Hierarchical Names, Tasks and Functions.	(6)
2.	**MODELING IN VERILOG HDL:** Gate-Level Modelling: Gate Types (And/ Or Gates, Buf/ Not Gates, Bufif/ Notif Gates), Gate Delays (Rise, Fall and Turn-Off Delays, Min, Max, and Typical Delays). Data-Flow Modelling: Continuous Assignments, Delay Specification, Expressions, Operators, Operands, Operator Types. Behavioural modelling: Structured Procedures (initial and always), Procedural Assignments (Blocking and Non-Blocking Statements), Timing Controls, Conditional Statements, Multi-way Branching, Loops, Sequential and Parallel Blocks. Generate Blocks. Switch-Level Modelling: Switch modelling Elements.	(10)
3.	**ADVANCED FEATURES OF VERILOG HDL:** Procedural Continuous Assignments, Overriding Parameters, Conditional Compilation and Execution, Time Scales, Useful System Tasks, Timing and Delays (Delay Model Types, Path Delay modelling, Timing Checks, Delay Back-Annotation), User-Defined Primitives (Basics of UDPs, Combinational UDPs, Sequential UDPs, UDP Shorthand Symbols. Programming Language, Logical Synthesis: Introduction and Impact of Logic Synthesis, Verilog HDL Synthesis	(8)
4.	**INTRODUCTION TO SYSTEM VERILOG** Introduction, data types, arrays, structures and unions, procedures and functions	(8)
5.	**MODELING IN SYSTEM VERILOG** Finite state machine modelling, Design hierarchy, Interfaces, behavioral and transaction level modeling, Case study	(10)

List of Simulations & Experiments:	**Number of Turns**
1. Write Verilog code to realize all the logic gates	1
2. Write a Verilog program for the following combinational designs a. 2 to 4 decoder b. 8 to 3 (encoder without priority & with priority) c. 8 to 1 multiplexer. d. 4 bit binary to gray converter 3. e. Multiplexer, de-multiplexer, comparator.	1
4. Write a VHDL and Verilog code to describe the functions of a Full Adder using three modeling styles.	1
5. Write a Verilog code to model 32 bit ALU	1
6. Develop the Verilog code for the following flip-flops, SR, D, JK and T.	1

7. Design a 4 bit binary, BCD counters (Synchronous reset and Asynchronous reset) and “any sequence” counters, using Verilog code.	1
8. Write HDL code to display messages on an alpha numeric LCD display	1
9. Write HDL code to control speed, direction of DC and Stepper motor.	1
10. Write HDL code to interface Hex key pad and display the key code on seven segment display.	1
11. Write HDL code to generate different waveforms (Sine, Square, Triangle, Ramp etc.,) using DAC - change the frequency.	1
12. Write HDL code to simulate Elevator operation.	1

Course Outcomes: By the end of this course, the students will be able to	
1.	Design asynchronous digital circuits.
2.	Identify and code the digital modules using different Verilog HDL modeling styles.
3.	Construct various digital logic circuits by using advanced features of Verilog HDL language.
4.	Implementation of synthesizable circuits and verification using test benches.

Suggested Books:

Sr. No.	**Name of Book/Authors/Publisher**	**Year of Publication /Reprint**
1.	Verilog HDL: A Guide to Digital Design and Synthesis, S. Palnitkar, Prentice Hall NJ, USA	2003
2	Switching and Finite Automata Theory, Zvi Kohavi and Niraj K, Cambridge University Press, Third Edition.	2010
3	‘Circuit design with VHDL’ by Voleni A Pedroni, MIT Press.	2011
4.	**System Verilog For Design: A Guide to Using SystemVerilog for Hardware Design ,** Stuart Sutherland, Simon Davidmann, Peter Flake, Springer Science	Latest edition
5.	A SystemVerilog Primer, by J. Bhasker	Latest edition

Course Name	**:**	**POWER ELECTRONICS**
Course Code	**:**	**EC2233 Pre-requisite: Electronic devices and circuits**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The objective of this course is to understand and acquire knowledge about various power semiconductor devices and to prepare the students to analyze and design different power converter circuits.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**POWER SEMICONDUCTOR DEVICES:** Power semiconductor devices their symbols and static characteristic, characteristics and specifications of switches, type of power electronic circuits, Thyristor operation, V-I characteristic, two transistor model, methods of turn-on operation of GTO, MCT and TRIAC, protection of devices, series and parallel operation of thyristors, commutation techniques of thyristor.	10
2	**DC-DC CONVERTORS:** Principles of step-down chopper, step down chopper with R-L load, principle of step-up chopper, and operation with R-L load, classification of choppers.	6
3	**PHASE CONTROLLED CONVERTERS:** Single phase half wave-controlled rectifier with resistive and inductive loads, effect of freewheeling diode, single phase fully controlled and half controlled bridge converters. Performance parameters, three phase half wave converters, three phase fully controlled and half controlled bridge converters, Effect of source inductance, single phase and three phase dual converters.	10
4	**AC VOLTAGE CONTROLLERS:** Principle of on-off and phase controls, single phase ac voltage controller with resistive and inductive loads, three phase ac voltage controllers (various configuration and comparison). **CYCLO CONVERTERS**: Basic principle of operation, single phase to single phase, three phase to single phase and three phase to three phase cyclo converters, output voltage equation.	10
5	**INVERTERS:** Single phase series resonant inverter, single phase bridge inverters, three phase bridge inverters, introduction to 120^{o} & 180^{o} mode of operation, voltage control of inverters, harmonics reduction techniques, single phase and three phase current source inverters.	6

Course Outcomes: By the end of this course, the students will be able to:	
1	Analyze various single phase and three phase power converter circuits and understand their applications..
2	Identify basic requirements for power electronics based design application.
3	Understand the use of power converters in commercial and industrial applications.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	L. Umanand, “Power Electronics Essentials and Applications”, Wiley India Ltd.	2009
2	JP Agrawal, “Power Electronic Systems: Theory and Design”, Prentice Hall, New York, NY, USA	2001
3	PS Bimbhra, “Power Electronics”, Khanna Publication	2008
4	M.D. Singh, K.B.Khanchandani, Power Electronics, Tata McGraw Hill Publishing company limited	2008
5	P.C. Sen, Power Electronics,Tata Mcgraw Hill Publishing company limited	1987

Course Name	**:**	**DIGITAL VLSI DESIGN**
Course Code	**:**	**EC 2234 (Pre-requisite: Electronic devices and circuits)**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:

By the end of this course, the students should be able to explain the MOS physics and its scaling effects, describe the fabrication process and mask designing of VLSI circuits. The students should also be able to design the basic CMOS circuits like inverters, combinational and sequential circuit, classify the static and dynamic behavior of CMOS circuits and compare the operation of semiconductor memories.

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1.	**MOSFET SCALING AND ITS EFFECTS** MOSFET Short Channel Effects, Geometric Scaling Theory and its effects– Full-Voltage Scaling, Constant-Voltage Scaling.	(4)
2.	**FABRICATION AND LAYOUT OF CMOS INTEGRATED CIRCUITS:** Overview of Integrated Circuit Processing – Oxidation, Photolithography, Self-Aligned MOSFET, Isolation and Wells – LOCOS, Trench Isolation, CMOS Process flow, Stick Diagram and Layout – MOSFET Dimensions, Design Rules, Latch-up.	(4)
3.	**CMOS INVERTERS:** CMOS Inverter, switching threshold and noise margin and their evaluation, static and dynamic behavior, switching characteristics- delay time calculation, Power, Energy and Energy-delay calculations, Interconnects: Resistance, Capacitance and inductance Estimation, Delay and crosstalk	(10)
4.	**CMOS COMBINATIONAL LOGIC GATES:** Complementary CMOS, Ratioed logic, Pass Transistors logic, Transmission Gate, CVSL, Dynamic logic: basic principle, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates	(8)
5.	**SEQUENTIAL MOS LOGIC CIRCUITS:** Behavior of Bistable Elements, SR latch circuits, Clocked latch and Flip-flop Circuits, CMOS D-latch and Edge triggered FF, Dynamic Transmission-Gate Edge-triggered Registers, NORA-CMOS—A Logic Style for Pipelined Structures	(8)
6.	**SEMICONDUCTOR MEMORIES:** Non-volatile and volatile memory devices, flash memories, SRAM Cell Design, Differential Sense Amplifiers, DRAM Design, Memory peripheral circuitry, power dissipation in memories	(8)

List of Experiments:		**No. of turns**
1.	Familiarization with Simulation Software for schematic and layout entry, circuit simulation	2
2.	DC transfer Characteristics of Inverters, Transient response, Calculating propagation delays, rise and fall times, power dissipation	2
3.	Implementation of Boolean logic using S-Edit for static logic.	2
4.	Implementation of Boolean logic using L-Edit for static logic, Design Rule Check (DRC), Electrical Rule Check (ERC) generation of layout and extraction.	2
5.	Design of flip-flops, counters, registers using HDL	2
6.	Design of state machines using HDL at various abstraction levels	2
7.	Creating test benches, Synthesis using FPGA kits	2

Course Outcomes: By the end of this course, the students will be able to	
1.	Describe the Physics of MOS device.
2.	Classify the CMOS process technology and layout design.
3.	Identify the characteristics of CMOS circuits and will be able to design the CMOS circuits using VLSI CAD tools.
4.	Compare between static and dynamic CMOS logic circuits.
5.	Classify the various semiconductor memories.

Suggested Books:		
Sr. No.	**Name of Book/Authors/Publisher**	**Year Of Publication /Reprint**
1.	CMOS Digital Integrated Circuits – Analysis and Design, S. Kang and Y. Leblebici, Tata McGraw Hill 3rd ed.	2008
2.	CMOS VLSI Design: A Circuits and Systems Perspective, N.H.E. Weste and K. Eshraghian, Addision Wesley 2nd ed.	1998
3.	Digital Integrated Circuits – A Design Perspective, J.M. Rabaey, A.P. Chandrakasen and B. Nikolic, Pearson Education 2nd ed.	2007
4.	CMOS Circuit Design, Layout and Simulation, R.J. Baker, H. W. Lee, and D. E. Boyce, Wiley - IEEE Press 2nd ed.	2004

Course Name	**:**	**PCB Circuit Design**
Course Code	**:**	**EC2331**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
The main aim of this course is to make students learn different PCBs for analog, digital, biomedical, wearable electronics, high frequency and power electronics applications. They will learn the electronic manufacturing and packaging aspects with the electrical, mechanical and thermal design considerations required for optimize designing of PCB

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**PCB Fundamentals:** PCB Advantages, components of PCB, Electronic components, IC's, Surface Mount Devices (SMD). Classification of PCB - single, double, multilayer and flexible boards, Manufacturing of PCB, PCB standards.	**8**
2	**Technology OF PCB:** Design automation, Design Rule Checking; Exporting Drill and Gerber Files; Drills; Footprints and Libraries Adding and Editing Pins, copper clad laminates materials of copper clad laminates, properties of laminates (electrical & physical), types of laminates, soldering techniques. Film master preparation, Image transfer, photo printing, Screen Printing, Plating techniques etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing and quality controls.	**10**
3	**Overview of Electronic Systems Packaging:** Definition of a system and history of semiconductors, Products and levels of packaging, Packaging aspects of handheld products, Definition of PWB, Basics of Semiconductor and Process flowchart, Wafer fabrication, inspection and testing, Wafer packaging; Packaging evolution; Chip connection choices, Wire bonding, TAB and flip chip	**8**
4	**Schematic & Layout Design:** Schematic diagram, General, Mechanical and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for library, Tracks, Pads, Vias, power plane, grounding.	**8**
5	**PCB design for EMC compliance:** Return path discontinuities-mixed signal PCB layout, Filtering circuit placement, decoupling and bypassing, Electronic discharge protection, Thermal management Experiments Design and development of PCBs using different simulator tools and prototyping.	**8**

List of Experiments

List of Experiments:		
Sr. No.	**Experiments**	**No. of turns**
1	Types of PCBs	1
2	Different materials for PCBs	2
3	Components and their types (SMD), through hole, Vias	3
4	Software for PCB design: Altioum Designer software (student version) or KiCAD (open source) or Autodesk Eagle or ORCAD PCB design professional	6
5	Development of PCB Board	2

Course Outcomes: By the end of the course, the student must be able to:	
1	Learn electronic manufacturing and packaging aspect.
2	Understands the electronics packaging including package styles or forms, hierarchy and methods of packaging necessary for various environments.
3	Understand the materials requirement and different optimization process of PCB design.
4	Design and develop PCB with MSI circuits for different applications.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Fabricating Printed Circuit Boards, Jon Varteresian, Newnes (Elsevier)	202
2	Printed circuit board design ,fabrication assembly and testing, R. S. Khandpur, Tata Mc Graw Hill	2005
3	EMC and Printed circuit board, Design theory and layout Made Simple , Mark I Montrose ,Wiley-IEEE Press	2000
4	Modeling and Design of Electromagnetic Compatibility for High-Speed Printed Circuit Boards and Packaging, Xing-Chang Wei, CRC Press	2017
5	Fundamentals of Microsystems Packaging, Rao R. Tummala, McGraw Hill, NY	2001
6	Introduction to System-on-Package: Miniaturization of the Entire System, Rao R Tummala & Madhavan Swaminathan, McGraw Hill	2008
7	K. Mitzner Complete PCB Design Using OrCad Capture and Layout, Elsevier,	2011
8	Printed circuit Board Design and technology, Walter C. Bosshart, Tata Mcgraw Hill	1984
9	Making Printed Circuit Boards, J. Axelson, TAB/McGraw Hill,	1993
10	Recent Published research papers	

Course Name	**:**	**FOUNDATIONS OF VLSI CAD**
Course Code	**:**	**EC2332**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
By the end of this course students should be able to explain the fundamentals of computer aided design tools for the modeling, design, analysis, test and verify digital VLSI systems. This course may also help the students to develop the algorithms as well as the working of the VLSI CAD software.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**LOGIC DESIGN ALGORITHMS:** SOP, POS minimization, Petrick's Method, Branch and Bound method, Dynamic Programming, Divide-Conquer, Greedy Algorithm based approach, Binary Design Diagram. Set covering problem solutions like Quine-McCluskey Algorithm, Iterated Consensus Method	**7**
2	**INTRODUCTION TO VLSI PHYSICAL DESIGN AND LAYOUT COMPACTION:** Introduction to VLSI Physical Design: Physical Design Automation, VLSI Design Cycle, New Trends in VLSI Design Cycle, Design Styles. VLSI Physical Design Automation: Physical Design, Physical Design Cycle, VLSI Design Automation. Layout Compaction: Design Rules, Symbolic Layout, Problem Formulation, Applications of Compaction, Informal Problem Formulation, Graph Theoretical Formulation, Maximum Distance Constants. Algorithms for Constant Graph Compaction: A Longest Path Algorithm for DAGs, The Longest Path in Graphs with Cycles, The Bellman-Ford Algorithm, Discussion: Shortest Paths, Longest Paths and Time Complexity	**10**
3	**PLACEMENT, PARTIONING & FLOOR PLANNING:** Placement and Partitioning: Circuit Representation, Wire-length Estimation, Types of Placement Problems, Placement at Various Levels, Design-Style specific Placement, Placement Algorithms: Constructive Placement, Iterative Improvement. Partitioning: Circuit Partitioning, Hierarchical Partitioning, Partition Levels, Problem Formulation, Classification of Partitioning Algorithms, The Kernighan-Lin Partitioning Algorithms Floor Planning: Floor-planning Concepts, Terminology and Floor-plan Representation, Hierarchical Design, Dead Spaces, Design-Style Specific Floor Planning Optimization Problems in Floor Planning, Slicing and Non-Slicing Floor-plans Shape Functions and Floor-plan Sizing	**10**
4	**ROUTING:** Types of Local Routing Problems, Area Routing, Channel Routing: Channel Routing Models, The Vertical Constant Graph, Horizontal Constants and the Left-edge Algorithm, Channel Routing Algorithms, Global Routing: Standard-cell Layout, Building-blockLayout and Channel Ordering, Algorithms for Global Routing: Taxonomy of VLSI Routers, Design-Style Specific Routing	**7**
5	**HIGH LEVEL SYNTHESIS:** Data flow Graphs, Hardware Optimization, Task Scheduling, Technology Mapping	**8**

Course Outcomes: By the end of this course the students will be able to	
1	Establish comprehensive understanding of the various phases of CAD for digital electronic systems,
2	Simulate digital logic to physical design, including test and verification.
3	Demonstrate knowledge and understanding of fundamental concepts in CAD and to establish capability for CAD tool development and enhancement.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	K. Hoffman and R.E. Kunze, Linear Algebra, Prentice Hall (India)	1986
2	Logic Synthesis and Verification by Gary. Hatchel	Latest edition
3	S.H. Gerez, "Algorithm for VLSI Design Automation", John Wiley & Sons	2002
4	N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers	2002

Course Name	**:**	**ANALOG VLSI DESIGN**
Course Code	**:**	**EC2333**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objective:
At the end of this course, the student should become aware of device modeling, various types of analog systems, CMOS amplifiers and op Amps. The students shall become familiarize with various analysis and simulation techniques.

Total No. of Lectures – 42		
Lecture wise breakup		**No. of Lectures**
1.	**INTRODUCTION:** Basics of CMOS, CMOS Capabilities and Limitations and CMOS Transistors and Logic. Analog IC Design and Analog Signal Processing. Overview of the VLSI technologies, VLSI Circuits and Analog IC Design Fundamentals, Analog layout techniques	(6)
2.	***CMOS DEVICE MODELLING:*** *Simple MOS* Large-Signal Model, Other MOS Large-Signal Model Parameters, Small Signal Model for MOS Transistor, Subthreshold MOS Model, Measurement of MOSFET Parameters- Diode Models: DC- Small Signal and High Frequency Model, DC Small Signal and High Frequency BJT Model- Measurement of BJT Model Parameters.	(6)
3.	**VLSI CIRCUIT DESIGN**: VLSI Circuits Design Theory, Process overview, Transistor device model, Circuit characterization. Technology libraries Overview. Pre-layout parasitics estimation. Post layout simulation techniques. VLSI Circuit Schematics and Simulation EDA Tool Flow.	(6)
4.	***ANALOG IC DESIGN:*** Analog IC Design Theory,Analog IC (CMOS) Detailed Design Flow, Active/Passive devices for Analog VLSI Design. Analog CMOS Subcircuits: MOS Switch, MOS Diode/Active Resistor, Current Sinks and Sources, Current Mirrors, Current and Voltage References, Bandgap Reference.	(7)
5.	***CMOS AMPLIFIERS:*** Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High-Gain Amplifier Architectures.	(5)
6.	***CMOS OPERATIONAL* AMPLIFIERS*:*** Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps and their Power Supply Rejection Ratio, Cascode Op Amps, Buffered Op Amps, High Speed/Frequency Op Amps, Differential Output Op Amps, Micro power Op Amps, Low Noise Op Amps, Low Voltage Op Amps.	(8)
7.	**ANALYSIS AND SIMULATION TECHNIQUES:** Different types of Analysis and Simulation techniques, Analog IC Schematics and Simulation EDA.	(4)

List of Simulations & Experiments:	**Number of Turns**
1. To study analog layout constraints. Layout, design and analysis of basic analog building blocks	3
2. Design and analysis of basic and cascode amplifier.	1
3. Design and analysis of basic current sink and by using negative feed back resistor	1
4. Design and analysis of cascode current sink and positive feed back boot strap current sink.	1
5. Design and analysis of simple current mirror and cascode current mirror.	1
6. Design and analysis of operational transconductance amplifier.	2
7. Design and analysis of Analog to Digital converter using CMOS technology	2

Course Outcomes: By the end of this course, the students will be able to	
1.	Explain the concepts of analog design.
2.	Design various analog systems including CMOS amplifiers, op Amps, and switched capacitor circuits.
3.	Describe different types of Analysis and Simulation techniques.

Suggested books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/Reprint**
1.	Allen, Phillip E. & Holberg, Douglas R. “CMOS Analog Circuit Design” Oxford University Press	2002
2.	Kang S.M, Leblebici Y,"CMOS Digital Integrated Circuits : Analysis and Design" Tata McGraw Hill, 3rd ed.	2006
3.	J. Baker “CMOS: Circuit Design, Layout, and Simulation” 2nd Edition,Wiley IEEE Press	2007
4.	B. Razavi, “Design of Analog CMOS Integrated Circuits ” McGraw Hill	2004

Course Name	**:**	**FPGA & ASICs**
Course Code	**:**	EC2334
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, students should have the knowledge of digital design techniques using field programmable gate arrays (FPGAs), FPGA architecture, digital design flow using FPGAs, and other technologies associated with field programmable gate arrays.

Total No. of Lectures - 42

Lecture wise breakup		**No. of Lectures**
1.	**INTRODUCTION:** VLSI Design Flow, Design Hierarchy, Structured Design Strategies, VLSI Design Styles, Chip Design Options, FPGA Design Flow, Role of FPGAs, FPGA Types, FPGA vs Custom VLSI, ASIC Design Flow, Type of ASIC, Full custom ASIC, Gate Array Based ASIC and Types of Arrays, Standard Cell Based ASIC, Timing and Electrical Characteristics, Power Dissipation, Case Studies and Economics of ASIC	(10)
2.	**PROGRAMMABLE LOGIC DEVICES:** Introduction, Evolution, PROM, PLA, PAL, GAL, Applications, Design Flow, Programmable Interconnections	(4)
3.	**FUNDAMENTALS OF FPGA:** A Simple Programmable Function, Fusible Link Technologies, Anti-Fuse Technologies, Static RAM based Technologies, E-PROM, EE-PROM, Flash Based Technologies, Permanently Programmed FPGAs, Chip I/O, Circuit Design of FPGA fabrics.	(8)
4.	**FPGA ARCHITECTURES:** Fine, Medium-Grained, Coarse-Grained, MUX and LUT Based Design, CLBs, LABs and Slices, Fast-Carry Chains, Embedded RAMs, Embedded Multipliers, Adders, MACs Embedded Processor Cores, Clock Trees and Clock Managers, General Purpose I/Os, Gigabit Transceivers, Hard IP, Soft IP and Firm IP, System Gates versus Real Gates.	(5)
5.	**CONFIGURING FPGA:** Configuration files, Configuration Ports, JTAG in brief, Programming using JTAG port.	(4)
6.	**ASIC LIBRARY DESIGN:** Transistor as Resistor, Transistor Parasitic Capacitance, Logical Effort, Predicting Delay, Logical Area, Logical paths, multistage cells, Optimum Delay, Library Cell Design.	(6)
7.	**LOGICAL SYNTHESIS AND DESIGN TOOLS:** Physical Design Compilation, Simulation, and Implementation, Design Flow, Tools for Simulation and Synthesis, Case Studies based on designing and synthesis of various digital systems.	(5)

Course Outcomes: By the end of this course student will be able to:	
1.	Explain various FPGA architectures.
2.	Design Digital Circuits using field programmable gate arrays.
3.	Identify Various Design Tools.
4.	Explain various Programmable Logic Devices.

Suggested Books:

Sr. No.	Name of the book/authors/ publisher	Year of publication/reprint
1	Design Warriors Guide to FPGA by Clive Max, Elsevire.	2004
2	Verilog HDL: A Guide to Digital Design and Synthesis, S. Palnitkar, Prentice Hall NJ, USA	2003
3	'Circuit design with VHDL' by Voleni A Pedroni, MIT Press.	2011
4	FPGA- Based System Design, Wayne Wolf, Pearson Education, LPE 1st Indian Edition	2000
5	'Digital design Principles and Practices' by John F. Wakerly, Prentice hall	2006
6	Richard C. Dorf "Field Programmable Gate Arrays" John Wiley & Sons	1995
7	Michad John, Sebastian Smith "Application Specific Integrated Circuit",Pearson Education, LPE.	2006

Course Name	:	**NANOTECHNOLOGY**
Course Code	:	EC 2431
Credits	:	4
LTP	:	3 1 0

Course Objective:
By the end of this course students should be able to describe the evolution and basics of nanotechnology, explain the various synthesis and nanofabrication process and their applications.

Total number of Lectures - 42

Lecture wise breakup		**Number of Lecture**
1	**INTRODUCTION TO NANOTECHNOLOGY AND NANO MATERIALS** History, ethical issues, applications in different fields, bottom up and top down approaches, Introduction to Zero, One and Two Dimensional Nanostructures, Quantum devices: Resonant tunneling diode, Coulomb Blockade, Single Electron Transistor.	**10**
2	**NANOMATERIAL SYNTHESIS TECHNIQUES** Physical methods: ball milling, Atomic Layer Deposition, Molecular beam epitaxy, spray pyrolysis, Chemical Methods: Sol gel, self-assembly, Chemical Vapor depositions, Oxidation and Nitridation, template manufacturing, Carbon nanotubes, structures and synthesis, growth mechanism and properties, devices applications, Nanowires: synthesis and characterization	**12**
3	**NANO-FABRICATION** High resolution nano lithography, E-beam and nano imprint lithography, Dip-Pen lithography, AFM Lithography. Nano characterization: High Resolution TEM, Scanning Probe Microscopes: Atomic Force Microscope and Scanning Tunneling Microscope, Nano manipulator, Lab on a Chip concept, Packing of Electronics devices (wire bonding, device encapsulation).	**10**
4	**APPLICATIONS** Introduction to novel smart materials, Photovoltaic technology and design, Flexible electronics, Emerging Memory technologies (Magnetic, Phase Change, Resistive) Molecular Switches and logic gates and Introduction to electronics and Bio sensors.	**10**

Course Outcomes:	
1	Outline the importance of nano dimensional materials and their applications.
2	Realize and explain the growth of nano-materials.
3	Characterize and study the properties of material

4	Understand the physical laws and effects that are active in the nano-world. The relationship between these laws and the extraordinary properties of nanodevices and demonstrate the applications of nano electronic devices

Suggested Books :

Sr.No.	**Title of Book/Name of Author(s)/Publisher**	**Year of Publication/Reprint**
1	Introduction to Nanotechnology First Edition Risal Singh & shipra mital gupta Oxford India press	2016
2	Fundamentals of Microfabrication and Nanotechnology (3rdEdition) by Marc Madou, CRC Press	2011
3	Nano: The Essentials: Understanding Nanoscience and Nanotechnology by T. Pradeep,McGraw Hill Professional	2008
4	Handbook of Nanotechnology (3rd Edition) by Bhushan, Springer	2007

Course Name	**:**	**MEMS AND MICROSYSTEMS**
Course Code	**:**	**EC2432**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
By the end of this course students should be able to explain the evolution, basics of MEMS and microsystems technology, summarize the basic concepts and design methodology of MEMS and Microsystems for various applications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**OVERVIEW OF MEMS AND MICROSYSTEMS** Introduction Microsystem vs. MEMS, Microsystems and Microelectronics, the Multidisciplinary Nature of Microsystem design and manufacture, Application of MEMS in various industries. MEMS and Miniaturization: Scaling laws in miniaturization: Introduction to Scaling, Scaling in: Geometry, Rigid Body dynamics, Electrostatic forces, Electromagnetic forces, Electricity, Fluid Mechanics, Heat Transfer. Materials for MEMS and Microsystems – Si as substrate material, mechanical properties of Silicon, Silicon Compounds (SiO2, Si3N4, SiC, polySi, Silicon), Piezoresistors, GaAs, Piezoelectric crystals, Polymers, Packaging Materials, Surface Plasmon effects.	**12**
2	**MICROMACHINING PROCESSES** Overview of microelectronic fabrication processes used in MEMS, Bulk Micromachining – Isotropic & Anisotropic Etching, Comparison of Wet vs Dry etching, Surface Micromachining –General description, Processing in general, Mechanical Problems associated with Surface Micromachining, Introduction to LIGA process, Introduction to Bonding. Assembly of 3D MEMS - foundary process.	**10**
3	**MICROSYSTEMS & MEMS DESIGN** Design Considerations: Design constraints, Selection of Materials, Selection of Manufacturing processes, Selection of Signal Transduction, Electromechanical system, packaging. Process design, Mechanical Design – Thermo mechanical loading, Thermo mechanical Stress Analysis, Dynamic Analysis, Interfacial fracture Analysis, Mechanical Design using Finite Element Method, Micromachining Technology – Surface and Bulk Micromachining, Micromachined Microsensors.	**10**
4	**DESIGN CASE USING CAD. PRINCIPLES OF MEASURING MECHANICAL QUANTITIES** Transduction from Deformation of Semiconductor Strain gauges: Piezo resistive effect in Single Crystal Silicon, Piezo resistive effect in Poly silicon Thin films, Transduction from deformation of Resistance. Capacitive Transduction: Electro mechanics, Diaphragm pressure sensors. Structure and Operation of Accelerometers, Resonant Sensors, Thermal Sensing and actuation.	**10**

Course Outcomes: By the end of the course, the student must be able to:	
1	Explain the operation principles of advanced micro- and nanosystems.
2	Describe the technology to fabricate advanced micro- and nanosystems.
3	Apply a concept of a micro- and nano-device into a real device considering the scaling laws and boundary conditions involved.
4	Present the basics of implementation of MEMS into products.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Microsystem Design (5th Edition) by Stephen D. Senturia, Kluwer Academic Publishers	2003
2	Micro Technology and MEMS by M. Elwenspoek and R. Wiegerink, Springer,	2000
3	Fundamentals of Microfabrication and Nanotechnology (3rdEdition) by Marc Madou, CRC Press	2011

4	MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering (2nd Edition)by Tai-Ran H Su, Tata Mcgraw.	2008
5	Electromechanical Sensors and Actuators, Ilene J. Busch-Vishniac, Springer	2008

Course Name	**:**	**LOW POWER VLSI DESIGN**
Course Code	**:**	**EC2433**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The objective of this course is to familiarize the students with sources of power in an IC. Identify the power reduction techniques and to introduce with the Device & Technology Impact on Low Power.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**LOW POWER BASICS:** Introduction: Need for Low Power Circuits, Low Power Techniques at different Hierarchical Levels, Parameters involved in power dissipation, Need for low power VLSI chips, Dynamic Power Dissipation, Short Circuit Power, Switching Power, Gliching Power, Static Power Dissipation. Emerging Low power approaches. Physics of power dissipation in CMOS devices. Silicon- on-Insulator**.**	8
2	**DEVICE & TECHNOLOGY IMPACT ON LOW POWER:** Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.	8
3	**LOW-POWER DESIGN APPROACHES:** Low-power Design Methodologies: Supply voltage scaling approaches at different levels of hierarchy, Leakage Power minimization Approaches: Variable-threshold-voltage CMOS (VTCMOS) approach, Multi-threshold-voltage CMOS (MTCMOS) approach. **ARCHITECTURAL LEVEL APPROACH**: Pipelining and Parallel Processing Approaches. **SWITCHED CAPACITANCE MINIMIZATION APPROACHES:** System Level Measures, Circuit Level Measures.	14
4	**ARITHMETIC COMPONENTS AND POWER ESTIMATION:** Low power arithmetic components: Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look- Ahead Adders. **POWER ESTIMATION TECHNIQUES**: Logic power estimation – Simulation power analysis Probabilistic power analysis.	12

Course Outcomes: By the end of this course, the students will be able to:	
1	Demonstrate the sources of power dissipation in an IC in various applications.
2	Summarize the power reduction techniques.
3	Explain various power estimation techniques.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Kaushik Roy, Sharat C. Prasad, "Low power CMOS VLSI circuit design", Wiley Inter science Publications"	1987
2	Practical Low Power Digital VLSI Design – Gary K. Yeap, Kluwer Academic Press	2002
3	Low Power CMOS VLSI Circuit Design – A. Bellamour, M. I. Elamasri, Kluwer Academic Press	1995
4	Ajit Pal, ―Low-Power VLSI Circuits and Systems‖, Springer	2015
5	J. B. Kuo and J-H. Lou, ―Low-Voltage CMOS VLSI Circuits‖, Wiley	1999

Course Name	**:**	**ADVANCE VLSI DEVICES**
Course Code	**:**	**EC2434**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The objective of this course is to familiarize the students with the Physics, Analysis, and Design of Novel and Advanced VLSI Device (Mostly in Nano-scale dimensions) Structures. The main topics for this course center around Nano FETs (Field-Effect Devices) the most promising VLSI Device till date.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Nanoscale MOSFETs** Challenges of Nanoscale MOSFETs. Limitations of Nanoscale MOSFETs: Subthreshold Leakage, Threshold Voltage Variation, Mobility Degradation, Hot Carrier Effects, Source Drain Tunneling Parasitic Resistance and Capacitance, Reverse Biased Junction Leakage Current, Ballistic and Quasi-Ballistic MOSFETs.	8
2	**Advanced MOSFETs** Silicon-on-Insulator (SOI) MOSFETs: Fully Depleted (FD) SOI, Partially Depleted (PD) SOI, Junction Less SOI. Other Multigate SOI-MOSFETs: Double Gate, FinFET, π Gate, Ω Gate, Gate-All-Around (GAA) or surrounding gate, Silicon on Nothing (SON), Nanowire FET, (i) Channel Engineering: Retrograde Substrate and Halo Doping profiles; (ii) Gate Engineering: High-k gate dielectrics, Metal Gate-Stack; (iii) Source/Drain (S/D) Engineering: S/D Engineering of nanoscale double gate SOI MOSFETs, Schottky-barrier S/D Technology; (iv) Material Engineering: high mobility materials (e.g. Ge, GaAs/InGaAs etc.) for channel of FET.	10
3	**Advanced CMOS** New Materials and Device Structures (CMOS circuits, SOI MOSFETs, Heterostructure FETs, Nanotube FETs, Nanowire FETs, Novel steep subthreshold slope devices, Alternative devices (Excitons, Spin, Phase Transitions).	8
4	**Promising Nanodevices Beyond CMOS** Thin Film Transistors (TFT): Hydrogenated amorphous silicon (a-Si:H) TFT, Impact-Ionization MOSFETs (IMOSFETs), Tunnel FETs (TFETs), Schottky-Barrier FETs (SBTFETs), Carbon Nanotube-FETs (CNTFETs), Organic FETs (OFETs)	8
5	**Photonic devices** LED and Semiconductor Lasers: Introduction, Radiative Transitions, Semiconductor Laser Physics, Laser Operating Characteristics Photodetectors: Introduction, Photoconductor, Photodiode, Avalanche Photodiode Solar Cells: Introduction, Solar Radiation and Ideal Conversion Efficiency, p-n junction Solar Cells, Heterojunction, Interface and thin film solar cells	8

Course Outcomes: By the end of this course, the students will be able to:	
1	Make projections about MOS device scaling and how it affects circuit/system performance.
2	Recognize the relevant device physics that underlies CMOS device design.
3	Go to a conference or read a journal article about CMOS devices and use the knowledge obtained in this course to understand the material.
4	Develop an intuitive feel in addition to solving equations.
5	Obtain necessary skills to explore the research space of state-of-the-art VLSI technology.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	S. M. Sze and K. K. Ng,Physics of Semiconductor Devices, Third Edition, Wiley.	2006
2	Jean-Pierre Colinge (Ed), FinFETs and Other Multi-Gate Transistors, Springer.	2008

3	S. D. Brotherton, Introduction to Thin Film Transistors: Physics and Technology of TFTs,Springer.	2013
4	Yuan Taur and Tak H. Ning, Fundamentals of Modern VLSI Devices, Cambridge university press.	2013
5	Weste, Neil HE and David Harris, CMOS VLSI design: a circuits and systems perspective, Pearson Education India.	2015
6	Recent Published research papers	

Embedded Systems Pool

Course Name	**:**	**MICROPROCESSOR AND MICROCONTROLLER**
Course Code	**:**	**EC 2221**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

At the end of the course, the students should be able to explain the architecture and programming of 8086 microprocessor and 8051 microcontroller. The student should be able to demonstrate various interfacing techniques.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**8086 ARCHITECTURE:** Introduction of microprocessor, 8086 architecture- functional diagram, Register organization, memory segmentation, programming model, Memory addresses, physical memory organization, Signal descriptions of 8086-common function signals, timing diagrams, Interrupts of 8086.	**6**
2	**PROGRAMMING AND INTERFACING FOR 8086:** Instruction formats. Addressing modes, instruction set, assembler directives. Macros, Simple programs involving logical, branch and call instructions. Sorting, evaluating arithmetic expressions, string manipulations. Memory addressing, decoding and Memory interfacing – Interrupts and interrupts handling. Introduction to 8087 math coprocessor.	**10**
3	**I/O INTERFACE:** 8255 PPI, various modes of operation and interfacing to 8086, interfacing of key board, display. Stepper motor interfacing, D/A &A/D converter. 8251 USART architecture and Interfacing.	**8**
4	**8051 MICROCONTROLLERS:** Architecture, Pin configuration, SFR's, Memory, 8051 Addressing modes	**4**
6	**8051 INSTRUCTIONS:** Introduction to 8051 assembly language programming: JUMP, LOOP and CALL instructions, Arithmetic instructions: Unsigned addition and subtraction, unsigned multiplications and Division, signed number concepts and arithmetic operations, Logic and Compare instructions.	**5**
7	**I/O PORT PROGRAMMING:** Single bit instruction programming, Single bit operations with CY, Programming 8051 timers, counter programming, generating pulse waveforms.	**5**
8	**8051 INTERRUPTS:** Programming Timer Interrupts, Programming External Hardware Interrupts.	**4**

Sr. No.	**List of experiments**	**Number of Turns**
1	8086 based experiments for data transfer operations.	2
2	8086 based experiments for arithmetic operations.	2
3	8086 based experiments for logical operations.	2
4	8086 based experiments for data conversions.	2
5	Simple Calculator using 6 digit seven segment displays and Hex Keyboard interface to 8051.	2
6	External ADC and Temperature control interface to 8051	2

7	To get familiar with KEIL and develop at least 10 programs for 8051 Microcontroller	2

Course Outcomes: By the end of this course student will be able to:	
1	Explain the functioning of microprocessor and microcontrollers.
2	Demonstrate microcontrollor based projects.
3	Enhance the programming skills.
4	Identify the importance of Assembler Directives and Operators.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Microprocessors and Microcontrollers Architecture, Programming and Interfacing Using 8085, 8086 and 8051 SoumitraMandal Tata McGraw-Hill	2017
2	A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing ", second edition, Tata McGraw-Hill	2006
3	Microprocessors and Peripherals by- B.Brey, CBS.	1989
4	The 8051 Microcontrollers by- Ayala, Penram Publications.	2010

Course Name	**:**	**INDUSTRIAL AUTOMATION**
Course Code	**:**	**EC 2222**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The main aim of this course is to make students will learn about the automation used in various industrial applications and the use of PLC, DCS and SCADA in different processes.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Programmable Logic Controllers (PLC):** Architecture of PLC- Different Modules, Power Supply Unit Etc, Need of PLC in Designing. Different Types Of Sensors- Sinking, Sourcing, NPN, PNP, Monitoring the Process through Sensors- Connection Details.Analogy Addressing, Continues Process Monitoring And Control.Different Types of Controllers- ON/OFF, Proportional, Derivative, Integral and PID Control.PLC Programming of Branded PLCs.NO/ NC Concept.Data File Handling- Forcing I/O.Wiring and Fault Correction.Programming Practices..	**12**
2	**Supervisory Control And Data Acquisition (SCADA):** SCADA Packages, Role of SCADA in Industrial Automation, SCADA System Configuration, RTU, Communication Protocols.Script Programming.Real Time and Historical Trend.Configuring Alarms.Real Time Project Development with PLC Interfacing.Communication with Other Software.Recipe Management.Accessing Different Security Levels.Report Generation of Current Plant.	**12**
3	**Distributed Control System (DCS)** Architecture of DCS, Yokogawa Centum CS 3000, Comparison of PLC with DCS, Programming Languages for DCS, Different Types of Cards and Their Functions.	**10**
4	**Human Machine Interface** Different Types of Operator Interfaces, Textual, Graphical, Wiring Practice of HMI, Data Handling With HMI, Configuration and Interfacing to PLC and PC, Communication Standards- DF1, Ethernet, DH45, RS232, RS485, Profibus.	**8**

Course Outcomes: By the end of the course, the student must be able to:	
1	Compare conventional sequential control with programmable logic control system
2	Develop programs using different PLC programming languages for sequential and continuous process
3	Interface analog and digital input/ output devices with PLC using different communication protocol
4	Understand the basic types, levels, strategies of automation

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Programmable logic controller by Frank D. Petrusella, Tata McGraw-Hill	2005
2	Introduction to programmable logic controller by Gary dunning, Thomson Asia Pte Ltd	2005
3	PLCs & SCADA - Theory and Practice by Rajesh Mehra, Vikrant Vij	2012
4	SCADA: Beginner's Guide by Francis G.L	2015
5	SurekhaBhanot, Process Control: Principles and Applications, Oxford University Press	2008
6	G. Dunning, Introduction to Programmable Logic Controllers, Cengage Learning	2005
7	Recent Published research papers	

Course Name	**:**	**EMBEDDED SYSTEM DESIGN**
Course Code	**:**	**EC 2223**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
At the end of this course, the student should be able to learn concepts of embedded systems, explain the architecture and Programming ARM - Cortex and PIC microcontrollers and its support devices .

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO EMBEDDED SYSTEMS:** Fundamentals of Micro-controllers and Embedded Systems, Block Diagram, Micro-Controllers versus Microprocessors, Applications of Micro-Controllers and Embedded Systems, Development Systems for Micro-Controllers and Embedded Systems	**2**
2	**ARM EMBEDDED SYSTEMS:** CISC versus RISC Architectures, RISC Design Philosophy, ARM Design Philosophy, Embedded System Hardware: ARM Bus Technology, Memory, Peripherals. Embedded System Software: Initialization Boot Code, Operating System, Von-Neumann versusHarvard Architectures, Registers, Current Program Status Register (CPSR), Pipeline, Exceptions, Interrupts and the Vector Tables, Core Extensions: Cache, Memory Management, Coprocessors	**8**
3	**ARM INSTRUCTION SET:** Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instructions, Program Status Register Instructions, Loading Constraints, Conditional Execution, Thumb Register Usage, ARM-Thumb Interworking, Branch Instructions, Data Processing Instructions, Load-Store Instructions, Stack Instructions, Software Interrupt Instructions	**14**
4	**PIC18FXXXX FAMILY:** Introduction to PIC microcontrollers, Architecture of PIC18 family of devices, PIC18F programming model, instruction set, instruction format. Data copy, arithmetic, branch, logical, bit manipulation and multiply-divide operations. Stacks, subroutines and macros.	**7**
5	**INPUT/OUTPUT PORTS AND INTERFACING:** Concepts of I/O interfacing, PIC18 I/O ports, Interfacing of output and input peripherals, Concept of serial I/O, PIC18 serial communication module	**5**
6	**INTERRUPTS, TIMERS and DATA CONVERTERS:** Concepts of Interrupts and Timers, Interrupts and their implementation in PIC18, timer operation, Use of Interrupts in applications, Basic concepts of Data Converters, PIC18F452 A/D and D/A converter modules and its Applications	**6**

List of Experiments:		**Number of Turns**
1	To get familiar with KEIL and develop at least 5 programs for using ARM processor	**1**
2	Interfacing ADC and DAC with ARM	**2**
3	Interrupt performance characteristics of ARM	**3**
4	Implementing zigbee protocol with ARM	**4**

5	To get familiar with MPLAB and FLOWCODE software and develop at least 8 programs on each for PIC Microcontroller	**5**
6	Using Flowcode, use ZIGBEE, Bluetooth module, GPS module along with PIC Controller	**6**

Course Outcomes: By the end of this course, the students will be able to:	
1	Understand the Embedded Concepts and Architecture of Embedded Systems.
2	Understand the architecture and programming of ARM Cortex Microcontroller.
3	Design and develop systems based on PIC micro-controller and its interfaces.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010.	2010
2	ARM System-On-Chip Architecture‖, Steve Furber, - Second Edition, Pearson Publisher, 2015	2015
3	ARM System Developer's Guide -Designing and Optimizing System Software by: Andrew N Sloss, Dominic Symes, Chris Wright; Elseiver	2004
4	PIC Microcontroller and Embedded Systems using Assembly and C for PIC18 by M.A. Mazidi, R.D. McKinlay and D. Causey, Pearson	2007
5	Cortex-M series-ARM Reference Manual	NA
6	Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family), Ramesh GAONKAR, Penram International Publishing	2007

Course Name	**:**	**IoT with ARDUINO AND RASPBERRY PI**
Course Code	**:**	**EC2224**
Credits	**:**	**4**
L T P	**:**	**302**

Course Objectives:
The objective of this course is to familiarize the students in IoT system design using Arduino and Raspberry pi.Students should (a) learn about the Arduino, Raspberry Pi, and all other associated platforms(b) learn about basic programming and structures required for basic operation of the platform, (c) understand how to recognize functions, operations and syntax of Python (d) understand various internet communication protocol and application of IoT in Industry and Home automation.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Embedded System design:** Introduction to embedded systems, Components of embedded system. Advantages and applications of embedded systems, Examples of real time embedded systems and how they are manufacturedindustry ready. .	2
2	**Learning Arduino Platform:** Arduino platform, Prototyping environment, Electronic component overview, Arduino Development, Environment, setting up the Arduino board, creating sketches, using Libraries, using example codes,Debugging Using the Serial MonitorArduino C, Data types, Decision making, Loops, Functions, Pointers, Structures. andHardware Interfacings with Arduino, Interfacing sensors and actuators using Arduino.Wired and Wireless Communication, Communication Protocols, Interfacing Communication Modules with Arduino.Interfacing , Types of motors - DC, Servo, Stepper, Motor Drivers, Speed and direction control.	14
3	**Getting Started with Raspberry Pi:** Basic functionality of the Raspberry Pi board and its Processor, setting and configuring the board, differentiating Raspberry Pi from other platform like arduino, begal, asus thinker etc., Overclocking, Component overview. Introducing to Python programming language: Python Programming Environment, Python Expressions, Strings, Functions, Function Arguments, Lists, List Methods, Control Flow, Numpy, PIP (Python Installation Package) and customized libraries, Communication facilities on raspberry Pi (I2C, SPI, UART), working with RPil. GPI library, Interfacing of Sensors and Actuators, Internet of Things on Raspberry Pi.	14
4	**Exploring IoT** – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. An IoT architecture outline, standards considerations. Review of internet protocols –Processing platforms for IoT-sensors – actuators-Cloud computing models –low power, low range protocols –Zigbee –BLE – 6LoWPAN. Applications for IoT-Smart home, city, agricultureetc,.	12

Sr. No.	**List of experiments**	**Number of Turns**
1	Introduction to Arduino Uno (or ARM Processor like Raspberry pi)	1
2	LCD interfacing with Arduino Uno. 16x2 RGB backlight LCD interfacing.	1

3	Relay control by a button.: When the button gets pressed, the relay will close, allowing current to flow through the connected appliance.	1
4	Controlling LED with Sound sensor	1
5	Using Light Sensor Turn ON an LED when the light intensity falls below the preset threshold.	1
6	Controlling LED brightness using Rotary angle sensor.	1
7	Servo Control Use a potentiometer to control the position of the servo.	1
8	RFID Automatic Identification and Data Capture	1
9	Working with GSM/GPRS based control using SIM900 module	1
10	Project: RFID based Assets and Vehicle Tracking	1
11	Perform Experiment using Arduino Uno to measure the distance of any object using Ultrasonic Sensor.	1
12	Create a circuit using Arduino and sensors. Perform experiment using Arduino Uno to Learn Working of Servo Motor	1
13	OPEN Ended problem: Students are required to submit an IOT based project using the Microcontroller or a Raspberry Pi and connecting various sensors and actuators. The data for the same should be displayed via a webpage or a web app.	2

Course Outcomes: By the end of this course, the students will be able to:	
1	Understand how the Arduino platform works in terms of the physical board and libraries and theIDE (Integrated Development Environment).
2	Develop an understanding of implementation methodology of Arduino.
3	Understand the working of Raspberry Pi, its featuresand how various components can be used with Pi.
4	Create IoT solutions for Industrial and Commercial Building Automation and Real World Design Constraints.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Margolis, M. Arduino cookbook: Recipes to begin, expand, and enhance your projects. O'Reilly Media, Inc.	2011
2	Mark Lutz, "Learning Python", O'Reilly Media, 5th Edition.	2016
3	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, DavidBoyle, 1st Edition, Academic Press,	2014
4	The official raspberry Pi Projects Book: https://www.raspberrypi.org/magpi-issues/Projects_Book_v1.pdf	NA
5	Raspberry Pi Assembly Language RASPBIAN Beginners THIRD EDITION, CreateSpace Independent Publishing Platform.	2013

Course Name	**:**	**NEURAL NETWORKS AND FUZZY SYSTEMS**
Course Code	**:**	**EC 2321**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of the course, the students should have knowledge of different Neural Networks and problems based onpattern classification and recognition. Students should also be able to design various real time applications using the concepts of Fuzzy Logic systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**FUZZY LOGIC AND SETS:** Concepts of fuzzy logic, Crisp and fuzzy sets, properties of fuzzy sets, operations on fuzzy sets, fuzzy relations, operations on fuzzy relations.	6
2	**FUZZY LOGIC SYSTEM COMPONENTS:** Membership function, features of membership function, fuzzification, membership value assignment, fuzzy decision making, fuzzy system,	4
3	**FUZZY RULE BASED SYSTEM:** Formation of rules, decomposition of rules, aggregation and properties of fuzzy rules, fuzzy interference systems.	4
4	**INTRODUCTION TO NEURAL NET:** Artificial Neural Networks, Biological Neural Networks, Applications of Neural Nets, Architecture of Neural Networks, History of Neural Networks, MC Culloch-Pitt Neuron.	4
5	**PATTERN CLASSIFICATION:** Biases and threshold, Linear separability, Hebbnet, Perceptron, Adaline, Madaline.	4
6	**PATTERN ASSOCIATION:** Training Algorithms for Pattern Association, Heteroassociative Memory Neural Network, Auto associative Net, Iterative Auto associative Net, Bidirectional Associative Memory (BAM).	6
7	**NEURAL NETWORKS BASED ON COMPETITION:** Maxnet, Mexican Hat, Hamming Net, Kohonen Self Organizing Maps, Learning Vector Quantization, Full and Forward Counterpropagation.	6
8	**ADAPTIVE RESONANCE THEORY:** Introduction, Architecture and algorithm of ARTI and ART2.	4
9	**BACKPROPAGATION NEURAL NET:** Standard Back propagation, Architecture, Algorithm, Variations, Derivation of learning rules.	4

Course Outcomes: By the end of this course student will be able to:	
1	Describe the concepts of feed forward neural networks.
2	Explain Adaptive neural networks.
3	Design various networks for real time applications.
4	Summarize the concept of fuzziness involved in various systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Fundamentals of Neural Networks, Laurence Fausett, Pearson Education	2006

2	Neural networks and Fuzzy Logic, K VinothKumar,R. Saravana Kumar, Katson Books	2012
3	Neural Netorks and machine learning, Haykin, Pearson Education	2008
4	Neural Networks, Satish Kumar, TMH	2012

Course Name	**:**	**COMPUTER ARCHITECTURE**
Course Code	**:**	**EC 2322**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, the students should be able to identify and define the architecture and organization of thebasic computer. The students should also be able to explain the role of different modules like control unit, centralprocessing unit, input-output organization, memory unit in the organization of basic computer, solve computer arithmetic and define the concept of parallel processing.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**REGISTER TRANSFER AND MICRO OPERATIONS:** Register transfer Language, Register transfer, Bus & memory transfer, micro operations, Instruction codes, Computer instructions, Timing & control, Instruction Cycles, Memory reference instruction, Input /Output & Interrupts, Complete computer description & design of basic computer.	8
2	**CONTROL UNIT:** Hardwired vs. Micro programmed control unit. Introduction of GPU.	4
3	**CENTRAL PROCESSING UNIT:** General register organization, Stack organization, Instruction format, Data transfer & manipulation, Program control, RISC, CISC.	7
4	**COMPUTER ARITHMETIC:** Addition & subtraction, Multiplication Algorithms, Division algorithms.	5
5	**INPUT-OUTPUT ORGANIZATION:** Peripheral devices, I/O interface, Data transfer schemes, Program control, Interrupt, DMA transfer, I/O processor.	7
6	**MEMORY UNIT:** Memory hierarchy, Processor vs. memory speed, Hard disk drive, High-speed memories, Cache memory, Associative memory, Interleave, Virtual memory, Memory management	8
7	**PARALLEL PROCESSING:** Types of parallel processors, performance considerations, pipeline processors, array processors, multicore systems	3

Course Outcomes: By the end of this course, the students will be able to	
1	Define the syntax of Register transfer Language and different micro operations.
2	Design and construct the instruction format & addressing modes for a given operation and algorithms for
	addition, subtraction, multiplication & division.
3	Explain the interdependence of different modules like control unit, CPU and I/O interface and their design aspects.
4	Summarize the working of different types of memories like associate memory, cache memory, virtual memory etc. and their mapping techniques.
5	Outline the concept of pipelining and multiprocessors.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Computer System Architecture, Morris M. Mano, Prentice Hall, 3rd ed.	1992
2	Computer Architecture and Organization, J.P. Hayes, McGraw Hill, 3rd ed.	1998
3	Computer Architecture A Quantitative Approach, J.L. Hennessy, D.A. Patterson and D. Goldberg , Pearson Education Asia, 5th ed.	2006
4	System Architecture: software and hardware concepts, W.E. Leigh, and D.L. Ali, South Wester Publishing Co.	2000

Course Name	**:**	**MULTIMEDIA TECHNOLOGY**
Course Code	**:**	**EC2323**
Credits	**:**	
L T P	**:**	**3 1 0**

Course Objective:
The objective of the course is to learn the technical details of common multimedia data formats, protocols, and compression techniques of digital images, video and audio content. It enables to learn about the significance of quality of service in multimedia networking

Total No. of Lectures-42

Lecture wise breakup		**No of lectures**
1.	**INTRODUCTION:** Media types (text, graphics, images, audio, speech, video, animation), Components of the multimedia system, Hypermedia and the Web, Hypertext, Multimedia Systems: Characteristics, Challenges, Desirable Features, Components and Applications, Trends in Multimedia.	4
2.	**MEDIA AND DATA STREAMS:** Discrete and Continuous Media, Analog and Digital Signals, Text and Static Data, Audio: digitizingsound, Graphics, Images and Video, Multimedia Authoring Paradigms, Design Issues in Multimedia Applications, Standardsfor Document Architecture: SGML (Standard Generalized Markup Language), ODA (Open Document Architecture); Multimedia Standards for Document Interchange: MHEG (Multimedia Hypermedia Expert Group).	8
3.	**STORAGE MEDIA:** Magnetic and Optical Media, RAID and its levels, Compact Disc and its standards, DVD and its standards, Multimedia Servers.	4
4.	**GRAPHICS , IMAGES AND VIDEOS:** Display types and file formats, Review of color images and video clips: basic models of color, Video: Component and composite video, S-video, analog and digital video, Digital Audio: Sampling, quantization, coding and transmission of sound.	6
5.	**IMAGE COMPRESSION:** Types of Redundancies, Classifying Compression Algorithms, Basics of Information Theory, Entropy Encoding: Run-length Encoding, Pattern Substitution, Huffman Coding, Huffman Coding of Images, Adaptive Huffman Coding, Arithmetic Coding, Lempel-Ziv-Welch (LZW) Algorithm, Source Coding Techniques: Transform Coding, Frequency Domain Methods, Differential Encoding, Hybrid Coding: Vector Quantization, JPEG Compression.	8
6.	**AUDIO COMPRESSION:** Simple Audio Compression Methods, Psychoacoustics Model, MPEG Audio Compression.	4
7.	**VIDEO COMPRESSION:** Intra Frame Coding (I-frame), Inter-frame (P-frame) Coding, H.261 Compression, MPEG Compression, MPEG Video, MPEG Video Bit stream, Decoding MPEG Video in Software.	4
8.	**MULTIMEDIA COMMUNICATION:** Building Communication Network, Application Subsystem, Transport Subsystem, QOS, Resource Management, Distributed Multimedia Systems, Elements of (immersive/non-immersive) Virtual Reality, Augmented Reality and Telepresence Applications, Mobile technologies	4

COURSE OUTCOME: At the end of the course, students will be able to	
1.	Describe the types of media and define multimedia system.
2.	Describe the process of digitizing (quantization) of different analog signals (text, graphics, sound and video).
3.	Use and apply tools for image processing, video, sound and animation.
4.	Apply methodology to develop a multimedia system.
5.	Apply acquired knowledge in the field of multimedia in practice and independently continue to expand knowledge in this field.

Suggested Books:		
Sr. No.	**Name of Book/Authors/ Publisher**	**Year of Publication/Reprint**
1.	Multimedia Computing, Communications and Applications, Ralf Steinmetz and KlaraNahrstedt, Pearson Education	2012
2.	Multimedia System Design, Prabhat K. Andleigh, KiranThakkar, PHI	1996
3.	Introduction to Information Theory and Data Compression‟ Second Edition, Darrel Hankerson, Greg A Harris, Peter D Johnson, Chapman and Hall ,CRC press	2003
4.	Multimedia Communications, Fred Halsall, Pearson Education	2006

Course Name	**:**	**DIGITAL IMAGE PROCESSING**
Course Code	**:**	**EC2324**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to learn and understand the fundamentals of image processing, transformation techniques, design & applications of image processing. The students should also be able to provide a useful skill base that would allow them to carry out further study should they be interested and to work in the field.

Total No. of Lectures-42

Lecture wise breakup		**No. of Lectures**
1	**FUNDAMENTALS OF IMAGE PROCESSING:** Introduction,Human visual system,Steps in image processing systems, Image acquisition, Sampling and Quantization, Pixel relationships,Light, brightness adaption and discrimination, Color fundamentals and models, File formats, Image operations, Arithmetic, Geometric and Morphological.	**9**
2	**IMAGE ENHANCEMENT:** Basic of intensity transform and spatial domain, Gray level Transformations, Contrast stretching, Thresholding, Image negative, Log transformation, Power-low transformation, Intensity level slicing and Bit-plane slicing, Histogram processing, Histogram equalisation process, Spatial filtering smoothing and sharpening, Filtering in frequency domain, Fourier transform of sampled function, DFT, FFT, DCT, Image smoothing and sharpening filters – Homomorphic Filtering.	**9**
3	**IMAGE SEGMENTATION AND FEATURE ANALYSIS:** Fundamentals,Detection of Discontinuities, Edge operators, Edge linking and Boundary Detection, Thresholding, Edge based segmentation, Region based segmentation,Region split and merge techniques, Morphological Watersheds,Motion Segmentation, spatial techniques and frequency domain techniques, feature analysis and extraction .	**8**
4	**MULTI RESOLUTION ANALYSIS AND COMPRESSIONS:** Multi Resolution Analysis: Image Pyramids, Multi resolution expansion, Wavelet Transforms, Image compression:Fundamentals, Image compression models, Elements of Information Theory , Error free compression , Lossy Compression, Image formats, and Compression Standards, Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, JPEG compression standard.	**8**
5	**APPLICATION OF IMAGE PROCESSING:** Image classification, Image recognition, Image fusion, Steganography, Colour Image Processing, Color models, Pseudo-colour image processing, Pattern recognition.	**8**

Course Outcomes: By the end of this course, the students will be able to:	
1	Acquire the fundamental concepts of a digital image processing system.
2	Design and implement with Matlab algorithms for digital image processing.
3	Utilize the skill base necessary to further explore advanced topics of Digital Image Processing.

S.No.	**Name of Book/Authors/Publisher**	**Year of Publication/ Reprint**
1	Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education	2001
2	Milan Sonka, ValclavHalavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd Edition, Thomson Learning	1998
3	Anil K. Jain, "Fundamentals of Digital Image Processing". Pearson Education,	1989
4	S Jayaraman, S Esakkirajan, T Veerakumar, "Digital Image Processing", Tata McGraw Hill Publication	2009
5	Rafael C. Gonzalez, Richard E. Woods & S L Eddins, "Digital Image Processing using MATLAB", Prentice hall.	2003

Course Name	**:**	**Advanced Sensing Technology**
Course Code	**:**	**EC2421**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The main aim of this course is to make students learn different sensing technology and methods for everyday useand it also highlights the future trend of sensors to mankind.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ELECTROCHEMICAL SENSORS:** Galvanic Cells, Electrode – ElectrolyteInterface, Fluid Electrolytes, Transduction Elements- Ion-Selective Electrodes, Nernst Equation, voltammetry, amperometry, conductivity, FET, Modified electrodes, Thin-Film Electrodes andScreen-Printed electrodes. Amperometric-bio sensors (Glucosesensor) and gas sensors.	**10**
2	**CONDUCTOMETRIC-CHEMIRSISTOR** Biosensor based chemiresistors, Semiconducting oxide sensor, CHEMFETs, ISFETs, FET basedBiosensors. Piezoelectric effect- Gas sensor applications, Biosensorapplications- Quartz crystal microbalance, surface acoustic waves,enzymatic mass sensor, Glucose thermistor, catalytic gas sensor.	**10**
3	**INTRODUCTION FIBER OPTIC SENSOR** Industrial Applications of Fiber Optic Sensors: Temperature, Pressure, fluid level, flow, position, vibration, rotation measurements, Current, voltage measurement, Chemical analysis. Introduction to smart structures Applications.	**8**
5	**FLEXIBLE AND WEARABLE SENSORS** Materials for flexible electronics, degrees of flexibility, substrates,Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-to Roll processing - Additive printing, Materials considerations for flexible electronics: Inorganics semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing active materials	**8**
5	**MEMS (MICROSENSORS)** Pressure sensor- accelerometers- gyroscope, Introduction to nanotechnology, Future requirements andopportunities of nanotechnology in sensing, CNT 2D material and nanostructure based sensors, Nano electronics and nano photonics.Recent trends in Smart sensor, Agriculture sensor	**6**

Course Outcomes: By the end of the course, the student must be able to:	
1	By the end of this course students can realize the technology developments in the semiconductor technology.
2	To develop wearable sensors for Healthcare, Wellness and Environmental Applications.
3	To understand the materials requirement and different fabrication process of MEMS devices.
4	Present the basics of implementation of sensors into products.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Loic J Blum and Coulet, "Biosensor: Principle and applications",CRC Press, 2nd edition	2010
2	Brian R Eggins, "Chemical sensors and Biosensors", John Wileysons Ltd,	2004
3	K. T. V. Grattan, T. Sun (auth.), K. T. V. Grattan, B. T. Meggitt(eds.) Optical Fiber Sensor Technology: Fundamentals, SpringerUS,	2000
4	Peter Grundler, "Chemical Sensors: Introduction for Scientistsand Engineers", Springer,	2007
5	GuozhenShen, Zhiyong Fan, "Flexible Electronics: FromMaterials to Devices", 1st Edition, World Scientific Publishing Co,	2015
6	Microsystem Design (5thEdition) by Stephen D. Senturia, Kluwer Academic Publishers	2003
7	Micro Technology and MEMS by M. Elwenspoek and R. Wiegerink, Springer,	2000
8	Fundamentals of Microfabrication and Nanotechnology (3rdEdition) by Marc Madou, CRC Press	2011
9	MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering (2ndEdition)by Tai-Ran H Su, Tata Mcgraw.	2008
10	William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 1st Edition, Springer,	2011
11	Recent Published research papers	

Course Name	**:**	**ROBOTICS**
Course Code	**:**	**EC2422**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The main aim of this course is to introduce the modelling, simulation, and control of spatial multi-degree-of-freedom robotic manipulators. In particular, the student will study the kinematics and dynamics of robotic manipulators. Additionally, student will get awareness about the trajectory planning and control of robotic arm.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** History of the development of robots, basic components of robotic systems, Anatomy and structural design of robot, manipulation, arm geometry, Drives and control (hardware) for motions, End effectors and grippers..	**2**
2	**KINEMATICS:** Translation, orientation of rigid bodies, Representation of links and joints, workspace, velocities, manipulator jacobian, singularities of robots and mechanisms, Kinematics for serial and parallel manipulators, election of coordinate frames, Homogeneous transformation, DH parameters, Direct and Inverse kinematics: Two link planner, PUMA 560, Stanford arm, SCARA and Stewart Platform.	**10**
3	**DYNAMICs of ROBOTS:** Introduction to robot dynamics, Forward and inverse dynamics of robot manipulators, Rigid link Recursive Acceleration, Lagrange-Euler Dynamic formulation.	**8**
4	**TRAJECTORY PLANNING and CONTROL:** Path planning, trajectory planning, Joint space trajectory planning, Cartesian space trajectory, planning, Continuous trajectory recording (Trajectory following), position, velocity and force control.	**6**
5	**MOBILE ROBOTICS:** Wheeled mobile robots, bipeds, swarm robotics, Military mobile robots, Underwater robots, Surveillance robots, Nano robots.	**4**
6	**SLAM (Simultaneous Localization and Mapping):** Localization, Planning,Segmented Ste, Fun with Parameters, SLAM, Graph SLAM, Implementing Constraints, Adding Landmarks, Matrix Modification, Untouched Fields, Landmark Position, Confident Measurements, Implementing SLAM.	**7**
7	**VIRTUAL REALITY and HAPTICS:** Virtual reality concepts, virtual world and real world, Interface to virtual world (inputs and outputs), Types of interaction, Applications, Definition of Haptics, Importance of Touch, Tactile Proprioception, Tactual Stereo genesis, Kinesthetic Interfaces, Tactile Interfaces, Human Haptics, Overview of existing applications. Case studies.	**5**

Course Outcomes: By the end of the course, the student must be able to:	
1	Design and simulate the forward and inverse kinematic model.
2	Develop and analyze the trajectory planning.
3	Model robot dynamics for a given serial robotic manipulator
4	Apply the joint- and Cartesian-based schemes to control the manipulators in different applications.
5	Analyze mobile robot in virtual and real environment

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Spong, Mark W., and Mathukumalli Vidyasagar. Robot dynamics and control. John Wiley and Sons.	2008
2	Craig, John J. Introduction to robotics: mechanics and control, 3/E. Pearson Education India.	2009
3	Lewis, Frank L., D. M. Dawson, and Chaouki T. Abdallah. Control of robot manipulators. Prentice Hall PTR.	1993
4	Crane III, Carl D., and Joseph Duffy. Kinematic analysis of robot manipulators. Cambridge University Press.	2008
5	Koren, Yoram. Robotics for engineers. McGraw-Hill.	1985
6	Sensors And Transducers, D. Patranabis, Prentice-Hall India, 2nd Ed.	2004
7	Ranky, Paul G., Chung You Ho, and Paul G. Ranky. Robot modelling: control and applications with software. IFS (Publications).	1985
8	Fu, King Sun, Ralph Gonzalez, and CS George Lee. Robotics: Control Sensing. Vis. Tata McGraw-Hill Education.	1987
9	Recent Published research papers	

Course Name	**:**	**PLC DESIGNING**
Course Code	**:**	**EC 2423**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The main aim of this course is to make students learn programmable logic controllers (PLCs), process control algorithms, interfacing of sensors and other I/O devices, simulation and networking.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**PLC INTRODUCTION:** Programmable Logic Controllers (PLCs): Introduction; definition & history of the PLC; Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; Solid state memory; the processor; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers, PLC Application. Programming equipment; proper construction of PLC ladder diagrams; process scanning consideration; PLC operational faults.	**8**
2	**PLC HARDWARE COMPONENTS** The I/O section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O specifications, The CPU, Memory design, Memory Types, Programming Devices, Selection of wire types and size. Various INPUT /OUTPUT Devices and its interfacing with PLC.	**8**
3	**PLC PROGRAMMING** Processor Memory Organization, Program Scan, PLC Programming languages, Relay type instructions, Instruction addressing, Branch Instructions, Internal Relay Instructions, Programming Examine if Closed and examine If Open instructions, Entering the ladder diagram, Modes of operation.Creating Ladder Diagrams from Process Control Descriptions.Ladder diagram & sequence listing; large process ladder diagram construction, flowcharting as programming method, Industrial Examples, Programming Timers and Programming Counters.	**10**
4	**PLC INSTRUCTIONS** Bit Logic Instructions, Clock, Different Logical operation Instructions, Different Integer Math Instructions, Different Conversion Instructions, Different Comparison Instructions, Program Control Instructions, Sequencer and shift register instructions, Different Interrupt Instructions, Data Handling Functions,	**8**
5	**PLC NETWORKING** Introduction, Levels of Industrial Control, Types of Networking, Network communications.PLC Installation practices, Editing and Troubleshooting, PLC Enclosures, Electrical Noise, Leaky Inputs and Outputs, Grounding, Voltage variations and Surges, Program Editing, Programming and Monitoring, Preventive Maintenance, Troubleshooting, Connecting PC with PLC, Alternative Programming Languages, Various Brands of PLCs and their revolution.	**8**

Course Outcomes: By the end of the course, the student must be able to:	
1	Compare conventional sequential control with programmable logic control system
2	Develop programs using different PLC programming languages for sequential and continuous process
3	Interface analog and digital input/ output devices with PLC using different communication protocol
4	Test the PLC based system and troubleshoot the errors associated with it.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Programmable logic controller by Frank D. Petrusella, Tata McGraw-Hill	2005
2	Introduction to programmable logic controller by Gary dunning, Thomson Asia Pte Ltd	2005
3	Programmable Logic Controllers: Principles and Applications by John W. Webb and Ronald A. Reis, Prentice –Hall India	1994
4	Programmable Logic Controllers by W. Bolton, Elsevier	2015
5	Programmable Controllers An engineer's guide by E.A.Parr, Elsevier	2003
6	S7-200, S7-300, PLC Manual of Siemens for Instructions	2008
7	Recent Published research papers	

OPEN ELECTIVE

1	Communication Systems* (3-1-0) (EC6011/EC5001)
2	Digital Image Processing*$ (3-1-0) (EC6012/EC5003)
3	Computer Networks (3-1-0) (EC6013)
4	Advanced Communication Systems (3-1-0) (EC6014)
5	Mobile and Cellular Communication (3-0-2) (EC6015)
6	Digital Signal Processing*$ (3-1-0) (EC6016/EC5004)
7	Analog and Digital Electronics * (3-1-0) (EC6021/EC5002)
8	Introduction to Printed Circuit Board (3-0-2) (EC61022)
9	Electronic Measurements and Instrumentation (3-1-0) (EC6023)
10	MEMS and Microsystems (3-1-0) (EC6024)
11	Electronics Device Fabrication (3-0-2) (EC6025)
12	Nano Electronics Devices (3-0-2) (EC6026)
13	PLC designing (3-1-0) (EC6031)
14	ARDUINO Programming and Raspberry Pi (3-1-0) (EC6032)
15	Sensing Technology (3-1-0) (EC6033)
16	Multimedia Technology (3-1-0) (EC6034)
17	Microcontrollers and their Applications*# (3-1-0) (EC6035/EC5005)
18	Microprocessor and Microcontroller*# (3-1-0) (EC6036/EC5006)

* Fixed for Minor Specialisation; $/# : any one subject

Course Name	:	**COMMUNICATION SYSTEMS**
Course Code	:	**EC6011/EC5001**
Credits	:	**4**
L T P	:	**3-1-0**

Course Objectives:
By the end of this course, the students should be able to describe the concepts used in communication technology. The students should also be able to explain the modulation techniques used in Analog and digital communication and their applications.

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1.	**ANALOG COMMUNICATION** Introduction to Communication Systems: Block diagram, Need for Modulation, Theory of different types of modulation: Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM); Noise; Source of Noise: Externa & Internal Noise, Noise Calculation, Comparison of Various Analog Communication System(AM,FM,PM)	10
2.	**DIGITAL COMMUNICATION** Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK): BPSK, QPSK, 8PSK, Quadrature Amplitude Modulation (QAM), Bandwidth Efficiency, Comparison of Various Digital Communication System (ASK,FSK, PSK, QAM).	8
3.	**DATA AND PULSE COMMUNICATION** Data Communication: History of Data Communication, Sampling theorem, Pulse Communication: Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PTM), Pulse Position Modulation (PPM), Pulse Code Modulation (PCM), Comparison of Various Pulse Communication Systems (PAM, PWM, PPM, PCM).	8
4.	**SOURCE AND ERROR CONTROL CODING** Entropy, Mutual Information, Source Encoding Theorem, Shannon Fanon Coding, Huffman Coding, Channel Capacity, Channel Coding Theorem, Error Control Coding, Linear Block Codes, Cyclic Codes, Error Detection and Correction Techniques	8
5.	**APPLICATIONS OF RADIO COMMUNICATION** Mobile communication, Internet, HDTV, FM Radio, Compression Techniques (JPEG, MPEG), AMPS, GSM, CDMA, 4G, 5G	8

Course Outcomes: By the end of this course, the students will be able to	
1.	Describe Block Diagram of communication systems.
2.	Explain the modulation Techniques used in Analog and Digital Communication System
3.	Describe the concept of Information and coding in data communication
4.	Aware of Applications of Communication technology

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1.	Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons	2004
2.	H.Taub, D L Schilling and G Saha, “Principles of Communication”, 3rd Edition, Pearson Education	2007
3.	B. P.Lathi, “Modern Analog and Digital Communication Systems”, 3rd Edition, Oxford University Press	2007
4.	Blake, “Electronic Communication Systems”, Thomson Delmar Publications	2002
5.	Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education	2007

Course Name	**:**	**DIGITAL IMAGE PROCESSING**
Course Code	**:**	**EC6012/EC5003**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course, the students should be able to familiarize with the fundamentals of image processing, transformation techniques, and design & applications of image processing. The students should also be able to provide a useful skill base that would allow them to carry out further study should they be interested and to work in the field.

Total No. of Lectures - 42

	Lecture Wise Breakup	**No. of Lectures**
1	**FUNDAMENTALS OF IMAGE PROCESSING:** Introduction ,Steps in image processing systems, Image acquisition, Sampling and Quantization , Pixel relationships , Color fundamentals and models, File formats, Image operations, Arithmetic, Geometric and Morphological.	9
2	**IMAGE ENHANCEMENT:** Spatial Domain: Gray level Transformations ,Histogram processing, Spatial filtering smoothing and sharpening. Frequency Domain: Filtering in frequency domain , DFT, FFT, DCT , Smoothing and sharpening filters – Homomorphic Filtering.	9
3	**IMAGE SEGMENTATION AND FEATURE ANALYSIS:** Detection of Discontinuities, Edge operators, Edge linking and Boundary Detection, Thresholding, Region based segmentation, Morphological Watersheds, Motion Segmentation, Feature Analysis and Extraction.	8
4	**MULTI RESOLUTION ANALYSIS AND COMPRESSIONS:** Multi Resolution Analysis: Image Pyramids, Multi resolution expansion, Wavelet Transforms, Image compression: Fundamentals , Models, Elements of Information Theory , Error free compression , Lossy Compression , Compression Standards.	8
5	**APPLICATION OF IMAGE PROCESSING:** Image classification, Image recognition , Image fusion, Stegenography, Colour Image Processing.pattern recognition.	8

Course Outcomes: By the end of this course, the students will be able to:	
1.	Acquire the fundamental concepts of a digital image processing system.
2.	Design and implement with Mat lab algorithms for digital image processing.
3.	Utilize the skill base necessary to further explore advanced topics of Digital Image Processing.

Suggested Books:

Sr.no	**Name of Book / Author / Publisher**	**Year of Publish / Reprint**
1.	Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education	2001
2.	Milan Sonka, ValclavHalavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd Edition, Thomson Learning	1998
3.	Anil K. Jain, "Fundamentals of Digital Image Processing". Pearson Education,	1989

Course Name	**:**	**COMPUTER NETWORKS**
Course Code	**:**	**EC6013**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

By the end of this course, the students should be able to define the basic concepts of Data communication with different models, classify and compare the physical layer, Data Link Layer, Network Layer and Transport Layer and their functions. The students should also be able to summarize the switching concept, its different types and explain the working of various types of wireless networks and their protocol.

Total No. of Lectures: 42

	Lecture wise breakup	**No. of Lectures**
1.	**OVERVIEW OF DATA COMMUNICATION AND NETWORKING**: Data communications, Networks, The Internet, Protocols and standards, Layered tasks, OSI model, TCP /IP protocol Architecture, History of the computer network	(3)
2.	**PHYSICAL LAYER:** Data rate limit, Transmission impairments, Line coding, Block coding, Sampling, Transmission mode, Modulation of digital data, Telephone modems, Modulation of analog signal, FDM, WDM, TDM, Guided media, Unguided media	(5)
3.	**DATA LINK LAYER:** Types of errors, Detection, Error correction, Flow and error control, Stop and wait ARQ, go back n ARQ, Selective repeat ARQ, HDLC, Point to point protocol, PPP stack, Random access (ALOHA, CSMA), Controlled access (Reservation, Polling, Token Passing), Channelization (FDMA,TDMA, CDMA), Traditional Ethernet, Fast Ethernet, Gigabit Ethernet	(8)
4.	**NETWORKING AND INTERNETWORKING DEVICES:** Repeaters, Bridges, Type of Bridges, Routers, Routing concepts, Gateways, Internetworks, ARP, IP, ICMP, IPV6, Unicast routing, Unicast routing protocol, Multicast routing, Multicast routing protocols, introduction to Security, Cryptography, and SSL, Security - firewalls, DoS, etc.	(8)
5.	**TRANSPORT LAYER:** Process to process delivery, User datagram protocol (UDP), Multiplexing and Demultiplexing, Connection less transport (UDP), Principles of reliable data transfer, Transmission control protocol (TCP), Data traffic, Congestion, Congestion control, Quality of service	(5)
6.	**APPLICATION LAYER:** DNS, Electronics mail architecture and services, message formats and transfers, WWW architectural overview, static and dynamic web pages, HTTP, Digital audio and video	(4)
7.	**WIRELESS NETWORKS:** Cordless system, Wimax and IEEE 802.16 broadband wireless access standards, Mobile IP, Wireless Application Protocol, IEEE 802 Architecture, IEEE 802.11 Architecture and Services, IEEE 802.11 Medium Access Control, IEEE 802.11 Physical Layer, Other IEEE 802.11 Standards, Wi-Fi Protocol Access, Bluetooth and IEEE 802.15, Ad-hoc wireless and sensor networks.	(5)
8.	**SWITCHING:** Circuit Switching, Space division switching, Time division switching, Space and time division switching combinations, Packet switching, Data gram approach, Virtual circuit approach, message switching, Network Layer connection oriented and connectionless services, ATM, ISDN, MPLS, GMPLS.	(4)

Course Outcomes: By the end of this course, the students will be able to	
1.	Describe the computer network system and its communication.
2.	Identify and compare the various layers of a computer network model, their role and characteristics.
3.	Explain various routing algorithms and switching concepts.
4.	Identify the various wireless network models.

Suggested Books:		
Sr. No.	**Name of Book/Authors/Publisher**	**Year Of Publication /Reprint**
1.	Introduction to Data Communication & Networking by Behrouz Forouzan, Tata McGraw Hill Edition	2012
2.	Data and Computer Communications by William Stallings PHI 8th Edition.	2007
3.	Data Communication and Distributed Networks, Ulylers D. Black, PHI 3rd ed.	1999
4.	Computer Networks, Andrew S.Tanenbaum, , PHI 2nd ed.	2000

Course Name	:	**Advanced Communication Systems**
Course Code	:	**EC6014**
Credits	:	**4**
L T P	:	**3-1-0**

Course Objectives:
By the end of this course, the students should be able to explain the block diagram of digital communication system, various digital modulation techniques, and describe the basic concepts of information theory and coding. The students should also be able to identify and compare various fields of advanced communication and their applications.

Total No. of Lectures: 42

	Lecture wise breakup	**No. of Lectures**
1.	**INTRODUCTION** Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms.	06
2.	**DIGITAL MODULATION TECHNIQUES** Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-ary ASK, PSK, FSK, DPSK), Continuous phase modulation (QPSK and variants, MSK, GMSK).	10
3.	**INFORMATION THEORY AND CODING** Concept of information, Entropy, Mutual information, Source encoding, channel encoding, channel capacity	05
4.	**OPTICAL COMMUNICATION** Block diagram of Optical fiber communication system, Introduction to light, Optical fiber characteristics and classifications, losses and dispersion, Fiber optic components and systems, Installation, testing, and repair	06
5.	**MOBILE COMMUNICATION** Cellular concepts, mobile radio propagation, wireless channel modelling, Frequency reuse concept, cellular coverage planning	06
6.	**MICROWAVE AND RADAR ENGINEERING** Generation of Microwaves (Klystron, Magnetron), Applications of microwave (Radar, Satellite), Basic principal block diagram and operation of radar (Pulse CW, Doppler effect), Radar range equation, Pulse repetition frequency (PRF), Range ambiguities. Applications of radar	09

Course Outcomes: By the end of this course, the students will be able to

1.	Describe advanced communication systems.
2.	Apply the underlying principles for up-to-date examples of real world systems.
3.	Emphasize on modern digital data transmission concepts and modulation techniques.
4	Solve problems relevant to communication channel, capacity and coding
5	Build a basis for subsequent related courses such as optical, mobile communication, and microwave and radar Engineering.

Suggested Books:		
Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	Digital Communication by John G. Proakis and Masoud Salehi, Fifth edition, McGraw-Hill Higher education	2008
2.	Principles of Communication Systems by Taub and Schilling Tata McGraw-Hill Education, 3rd edition	2008
3..	Elements of Information Theory by Thomas M. Cover, Joy A. Thomas "A Wiley-Interscience publication, 2nd Edition	2005
4.	Electronics Communication Systems by George Kennedy and Bernard Davis, Fourth edition, TMH	2009
5.	Wireless communication, principal &practice, T.S Rappaport. 2nd Edition, PHI	2007
6.	Microwave devices and circuits (3rd Edition) by Samuel Liao, PHI	1996

Course Name	**:**	**MOBILE AND CELLULAR COMMUNICATIONS**
Course Code	**:**	**EC6015**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

By the end of this course, students should be able to familiarize with the evolution and basics of wireless communication technology, identify and explain the cellular concepts, like, frequency reuse, co-channel interference, cell splitting, and in-depth knowledge about the concept of handoff. The student should have an introduction to very-small-aperture terminal satellites and its applications in mobile communications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO CELLULAR SYSTEMS:** A basic cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular system, planning a cellular system, analog& digital cellular systems.	3
2	**CELLULAR WIRELESS COMMUNICATION SYSTEM:** Second generation cellular systems: GSM specification and air interface- specification of various units, GSM Architecture, 2.5 G systems: GPRS/EDGE specifications and features, 3G systems: UMTS & CDMA 2000 standards and specifications.	5
3	**ELEMENTS OF CELLULAR RADIO SYSTEMS DESIGN:** General description of the problem, Concept of frequency reuse channels, co-channel interference reduction factor, desired carrier to interference ratio (C/I) for an omni-directional antenna system, cell splitting, consideration of the components of cellular systems.	7
4	**INTERFERENCE:** Introduction to co-channel Interference, real time co-channel interference, co-channel measurement design of antenna system, antenna parameter and their effects, diversity receiver in co-channel interference, Equalization, Equalization in Communication Receiver, RAKE Receiver.	6
5	**CELL COVERAGE FOR SIGNAL & TRAFFIC**: General introduction, Obtaining the mobile point to point model, propagation over water or flat open area, foliage loss, propagation near in distance, long distance propagation, point to point prediction model characteristics, cell site, antenna heights and signal coverage cells, mobile to mobile propagation.	6
6	**FREQUENCY MANAGEMENT AND CHANNEL ASSIGNMENT:** Frequency Management, Frequency spectrum utilization, Channel Assignment definition and its types, i.e., fixed channel assignment, non-fixed channel assignment, traffic and channel assignment.	5
7	**HANDOFFS, DROPPED CALLS**: Need of handoffs, types of handoffs, i.e., based on signal strength and carrier to interference ratio (C/I), Initiation, delay and queuing of handoffs, Intersystem handoffs, dropped call rates & their evaluation.	4
8	**EARTH STATION AND VERY-SMALL-APERTURE TERMINAL SATELLITES (VSATS):** Spacecraft Structure, Primary Power, Various Subsystem of a Satellite, Transmitter, Receivers, Components of Earth Station, VSAT- type, VSTA uses in Mobile Communications.	6

Serial Number	List of Experiments	No. of Turns
1	To study GSM Architecture and network topologies	1
2	To study and estimate call flow (Voice and Data)	1
3	To comprehend the intra-circle roaming functionality	1
4	To estimate, calculate and design link budget.	1
5	To do frequency planning of the network along with neighbor definition	1
6	To estimate and design concept of frequency reuse	1
7	Create a scenario to study the bottleneck of the transmission rate of a link	2
8	To study optimization strategies to improve grade of service	2
9	To estimate various types of interference.	2
10	To study the effect of fading and measure the fading margin of a received signal on spectrum analyzer	2

Course Outcomes: By the end of this course the students will be able to	
1	Explain the fundamental concepts and evolution of mobile communication systems.
2	Learn cellular system design basics and frequency management techniques, especially the concept of frequency reuse, co-channel interference, cell splitting.
3	Understand co-channel interference and describe interference reduction strategies, i.e., equalization.
4	Determine the cell coverage area for different natural and man-made terrains
5	Appreciate the concept of handoffs in mobile communication systems.
6	Understand the working and design of very-small-aperture terminal satellites and their applications in mobile communications

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Mobile Cellular Telecommunications; William, by C Y Lee. 2nd Edition McGraw Hill	2006
2	Wireless Digital Communications : Modulation and Spread Spectrum Applications , by Dr. Kamilo Feher. 2nd Edition, PHI	2015
3	Wireless communication, Principles &Practice, by T.S Rappaport. 1st Edition, Pearson	2010
4	Digital Satellite Communication, by Tri T. Ha. 2nd Edition, McGraw Hill	2017

Course Name	**:**	**DIGITAL SIGNAL PROCESSING**
Course Code	**:**	**EC6016/EC5004**
Credits	**:**	**4**
L T P	**:**	**3 -1-0**

Course Objectives:

By the end of this course, students should be able to define concepts of DSP such as LTI Systems, stability, causality and differential equations, explain various transformation and design techniques and implementation of IIR and FIR filters.

		Total no of lectures:42
Lecture wise breakup		**No.of Lectures**
1	**REPRESENTING SIGNALS BY USING DISCRETE TIME COMPLEX EXPONENTIALS: THE Z- TRANSFORM:** Z-Transform and its properties, Region of convergence and its properties, inverse z transform, transfer function, causality and stability.	(07)
2	**TRANSFORMATION OF DISCRETE SIGNALS** Typical applications of DSP, Discrete Fourier Transform (DFT) and its properties, IDFT, Fast Fourier Transform (FFT), Decimation in time and decimation in frequency algorithms, IFFT	(08)
3	**DIGITAL FILTERS** Recursive and non-recursive systems, Frequency domain representation of discrete time systems, systems function, Ideal low pass filter	(05)
4	**DESIGN OF IIR FILTERS** Impulse invariance transformation technique, Bilinear transformation, Design of IIR Filters using Butterworth, chebyshev and elliptic filter, Digital frequency transformation	(09)
5	**DESIGN OF FIR FILTERS** Design of FIR filters using Window technique, frequency sampling technique, Equiripple Approx. technique, comparison of IIR and FIR filters	(08)
6	**REALIZATION OF DIGITAL SYSTEMS** Block diagrams and signal flow graphs for FIR and IIR systems, Direct form, cascade and parallel form realization of FIR and IIR systems.	(05)

Course Outcomes: By the end of this course student will be able to:	
1.	Define LTI systems, DTFT, FFT
2.	Explain various design techniques of IIR and FIR digital filters
3.	Explain the realization of IIR and FIR filters
4.	Outline the concept of DSP processor

Suggested Books:		
Sr. No.	**Name of Book/Author/Publisher**	**Year of Publication/ reprint**
1.	Digital Signal Processing by Proakis & Manolakis, Pearson Education	2006
2.	Digital Signal Processing by A.V Oppenheim and R.W.Schafer, Pearson Education	2006
3.	Digital Signal Processing by E C Ifeachor and B W Jervis .	2001
4.	Digital Signal Processing by S Salivahanan, A Vallavraj, C Gyanapriya, TMH	2011
5.	Digital Signal Processing By S. K. Mitra , TMH	2010

Course Name	**:**	**ANALOG AND DIGITAL ELECTRONICS**
Course Code	**:**	**EC6021/EC5002**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Total No. of Lectures – 42

Course Objectives:

At the end of this course, the student should be able to identify active and passive components and to solve simple electronic circuits. The student should also be able to explain construction, operation, characteristics and biasing of diodes, transistors, FETs and applications of operational amplifier. The student should be able to demonstrate the ability to use logic gates, Basic Boolean laws, minimization techniques for the designing of various combinational circuits. The student should also be able to describe operation, characteristic equations, excitation table of various flip flops and explain the conversion of flip flops.

Lecture wise breakup	**No. of Lectures**

1	**Circuit Theory Fundamentals** Electrical quantities, Electrical components, Circuit laws and theorems, Circuit analysis, Measurement equipment	(4)
2	**Diodes and Diode Circuits** Diode, Diode models, Rectifier circuits, Clippers, Clampers,	(4)
3	**Bipolar Junction Transistors** Junction transistor, Regions of operation, Transistor configurations, Current components in a transistor, Transistor as an amplifier, characteristics of CB, CE and CC configuration, Frequency Response of single stage CE amplifier, introduction to feedback amplifiers and oscillators	(7)
4	**Field Effect Transistors:** Introduction, FET Construction, types of FET, Characteristics of FETs, MOSFET: types and working principle.	(4)
5	**OPERATIONAL AMPLIFIERS:** Block diagram of a typical Opamp, Ideal Opamp, Open loop Opamp configurations, Opamp Characteristics, closed loop Opamp configurations, voltage series feedback or Non inverting amplifier, Voltage shunt feedback or inverting amplifier, Summing scaling and averaging amplifiers, Subtractor, voltage to current converter, current to voltage converter, Integrator, Differentiator, Comparator.	(5)
6	**Minimization Techniques** Sum of Products and Products of Sum forms, Minterms & Maxterms, Karnaugh Map for two, three, four five and six variables.	(4)
7	**Combinational Circuit Design** Half adder, full adder, subtractor, BCD adder, comparator, code converter, encoder decoder, multiplexer, demultiplexer, parity detector and generator	(4)
8	**Flip Flops** 1-bit memory cell, clocked and unclocked flip flops, S-R Flip flop, D flip flop, JK Flip flop, T flip flop, edge triggered flip flop, race around condition , Master slave flip flop.	(4)
9	**Counters And Shift Registers** Ripple counter, design of Mod-N ripple counter, synchronous counter, decade counter, serial in serial out shift register, serial in parallel out shift register,	(5)

	parallel in serial out shift register and parallel in parallel out shift register, bidirectional shift register, universal shift register.	
10	**Digital Memories & Programmable Logic** ROM, RAM (static and dynamic), PROMS, PLA and PAL	(4)

Course Outcomes: By the end of this course, the students will be able to	
1. 2. 3. 4.	Describe the behavior of electronic devices such as diodes, transistors and FETs. Explain basic building blocks of operational amplifier, their functioning and demonstrate its various applications in analog systems. Identify the components of combinational and sequential circuits and their operation. Compare the different memories.

Suggested Books:		
Sr. No.	**Name of Book/Authors/Publisher**	**Year Of Publication /Reprint**
1.	Integrated Electronics, Millman & Halkias, TMH.	2008
2.	Electronics Devices & Circuit Theory, RL Boylestead & L Nashelsky, PHI	2009
3.	Circuits and Networks: Analysis and Synthesis, Sudhakar and Shyam Mohan, TMH	2009
4.	Electronics Circuit Analysis and Design, Donald A. Neamen, Tata McGraw Hill	2008
5.	Digital Design by Morris Mano, PHI, 4th edition	2008
6.	Digital principles and Applications, by Malvino Leach, TMH	2011

Course Name	**:**	**INTRODUCTION TO PRINTED CIRCUIT BOARD**
Course Code	**:**	**EC6022**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
The main aim of this course is to make students learn different PCBs for analog, digital, biomedical, wearable electronics, high frequency and power electronics applications. They will learn the electronic manufacturing and packaging aspects with the electrical, mechanical and thermal design considerations required for optimize designing of PCB

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Introduction to PCB designing concepts** What is PCB, Difference between PWB and PCB, Types of PCBs: Single Sided (Single Layer), Multi-Layer (Double Layer), PCB Materials, Active Components (Diode, Transistor, MOSFET, LED), Passive components (Resistor, capacitor, inductor), IC's. PCB Advantages, components of PCB, Electronic components, Surface Mount Devices (SMD). Classification of PCB - single, double, multilayer and flexible boards, Manufacturing of PCB, PCB standards.	**10**
2	**Design of PCB** PCB layout design, Prototype Designing (Design Rule Check, Design for Manufacturing), PCB Making (Printing, Etching, Drilling), Assembly of components,PCB Layers: Electrical Layers (Top, Middle and Bottom), Mechanical (Drill, Board Outlines); Documentation Layers (component outlines, reference designation, text); Heat sinks and Package Density, Footprint, pad stack, Vias, Track (length, angle, joint, size),	**12**
2	**Materials and fabrication of PCB:** Standard FR-4 Epoxy Glass, Multifunctional FR-4, Tetra Functional FR-4, BT Epoxy Glass, copper clad laminates materials of copper clad laminates, Laminates characteristics and properties types of laminates, soldering techniques. Film master preparation, Image transfer, photo printing, Screen Printing, Plating techniques etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing and quality controls.	**12**
3	**PCB Compliance:** Environmental, Thermal management, Electromagnetic (Dielectric Breakdown, Static Charge Generation, Human Body Model, Static Discharge, ESD Protection)	**8**

List of Experiments:		
Sr. No.	**Experiments**	**No. of turns**
1	Types of PCBs	1
2	Different materials for PCBs	2
3	Components and their types (SMD), through hole, Vias	3
4	Software for PCB design: Altioum Designer software (student version) or KiCAD (open source) or Autodesk Eagle or ORCAD PCB design professional	6
5	Development of PCB Board	2

Course Outcomes: By the end of the course, the student must be able to:

1	Learn electronic manufacturing and packaging aspect.
2	Understands the electronics packaging including package styles or forms, hierarchy and methods of packaging necessary for various environments.
3	Understand the materials requirement and different optimization process of PCB design.
4	Design and develop PCB with MSI circuits for different applications.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Fabricating Printed Circuit Boards, Jon Varteresian, Newnes (Elsevier)	202
2	Printed circuit board design ,fabrication assembly and testing, R. S. Khandpur, Tata Mc Graw Hill	2005
3	EMC and Printed circuit board, Design theory and layout Made Simple , Mark I Montrose ,Wiley-IEEE Press	2000
4	Modeling and Design of Electromagnetic Compatibility for High-Speed Printed Circuit Boards and Packaging, Xing-Chang Wei, CRC Press	2017
5	Fundamentals of Microsystems Packaging, Rao R. Tummala, McGraw Hill, NY	2001
6	Introduction to System-on-Package: Miniaturization of the Entire System, Rao R Tummala & Madhavan Swaminathan, McGraw Hill	2008
7	K. Mitzner Complete PCB Design Using OrCad Capture and Layout, Elsevier,	2011
8	Printed circuit Board Design and technology, Walter C. Bosshart, Tata Mcgraw Hill	1984
9	Making Printed Circuit Boards, J. Axelson, TAB/McGraw Hill,	1993
10	Recent Published research papers	

Course Name	**:**	**ELECTRONIC MEASUREMENTS AND INSTRUMENTATION**
Course Code	**:**	**EC6023**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objective:

At the end of this course, the student should become aware of the principle of working of various instruments used to measure basic electronic parameters. The student should be aware of the design features of some of the instruments and transducers. The student should be able to identify and describe basic instrumentation systems.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1.	**INTRODUCTION STATISTICAL:** Basic characteristics of measuring devices, types of errors and their statistical analysis, accuracy, precision and ratings of instruments, fundamental, derived and international systems of units and their conversion.	(4)
2.	**ANALOG INSTRUMENTS:** Electromechanical instruments – moving, coil, moving iron, electrodynamics, rectifier, electrostatic instruments, current voltage and power measurements, induction type energy meter, q-meter frequency.	(5)
3.	**TRANSDUCERS:** Actuating mechanisms, electric types of transducers – self generating, piezo electric, photo. Variable parameter transducers – variable resistance strain gauges, variable capacitance – LVDT, magnetos ruction types.	(6)
4.	**OPTOELECTRONIC MEASUREMENTS AND BIOTECHNOLOGY INSTRUMENTS:** Radiometry and photometry, laws of illumination, optical transducers, light modulating techniques, fiber optic sensors, ECG, EEG, cardiovascular measurements, pacemakers, instrumentation for diagnostic x-rays.	(7)
5.	**SIGNAL GENERATORS AND ANALYZERS:** Sweep frequency generator, frequency synthesized signal generator and function generator, wave analyzer harmonic distortion and spectrum analyzer.	(6)
6.	**INDICATING AND RECORDING SYSTEMS:** Digital frequency counters, X-Y and X-T recorders, general purpose oscilloscopes, delayed time base, sampling and digital storage type oscilloscopes, probes	(7)
7.	**DAS AND MICROPROCESSOR BASED INSTRUMENTATION:** Modern Digital DAS Systems, Microprocessor Based Systems like multifunction test instrument, signature analyzer, logic analyzer, temperature monitoring system, water level sensing system, interface standards.	(7)

Course Outcomes: By the end of this course, the student should be able to:	
1.	Operate various electronic instruments required for measuring electronic parameters
2.	Troubleshoot the instruments associated.
3.	Outline various digital DAS systems and microprocessor Based Systems.

Suggested books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ reprint**
1.	Modern Electronics Instrumentation and Measurement Techniques – Albert D Helfrick, William D Cooper, Pearson Ed	2005
2.	Electronic Measurement and Instrumentation by Bernard M. Oliver, J.M. Cage, McGraw Hill	1971
3.	Instrumentation, Measurement and Feedback – B Jones	1977
4.	Electronic Measurement by Terman and Petizt	2005
5.	Biomedical Instrumentation and Measurements – Leslie Cromwell, Weibell, Pfeiffer, second edition,Prentice Hall Mark	2003 (Edition)
6.	A Courser in Electrical and Electronic Measurements and Instrumentation – A K Sawney	1996

Course Name	**:**	**MEMS AND MICROSYSTEMS**
Course Code	**:**	**EC6024**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
By the end of this course students should be able to explain the evolution, basics of MEMS and microsystems technology, summarize the basic concepts and design methodology of MEMS and Microsystems for various applications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**OVERVIEW OF MEMS AND MICROSYSTEMS** IntroductionMicrosystemvs. MEMS, Microsystems and Microelectronics, the Multidisciplinary Nature of Microsystem design and manufacture, Application of MEMS in various industries. MEMS and Miniaturization: Scaling laws in miniaturization: Introduction to Scaling, Scaling in: Geometry, Rigid Body dynamics, Electrostatic forces, Electromagnetic forces, Electricity, Fluid Mechanics, Heat Transfer. Materials for MEMS and Microsystems – Si as substrate material, mechanical properties of Silicon, Silicon Compounds (SiO2, Si3N4, SiC, polySi, Silicon), Piezoresistors, GaAs, Piezoelectric crystals, Polymers, Packaging Materials, Surface Plasmon effects.	**12**
2	**MICROMACHINING PROCESSES** Overview of microelectronic fabrication processes used in MEMS, Bulk Micromachining – Isotropic & Anisotropic Etching, Comparison of Wet vs Dry etching, Surface Micromachining –General description, Processing in general, Mechanical Problems associated with Surface Micromachining, Introduction to LIGA process, Introduction to Bonding. Assembly of 3D MEMS - foundary process.	**10**
3	**MICROSYSTEMS & MEMS DESIGN** Design Considerations: Design constraints, Selection of Materials, Selection of Manufacturing processes, Selection of Signal Transduction, Electromechanical system, packaging. Process design, Mechanical Design – Thermo mechanical loading, Thermomechanical Stress Analysis, Dynamic Analysis, Interfacial fracture Analysis, Mechanical Design using Finite Element Method, Micromachining Technology – Surface and Bulk Micromachining, Micromachined Microsensors.	**10**
4	**DESIGN CASE USING CAD. PRINCIPLES OF MEASURING MECHANICAL QUANTITIES** Transduction from Deformation of Semiconductor Strain gauges: Piezo resistive effect in Single Crystal Silicon, Piezo resistive effect in Poly silicon Thin films, Transduction from deformation of Resistance. Capacitive Transduction: Electro mechanics, Diaphragm pressure sensors. Structure and Operation of Accelerometers, Resonant Sensors, Thermal Sensing and actuation.	**10**

Course Outcomes: By the end of the course, the student must be able to:	
1	Explain the operation principles of advanced micro- and nanosystems.
2	Describe the technology to fabricate advanced micro- and nanosystems.
3	Apply a concept of a micro- and nano-device into a real device considering the scaling laws and boundaryconditions involved.
4	Present the basics of implementation of MEMS into products.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Microsystem Design (5thEdition) by Stephen D. Senturia, Kluwer Academic Publishers	2003
2	Micro Technology and MEMS by M. Elwenspoek and R. Wiegerink, Springer,	2000
3	Fundamentals of Microfabrication and Nanotechnology (3rdEdition) by Marc Madou, CRC Press	2011
4	MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering (2ndEdition) by Tai-Ran H Su, Tata Mcgraw.	2008
5	Electromechanical Sensors and Actuators, Ilene J. Busch-Vishniac, Springer	2008

Course Name	**:**	**Electronic Device Fabrication**
Course Code	**:**	**EC6025**
Credits	**:**	**4**
LTP	**:**	**3-0-2**

Course Objective:
To provide knowledge of device physics/operation, technologies and issues in nanoscale CMOS, other emerging devices and futuristic material based interconnects. Students earn the basic understanding of nano electronics and followed by the advanced understanding of the nano-micro fabrication techniques.

Total number of Lectures - 42

Lecture wise breakup		**Number of Lecture**
1	**EMERGING NANOSCALE DEVICES and INTERCONNECTS** History of semiconductor devices, Moore's law, feature size and minimum feature size trend. Si and hetero-structure nanowire MOSFETs, carbon nanotube MOSFETs, Tunnel FET, quantum wells, quantum wires and quantum dots, Resonant tunneling devices, Single electron transistors, Junction-less transistors, Spintronics devices. Optical interconnects, Superconducting interconnects, Nanotechnology interconnects, Silicon nanowires, Carbon nanotube (CNT) and Graphene nanoribbon (GNR) interconnects, performance comparison of CNTs, GNRs and copper interconnects.	8
2	**Material Preparation** Material properties, crystal structure, lattice, basis, planes, directions, angle between different planes, phase diagram and solid solubility, Crystal growth techniques, Epitaxy, Clean room and safety requirements. Oxidation: wet and dry oxidation, Deal-Grove model, Diffusion process, Ion implantation, modeling of Ion implantation, statistics of ion implantation, rapid thermal annealing, SIMS.	10
3	**NANO-FABRICATION** Epitaxy and Thin Film Deposition, Film growth: PVD Processes Evaporation (Thermal and ebeam), Chemical Growth Fundamentals of CVD growth Processes, Modern variants: MOCVD, PECVD and ALD Spin Coating.	7
4	**LITHOGRAPHY AND ETCHING TECHNIQUES** Optical lithography, resolution and depth of focus, resist processing methods and resolution enhancement, advanced lithography techniques for nanoscale patterning, Wet etching, selectivity, isotropy and etch bias, common wet etchants, orientation dependent etching effects; Introduction to plasma technology, plasma etch mechanisms, selectivity and profile control plasma etch chemistries for various films, plasma etch systems.	10
5	**CHARACTERISATION TECHNIQUES** Morphological characterization: Raman, XRD, SEM, AFM; Electrical Characterization: Electrical measurement techniques, two probe and four probe measurement technique; RF characterization	7

List of Experiments:		**Number of Turns**
1	Thin film metal deposition using E-beam Evaporation System	2
2	Forming Electrode pattern using E-beam/thermal vaporization technique	2
3	Material synthesis and composites formation	2

4	Nanomaterial synthesis using hydrothermal technique	2
5	Deposition of compound metal oxides using sol-gel/spin coating technique	2
6	Measurement of Electrical properties of thin film electronic device	2
7	Measurement of junction characteristics of fabricated thin film semiconducting diodes such as PN, Schottky, etc.	3

Course Outcomes: Upon successful completion of this course, the enrolled students will be gaining the following knowledge, skills and competences:	
1	An in-depth knowledge of CMOS Scaling
2	Futuristic material based interconnects such GNRs, CNTs
3	An in-depth knowledge of thin film deposition techniques
4	Understand operation of different fabrication tools and etching techniques
5	Characterize and study the properties of material

Suggested Books :

Sr.No	Title of Book/Name of Author(s)/Publisher	Year of Publication/ Reprint
1	Sze, S.M., “VLSI Technology”, 4th Ed., Tata McGraw-Hill	1999
2	Chang, C.Y. and Sze, S.M., “ULSI Technology”, McGraw-Hill	1996
3	Nano: The Essentials: Understanding Nanoscience and Nanotechnology by T. Pradeep,McGraw Hill Professional	2008
4	Gandhi, S. K., “VLSI Fabrication Principles: Silicon and Gallium Arsenide”, John Wiley and Sons	2003

Course Name	**:**	**Nanoelectronic Devices**
Course Code	**:**	**EC6026**
Credits	**:**	**4**
LTP	**:**	**3 1 0**

Course Objective:
By the end of this course students should be able to describe the evolution and basics of Nano electronic devices and its fabrication, which includes the various synthesis and nanofabrication process and their applications.

Total number of Lectures - 42

Lecture wise breakup		**Number of Lecture**
1	**SEMICONDUCTOR NANOPARTICLES:** Size and shape control of semiconductor Nanoparticles and their characterization; Study of their properties: optical and electronic and its application; Synthesis and application of Core-Shell structured semicoductor nanoparticles.	**10**
2	**NANOELECTRONICS:** Device scaling, Moore's law, limitations, role of quantum mechanics, Feynmans nanobot; Nanostructures: Impact, technology and physical consideration; Mesoscopic observables: Ballistic transport, phase interference	**12**
3	**SPINTRONICS:** Spin, propagation, detection, spin FETs; Fluxtronics: Fluxon, ratchet effect, rectification, flux-QUBIT; Nano-fabrication techniques: Top-down and bottom-up strategies, advantages/disadvantages/ limitations, e-beam lithography, Focussed Ion beam milling, self-organized structures, laser nano-patterning, nano-imprint, electrochemical synthesis, Fabrication of OEDs etc.; Special topics: Graphene, return to Feynmann's nanobot, future prospects.	**10**
4	**NANO-FABRICATION:** High resolution nano lithography, E-beam and nano imprint lithography, Dip-Pen lithography, AFM Lithography. Nano characterization: High Resolution TEM, Scanning Probe Microscopes: Atomic Force Microscope and Scanning Tunneling Microscope, Nano manipulator, Lab on a Chip concept, Packing of Electronics devices (wire bonding, device encapsulation).	**10**

Course Outcomes:	
1	Outline the importance of nano dimensional materials and their applications.

2	Realize and explain the growth of nano-materials.
3	Characterize and study the properties of material
4	Understand the physical laws and effects that are active in the nano-world. The relationship between these laws and the extraordinary properties of nanodevices and demonstrate the applications of nano electronic devices

Suggested Books :		
Sr.No.	**Title of Book/Name of Author(s)/Publisher**	**Year of Publication/Reprint**
1	Introduction to Nanotechnology First Edition Risal Singh & shipra mital gupta Oxford India press	2016
2	Fundamentals of Microfabrication and Nanotechnology (3rdEdition) by Marc Madou, CRC Press	2011
3	Nano: The Essentials: Understanding Nanoscience and Nanotechnology by T. Pradeep,McGraw Hill Professional	2008
4	Handbook of Nanotechnology (3rd Edition) by Bhushan, Springer	2007

Course Name	**:**	**PLC DESIGNING**
Course Code	**:**	**EC6031**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The main aim of this course is to make students learn programmable logic controllers (PLCs), process control algorithms, interfacing of sensors and other I/O devices, simulation and networking.

Total No. of Lectures – 42

	Lecture wise breakup	**Number of Lectures**
1	**PLC INTRODUCTION:** Programmable Logic Controllers (PLCs): Introduction; definition & history of the PLC; Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; Solid state memory; the processor; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers, PLC Application. Programming equipment; proper construction of PLC ladder diagrams; process scanning consideration; PLC operational faults.	**8**
2	**PLC HARDWARE COMPONENTS** The I/O section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O specifications, The CPU, Memory design, Memory Types, Programming Devices, Selection of wire types and size. Various INPUT /OUTPUT Devices and its interfacing with PLC.	**8**
3	**PLC PROGRAMMING** Processor Memory Organization, Program Scan, PLC Programming languages, Relay type instructions, Instruction addressing, Branch Instructions, Internal Relay Instructions, Programming Examine if Closed and examine If Open instructions, Entering the ladder diagram, Modes of operation.Creating Ladder Diagrams from Process Control Descriptions.Ladder diagram & sequence listing; large process ladder diagram construction, flowcharting as programming method, Industrial Examples, Programming Timers and Programming Counters.	**10**
4	**PLC INSTRUCTIONS** Bit Logic Instructions, Clock, Different Logical operation Instructions, Different Integer Math Instructions, Different Conversion Instructions, Different Comparison Instructions, Program Control Instructions, Sequencer and shift register instructions, Different Interrupt Instructions, Data Handling Functions,	**8**
5	**PLC NETWORKING** Introduction, Levels of Industrial Control, Types of Networking, Network communications.PLC Installation practices, Editing and Troubleshooting, PLC Enclosures, Electrical Noise, Leaky Inputs and Outputs, Grounding, Voltage variations and Surges, Program Editing, Programming and Monitoring, Preventive Maintenance, Troubleshooting, Connecting PC with PLC, Alternative Programming Languages, Various Brands of PLCs and their revolution.	**8**

Course Outcomes: By the end of the course, the student must be able to:	
1	Compare conventional sequential control with programmable logic control system
2	Develop programs using different PLC programming languages for sequential and continuous process
3	Interface analog and digital input/ output devices with PLC using different communication protocol
4	Test the PLC based system and troubleshoot the errors associated with it.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Programmable logic controller by Frank D. Petrusella, Tata McGraw-Hill	2005
2	Introduction to programmable logic controller by Gary dunning, Thomson Asia Pte Ltd	2005
3	Programmable Logic Controllers: Principles and Applications by John W. Webb and Ronald A. Reis, Prentice –Hall India	1994
4	Programmable Logic Controllers by W. Bolton, Elsevier	2015
5	Programmable Controllers An engineer's guide by E.A.Parr, Elsevier	2003
6	S7-200, S7-300, PLC Manual of Siemens for Instructions	2008
7	Recent Published research papers	

Course Name	**:**	**ARDUINO PROGRAMMING AND RASPBERRY PI**
Course Code	**:**	**EC6032**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The objective of this course is to familiarize the students in Embedded System Design using Arduino and Raspberry pi.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Embedded System design: Basics.** Introduction to embedded systems, Components of embedded system. Advantages and applications of embedded systems, Examples of real time embedded systems and how they are manufacturedindustry ready, Different Microcontroller Architectures (CISC, RISC, ARISC), Internal Resources & Hardware Chips in Details, History of AVR Microcontrollers and Features, Memory Architectures (RAM/ROM).	**10**
2	**Learning Arduino Platform:** Introduction to ARDUINO, ARDUINO History and Family, General Programming and Hardware Interfacings with Arduino, The basic sensors and actuators using Arduino, Controlling embedded system based devices using Arduino.	**10**
3	**Getting Started with Raspberry Pi:** Basic functionality of the Raspberry Pi board and its Processor, setting and configuring the board, differentiating Raspberry Pi from other platform like arduino, begal, asus thinker etc., Overclocking, Component overview.	**10**
4	**Programming the Raspberry Pi:** Introducing to Python programming language: Python Programming Environment, Python Expressions, Strings, Functions, Function Arguments, Lists, List Methods, Control Flow, Numpy, PIP (Python Installation Package) and customized libraries. Communication facilities on raspberry Pi (I2C, SPI, UART), working with RPil. GPIO library, Interfacing of Sensors and Actuators.	**12**

Course Outcomes: By the end of this course, the students will be able to:	
1	Understand how the Arduino platform works in terms of the physical board and libraries and theIDE (Integrated Development Environment).
2	Understand the working of Raspberry Pi, its featuresand how various components can be used with Pi.
3	It will also cover programming the Arduino using C code and accessing the pins on the board via the software to control external devices.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Margolis, M. Arduino cookbook: Recipes to begin, expand, and enhance your projects. O'Reilly Media, Inc.	2011
2	ARM System Developer's Guide -Designing and Optimizing System Software by: Andrew N Sloss, Dominic Symes, Chris Wright;Elseiver	2004
3	Mark Lutz, "Learning Python", O'Reilly Media, 5th Edition.	2016
4	The official raspberry Pi Projects Book: https://www.raspberrypi.org/magpi-issues/Projects_Book_v1.pdf	NA
5	Raspberry Pi Assembly Language RASPBIAN Beginners THIRD EDITION, CreateSpace Independent Publishing Platform.	2013

Course Name	**:**	**SENSING TECHNOLOGY**
Course Code	**:**	**EC6033**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The main aim of this course is to make students learn different sensing technology and methods for everyday useand it also highlights the future trend of sensors to mankind

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASIC of SENSORS:** Principles of Sensing, Classification and Terminology of Sensors,Measurements. Some basic discussion about electric field, potential,capacitance, resistance etc.	**4**
2	**PHYSICAL and CHEMICAL SENSORS:** Sensors in Different Application AreaOccupancy and Motion Detectors; Position, Displacement, andLevel; Velocity and Acceleration; Force, Strain, and TactileSensors; Pressure Sensors, Temperature Sensors, Galvanic Cells,voltammetry, conductivity, Amperometric-bio sensors (Glucose, chloesterolsensor) and gas sensors, Optical sensor, Fiber optics	**16**
3	**SEMICONDUCTOR SENSORS** Sensors Based On Semiconductor Junctions, Resonant Sensors, SAW Sensors, Sensors Based On MOSFET Transistors, Charge-Coupled And CMOS Image Sensors, Ultrasonic-Based Sensors, Biosensors.	**8**
4	**SENSORS and ACTUATORS FOR ROBOTICS** Proximity Sensors, Electro-Optical Sensors, Capacitive Sensors, Magnetic Sensors, Electric Drives, motors	**6**
5	**CASE STUDIES** Applications of sensors in wearable devices, agricultural field, MEMS sensors and devices	**8**

Course Outcomes: By the end of the course, the student must be able to:	
1	Know different types of sensors.
2	Develop wearable sensors for Healthcare, Wellness and Environmental Applications.
3	Know the semiconductor sensors and materials for these applications.
4	Present the basics of implementation of sensors into products.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Biosensor: Principle and applications,Loic J Blum and Coulet, CRC Press, 2nd edition	2010
2	Chemical sensors and Biosensors, Brian R Eggins,John Wileysons Ltd,	2004
3	Optical Fiber Sensor Technology: Fundamentals, K. T. V. Grattan, T. Sun (auth.), K. T. V. Grattan, B. T. Meggitt(eds.) SpringerUS,	2000
4	Chemical Sensors: Introduction for Scientistsand Engineers,Peter Grundler, Springer,	2007
5	Flexible Electronics: FromMaterials to Devices, GuozhenShen, Zhiyong Fan, 1st Edition, World Scientific Publishing Co,	2015
6	Sensors And Transducers, D. Patranabis,Prentice-Hall India, 2nd Ed., 2004.	2004
7	Handbook of Modern Sensors: Physics, Designs and Applications, Jacob Fraden, Springer, 3rd Ed	2004

Course Name	:	**MULTIMEDIA TECHNOLOGY**
Course Code	:	**EC6034**
Credits	:	**4**
L T P	:	**3 1 0**

Course Objective:
The objective of the course is to learn the technical details of common multimedia data formats, protocols, and compression techniques of digital images, video and audio content. It enables to learn about the significance of quality of service in multimedia networking.

Lecture wise breakup		**No of lectures**
1.	**Introduction** Media types (text, graphics, images, audio, speech, video, animation), Components of the multimedia system, Hypermedia and the Web, Hypertext, Multimedia Systems: Characteristics, Challenges, Desirable Features, Components and Applications, Trends in Multimedia	**5**
2.	**Media and Data Streams** Discrete and Continuous Media, Analog and Digital Signals, Text and Static Data, Audio: digitisingsound, Graphics, Images and Video, Multimedia Authoring Paradigms, Design Issues in Multimedia Applications	**6**
3.	**Representation of Multimedia Objects** Representation of Analog Signals, A/D: Sampling and quantization, Text: Font and their representation (bitmap, true type), Graphics: Raster & Vector representation, aliasing problems, Image: (bit depth, resolution, color (RGB, CMYK, HSB), introduction to BMP, GIF, TIFF, PNG and JPEG formats), Audio (speech and wideband audio, sampling rate and aliasing, quantization, introduction to MP3, WMA, WAV, MIDI etc.), Video (frame rate and resolution, interlaced and non-interlaced video, colour planes (YCBCR, YUV), Video broadcast standards (PAL, NTSC, SECAM), HD Video, 3D TV, Video representation: AVI, MPEG, Quick Time, real video (.rm)	**10**
4.	**Storage Media** Magnetic and Optical Media, RAID and its levels, Compact Disc and its standards, DVD and its standards, Multimedia Servers.	**5**
5.	**Introduction to Compression Technology** Concept of lossy and lossless compression. Concept of rate-distortion characteristics, Basics image compression (JPEG, JPEG 2000), Basics of Audio compression (MP3, MP4), Basics of Video Compression (MPEG, H.264)	**8**
6.	**Multimedia Communication** Building Communication Network, Application Subsystem, Transport Subsystem, QOS, Resource Management, Distributed Multimedia Systems, Elements of (immersive/non-immersive) Virtual Reality, Augmented Reality and Telepresence Applications, Mobile technologies.	**4**
7.	**Multimedia applications** Interactive television, video-on-demand, video conferencing, educational applications, industrial applications, multimedia archives and digital libraries, media editors.	**4**

Course Outcome: At the end of the course, students will be able to	
1.	Describe the types of media and define multimedia system.
2.	Describe the process of digitizing (quantization) of different analog signals (text, graphics, sound and video).

3.	Use and apply tools for image processing, video, sound and animation.
4.	Apply methodology to develop a multimedia system.
5.	Apply acquired knowledge in the field of multimedia in practice and independently continue to expand knowledge in this field.

Suggested Books:		
Sr. No.	**Name of Book/Authors/ Publisher**	**Year of Publication/Reprint**
1.	Multimedia Computing, Communications and Applications, Ralf Steinmetz and KlaraNahrstedt, Pearson Education	2012
2.	Multimedia Systems, Rajneesh Aggarwal & B. B Tiwari, Excel Publication, New Delhi	2007
3.	Multimedia making it work, Tay Vaughan, Tata McGraw-Hill,	2008
4.	Fundamentals of Multimedia , Li & Drew, Pearson Education	2009
5.	Introduction to Information Theory and Data Compression‟ Second Edition, Darrel Hankerson, Greg A Harris, Peter D Johnson, Chapman and Hall ,CRC press	2003
6.	Multimedia Communications, Fred Halsall, Pearson Education	2006

Course Name	**:**	**MICROCONTROLLERS AND THEIR APPLICATIONS**
Course Code	**:**	**EC6035/EC5005**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, student should be able to understand the functioning of microcontroller, and its interfacing, importance and need of support chips and their functioning. The students should also developprograms for the various applications of microcontrollers.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**DIGITAL LOGIC:** Boolean algebra, Logic Families, TTL, Gates, Latches, Encoders & Decoders	**2**
2	**8051 MICRO CONTROLLERS:** Architecture, Pin configuration, SFR's, Memory, 8051 Addressing modes.	**3**
3	**8051 INSTRUCTIONS:** Introduction to 8051 assembly language programming: JUMP, LOOP and CALL instructions, Arithmetic instructions: Unsigned addition and subtraction, unsigned multiplications and Division, signed number concepts and arithmetic operations, Logic And Compare instructions, BCD and ASCII Application Programs. Role of Assembler.	**6**
4	**I/O PORT PROGRAMMING:** Single bit instruction programming, Single bit operations with CY, Reading Input Pins Vs Port latch, Programming 8051 timers, counter programming.	**6**
5	**INTERFACING WITH 8051:** LCD & Keyboard Interfacing, ADC,DAC and Sensor Interfacing	**5**
6	**SERIAL COMMUNICATION** 8051 connection to RS 232, 8051 serial communications Programming.	**3**
7	**INTERRUPTS:** Programming Timer Interrupts, Programming External Hardware Interrupts, Programming the Serial Communication Interrupts, Interrupt Priority in the 8051.	**4**
8	**PIC18F FAMILY:** Architecture of PIC 18F Microcontroller, PIC18F instructions and assembly language.	**3**
9	**PROGRAMMING MODEL:** PIC18F programming model, instruction set, instruction format. Data copy, arithmetic, branch, logical, bit manipulation and multiply-divide instructions. Stacks, subroutines and macros. Role of Assembler.	**7**
10	**INPUT/OUTPUT PORTS AND INTERFACING:** PIC18 I/O ports and interfacing with peripherals.	**3**

Course Outcomes: By the end of this course student will be able to:	
1	Explain the architecture and functioning of various microcontrollers in detail.
2	Analyze interfacing, I/O communication and interrupts of these microcontrollers.
3	Develop programs for the various applications of microcontrollers

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	The 8051 Microcontroller and Embedded System by- Muhammad Ali Mazidi, Janice Gillespie Mazidi, Pearson EducationPublications.	2007

2	Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family), Ramesh Gaonkar, Penram International Publishing, 2007 edition.	2007

Course Name	**:**	**MICROPROCESSOR AND MICROCONTROLLER**
Course Code	:	**EC6036/EC5006**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of the course, the students should be able to explain the architecture and programming of8085microprocessor and 8051 microcontroller. The student should be able to demonstrate various interfacing techniques.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**8085 MICROPROCESSOR:** Introduction to Microprocessors and Microcomputers, 8085 Microprocessor architecture, Pin configuration, GPRs, Flags, Data bus, Address bus, other signals, 8085-based microcomputer.	**6**
2	**PROGRAMMING AND INTERFACING FOR 8085:** Programming model, instruction classifications, Addressing Modes, opcode and operand, fetch and execution cycle, timing diagram, machine cycle, instruction cycle and T states. Data Transfer, Arithmetic, Logical Branch and Machine control group of instructions- programming examples. Memory interfacing concepts and examples, Basic interfacing concepts.	**10**
3	**STACKS AND SUBROUTINES:** Stack, subroutine, restart, and conditional call and return instructions.	**3**
4	**COUNTERS AND TIME DELAYS:** Counters and time delays, generating pulse waveforms	**3**
5	**INTERRUPTS OF 8085:** Vectored and non-vectored, maskable and non-maskable interrupts, Use of RIM and SIM instructions.	**3**
6	**8051 MICROCONTROLLERS:** Architecture, Pin configuration, SFR's, Memory, 8051 Addressing modes	**4**
7	**8051 INSTRUCTIONS:** Introduction to 8051 assembly language programming: JUMP, LOOP and CALL instructions, Arithmetic instructions: Unsigned addition and subtraction, unsigned multiplications and Division, signed number concepts and arithmetic operations, Logic and Compare instructions.	**5**
8	**I/O PORT PROGRAMMING:** Single bit instruction programming, Single bit operations with CY, Programming 8051 timers, counter programming, generating pulse waveforms.	**5**
9	**8051 INTERRUPTS:** Programming Timer Interrupts, Programming External Hardware Interrupts.	**3**

Course Outcomes: By the end of this course student will be able to:

1	Explain the functioning of microprocessor and microcontrollers.
2	Demonstrate microcontrollor based projects.
3	Enhance the programming skills.
4	Identify the importance of Assembler Directives and Operators.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Microprocessor, Architecture Programming and Application with 8085 by- R.S Gaonkar, Penram Publications.	2013
2	The 8051 Microcontroller and Embedded System by- Muhammad Ali Mazidi, Janice Gillespie Mazidi, Pearson Education Publications.	2013
3	Microprocessors and Peripherals by- B.Brey, CBS.	1989
4	The 8051 Microcontrollers by- Ayala, Penram Publications.	2010