Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

B.Tech Programme

Electronics & Communication Engineering

CHOICE BASED CREDIT SYSTEM

[CBCS]

Regulation VTU R15

Curriculum & Syllabus

Department of Electronics and Communication Engineering

Vision of the Department

To be a centre of academic excellence through quality education and cutting edge research in the diversified fields of electronics and communication engineering to meet the global challenges and produce high quality professionals

Mission of the Department

M1. To enrich the knowledge of graduate engineers for global requirements by promoting quality education through innovative pedagogical practices
M2. To create an ambience of academic excellence by engaging in cutting-edge research and undertaking collaborative projects with academia and industry
M3. To develop competence by inculcating human and moral values with leadership and professional skills

Programme Educational Objectives:

PEO1. Our graduates will have the expertise to solve contemporary problems in the analysis and design of Electronics and Communication Devices and Systems

PEO2. Our graduates will conceive ideas for the societal issues and will design, implement and operate the Engineering products for the ideas conceived.

PEO3. Our graduates will perform in various roles with adequate Technical and Managerial Skills in Design, Development, Production and Support areas of Electronics, Communication and Allied Industries.

PEO4. Our graduates will pursue higher education and will be lifelong learners in their profession, effectively communicate the technical information and work in multidisciplinary teams.

PEO5. Our graduates will be ethical, environmental, health and safety concerned in their profession.

Programme Outcomes (POs)

Engineering graduates will be able to:

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

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

PO3 : Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

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

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

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

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

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

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

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

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

Program Specific Outcomes (PSOs)

On Successful Completion of the program, the graduates will be able to

PSO1: Solve the real world/societal problems by considering CDIO framework.

PSO2: Develop an electronic system for smart living using embedded programming.

Minimum Credits required in Course Categories

Course Category	Minimum Credits Required
Foundation Course	**60**
Program Core	**60**
Programme Elective	**18**
Allied Elective	**6**
Institutional Elective	**10**
Value Education Elective	**4**
Independent Learning	**20**
Industry / Higher Institute Learning Interaction	**2**
Total	**180**

Department of Electronics and Communication Engineering

B.Tech. Electronics and Communication Engineering

VTU R15 Curriculum

S.No	Course Code	Programme Core	L	T	P	C
1	1151EC101	Mathematics for Electronics and Communication Engineers	2	2	0	3
2	1151EC102	Electric Circuit Analysis	2	2	0	3
3	1151EC103	Analog Electronics	2	2	0	3
4	1151EC104	Digital Electronics	3	0	0	3
5	1151EC105	Linear Integrated Circuits	3	0	0	3
6	1151EC106	Analog and Digital Control Systems	2	2	0	3
7	1151EC107	Signals and Systems	2	2	0	3
8	1151EC108	Electromagnetic Fields	2	2	0	3
9	1151EC109	Analog Communication Systems	2	2	0	3
10	1151EC110	Microprocessor and Microcontroller	3	0	0	3
11	1151EC111	Data Communication Networks	2	2	0	3
12	1151EC112	Discrete Time Signal Processing	2	2	0	3
13	1151EC113	Wireless Digital Communication	3	2	0	4
14	1151EC114	Waveguides and Antennas	2	2	0	3
15	1151EC115	VLSI Design	3	0	0	3
16	1151EC116	Optical and Microwave Engineering	2	2	0	3
17	1151EC217	Embedded OS and Device Drivers	3	0	2	4
18	1151EC301	Analog Integrated Circuits Lab	0	0	4	2
19	1151EC302	Digital Electronics Lab	0	0	2	1
20	1151EC303	Microprocessor and Microcontroller Lab	0	0	2	1
21	1151EC307	Signals and Systems Lab	0	0	2	1
22	1151EC305	Communication Lab	0	0	2	1
23	1151EC306	Optical and Microwave Engineering Lab	0	0	2	1
		TOTAL CREDIT				**60**

S.No	Course Code	Programme Elective	L	T	P	C
VLSI Domain						
1	1152EC101	VLSI Signal Processing	3	0	0	3
2	1152EC102	Low Power VLSI Design	3	0	0	3
3	1152EC103	Silicon Validation	3	0	0	3
4	1152EC104	Analog VLSI Design	3	0	0	3
5	1152EC105	VLSI Design Techniques	3	0	0	3
6	1152EC106	VLSI for Wireless Communication	3	0	0	3
7	1152EC238	Reconfigurable Computing with FPGA	1	0	4	3
8	1152EC242	FPGA Architecture Technologies and Tools	2	0	2	3
9	1152EC143	Architectural Design of Digital Integrated Circuits	3	0	0	3
10	1152EC144	Solid State Devices	3	0	0	3
11	1152EC145	Nano Scale Transistors	3	0	0	3
Advanced Electronics Domain						
12	1152EC107	Integrated Product Development	3	0	0	3
13	1152EC108	Biomedical Instrumentation and Imaging	3	0	0	3
14	1152EC109	Opto Electronic Devices	3	0	0	3
15	1152EC110	Electronic Instrumentation	3	0	0	3
16	1152EC211	Virtual Instrumentation	1	0	4	3
17	1152EC112	Digital TV Engineering	3	0	0	3
18	1152EC239	Electronic Circuit Simulation and PCB Design	1	0	4	3
19	1152EC142	Sensors and Transducers	3	0	0	3
20	1152EC146	Nano Photonics	3	0	0	3
21	1152EC147	Fiber Lasers and Applications	3	0	0	3
Embedded System Domain						
22	1152EC113	Embedded System Design	3	0	0	3
23	1152EC214	Real Time Operating System	1	0	4	3
24	1152EC215	System on Chip (SOC)	1	0	4	3
25	1152EC116	Embedded Processors	3	0	0	3
26	1152EC117	Embedded Networking	3	0	0	3
27	1152EC118	Embedded Control System	3	0	0	3
28	1152EC237	Embedded Systems and Robotics	1	0	4	3
29	1152EC148	Video Surveillance System	3	0	0	3
30	1152EC255	Embedded C Programming	2	0	2	3
Communication System Domain						
31	1152EC119	Mobile Communication	3	0	0	3
32	1152EC120	Satellite Communication	3	0	0	3
33	1152EC221	Electromagnetic Interference and Compatibility	2	0	2	3

34	1152EC122	RF and Microwave Integrated Circuits	3	0	0	3
35	1152EC123	Radar and Electronic Navigation Systems	3	0	0	3
36	1152EC224	MIMO Wireless Communication	2	0	2	3
37	1152EC227	Software Defined Radio	2	0	2	3
38	1152EC140	Cellular Mobile Communication	3	0	0	3
39	1152EC149	Radio over Fiber System	3	0	0	3
Networks Domain						
40	1152EC225	Wireless Adhoc and Sensor Networks	2	0	2	3
41	1152EC126	Network Security	3	0	0	3
42	1152EC128	Optical Communication Systems and Networks	3	0	0	3
43	1152EC229	Internet of Things	1	0	4	3
44	1152EC130	Network Management	3	0	0	3
45	1152EC241	Software Defined Networking	2	0	2	3
46	1152EC250	Cognitive Radio Networks	2	0	2	3
47	1152EC151	Next Generation Mobile Networks	3	0	0	3
Signal Processing Domain						
48	1152EC131	Advanced Digital Signal Processing	2	2	0	3
49	1152EC132	Statistical Signal Processing	2	2	0	3
50	1152EC133	DSP Algorithms and Architecture	3	0	0	3
51	1152EC134	Signal Processing Techniques for Speech Recognition	3	0	0	3
52	1152EC235	Digital Image Processing	1	0	4	3
53	1152EC136	Digital Video Signal Processing	3	0	0	3
54	1152EC152	ANN and Deep Learning	3	0	0	3
55	1152EC153	Fuzzy-Neural Systems	3	0	0	3
56	1152EC154	Introduction to Machine Learning	3	0	0	3
57	1152EC256	Basics of Python Programming	2	0	2	3
58	1152EC259	Fundamentals of Machine Learning	2	0	2	3
59	1152EC261	Professional Python Programming	2	0	2	3
60	1152EC263	Python Programming	2	0	2	3
61	1152EC162	Medical Electronics	3	0	0	3

Allied Elective

S.No	Course Code	Allied Elective	L	T	P	C
1	1153EC101	Microprocessor and Microcontroller	3	0	0	3
2	1153EC202	Embedded Systems and Robotics	1	0	4	3
3	1153EC103	Embedded System Design	3	0	0	3
4	1153EC104	Real Time Operating System	3	0	0	3
5	1153EC105	Analog and Digital Communication	3	0	0	3
6	1153EC106	Wireless Communication Networks	3	0	0	3
7	1153EC107	Discrete Time Signal Processing	2	2	0	3
8	1153EC208	Reconfigurable Computing with FPGA	1	0	4	3
9	1153EC209	Real Time Embedded Systems	2	0	8	6
10	1153EC110	Control Systems	2	2	0	3
11	1153EC111	Electronic Devices and Circuits	3	0	0	3

Institutional Elective

S.No	Course Code	Institutional Elective	L	T	P	C
1	1154EC101	Avionics	3	0	0	3
2	1154EC102	Automotive Electronics	3	0	0	3
3	1154EC103	Industrial Automation	3	0	0	3
4	1154EC104	Building Automation	3	0	0	3
5	1154EC105	Wireless Technologies	3	0	0	3
6	1154EC106	Basics of Embedded System	3	0	0	3
7	1154EC107	Green Electronics	3	0	0	3
8	1154EC108	Nano Electronics	3	0	0	3
9	1154EC109	Medical Electronics	3	0	0	3
10	1154EC210	Embedded Systems and Robotics	1	0	4	3
11	1154EC111	Process Control	3	0	0	3
12	1154EC112	Intelligent Transport System	3	0	0	3
13	1154EC213	Vehicle Electronics	2	0	6	5

Value Education Elective

S.No	Course Code	Value Education Elective	L	T	P	C
1	1155EC101	Ethics in Engineering	1	0	0	1
2	1155EC102	Human Values for Engineers	1	0	0	1
3	1155EC103	Stress Relief for Anxious Mind	1	0	0	1

Course Code	Course Title	L	T	P	C
1151EC101	**MATHEMATICS FOR ELECTRONICS AND COMMUNICATION ENGINEERS**	2	2	0	3

a) Course Category

Program Core

b) Preamble

With rapid advancement in different branches of knowledge, a student of electronics and communication engineering has to possess analytical skills for finding solutions to several real life problems. This course provides an overview of various mathematical techniques for solving different kinds of problems that occur in Engineering.

c) Prerequisite

Nil

d) Related Courses

Transforms and Partial Differential Equations

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Solve application problems of systems of linear equations	K3
CO2	Calculate simple Probability measures for discrete andcontinuous cases ofrandom sample spaces e.g., uniform distributions over sample spaces.	K3
CO3	Examine the random experiments specified by two random variables and study the Distribution of their distributions	K3
CO4	Determine covariance and spectral density of stationary random processes	K3
CO5	Derive numerical methods for various mathematical	K3

	Operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.	

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	-	H	H	-	-	-	-	-	-	H	L	-
CO2	H	H	-	H	H	-	-	-	-	-	-	H	L	-
CO3	H	H	-	H	H	-	-	-	-	-	-	H	L	-
CO4	H	H	-	H	H	-	-	-	-	-	-	H	L	-
CO5	H	H	-	H	H	-	-	-	-	-	-	H	L	-

g) Course Content

UNIT I LINEAR ALGEBRA **12**

Vector Spaces and Subspaces -Definition and Examples, Linear Dependence and Independence Basis, Linear Transformation, Rank of a matrix, Homogeneous linear equations.

UNIT II RANDOM VARIABLES **12**

Random Variables, Discrete and continuous random variables – Moments – Moment generating functions –Binomial, Poisson, Uniform, Gaussian, Raleigh, Ricean probability distributions.

UNIT III TWO – DIMENSIONAL RANDOM VARIABLES **12**

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

UNIT IV RANDOM PROCESSES **12**

Random Processes-Classification – Stationary process – Markov process – Poisson process.

UNIT V NUMERICAL METHODS **12**

Solution of an equation by Newton –Raphson method. Solution of system of linear equations Gaussian elimination and Gauss-Jordon methods. Gauss –Jacobi and Gauss-Siedel methods. Interpolation- Newton’s forward and backward difference formulas-Lagrange method.

Total 60 Hrs

h) Learning Resources

Text Books

1. Kenneth M Hoffman, Ray Kunze, Linear Algebra, Prentice Hall, New Jersey, 1971.
2. Peebles JR. P.Z., Probability Random Variables and Random Signal Principles, Tata McGraw-Hill Publishers, Fourth Edition, New Delhi, 2002.
3. ShankerRao,G**.,** Numerical Analysis, New Age International, New Delhi, 2006.

Reference Books

1. G. Strang, Linear Algebra and its Applications, Cenage Learning, Singapore, 2006.
2. T.K Moon and W.C Stirling, Mathematical Methods and Algorithms for Signal Processing, Pearson Education, New Jersey, 2000.
3. Oliver C. Ibe, Fundamentals of Applied Probability and Random Processes, Elsevier, First Indian Reprint, New Delhi, 2007.
4. H. Stark and J.W. Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education (Asia), 3rd Edition, New Delhi, 2002.
5. Chapra, S. C and Canale, R. P. Numerical Methods for Engineers, 5th Edition, Tata McGrawHill, New Delhi, 2007.

Online Resources

1. ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/
2. http://nptel.ac.in/courses/117105085
3. http://ocw.mit.edu/courses/mathematics/18-335j-introduction-to-numerical-methods-fall-2004/

Course Code	Course Title	L	T	P	C
1151EC102	**ELECTRIC CIRCUIT ANALYSIS**	**2**	**2**	**0**	**3**

a) Course Category

Program Core

b) Preamble

The aim of this course is to develop the necessary fundamentals of circuits concepts which lays the foundation for communication engineers in analysis of practical circuits. The course deals with the analysis of circuits through graph theory, network theorems, fundamentals of AC circuit analysis, concepts of resonance, coupled circuits; transients through differential equations and Laplace transform technique.

c) Prerequisite

Nil

d) Related Courses

Electromagnetic Fields, Analog and Digital Control Systems

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Apply the basic laws and theorems for DC circuits	K3
CO2	Solve the problems on RL, RC and RLC for DC transient circuits	K3
CO3	Interpret the characteristics of steady state analysis and power analysis	K3
CO4	Apply the Laplace Transform technique to solve AC circuits	K3
CO5	Compute the parameters of the two port Network and the resonant frequency response characteristics.	K3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	H	-	-	M	L	M	-	M	L	-
CO2	H	H	H	-	H	-	-	-	L	M	-	M	L	-
CO3	M	M	M	-	-	-	-	-	L	L	-	L	L	-
CO4	H	H	-	-	-	-	L	-	L	L	-	L	L	-
CO5	M	M	-	-	-	M	-	-	L	M	-	L	L	-

g) Course Content

UNIT I THEOREMS IN CIRCUIT ANALYSIS 12

Review of voltage and Current laws: KCL, KVL, Node and Mesh Analysis; Theorems: Superposition, Thevenin, Norton, Maximum power transfer, Reciprocity, Tellegens, Compensation and Milliman's.

UNIT II DC TRANSIENT ANALYSIS 12

RL and RC Circuits: Source free circuit-Properties of Exponential Response and Step function functions Natural and Forced Response-Driven RL and RC circuits; RLC Circuits: Source free-damped and underdamped parallel RLC circuit-Critical Damping, Source free series RLC-Complete Response and lossless Circuits.

UNIT III SINUSOIDAL STEADY STATE AND POWER ANALYSIS 12

Steady State Analysis: Characteristics-Forced Response to Sinusoidal functions- Phasor Relationship for passive components-Impedance and Admittance-Application of network theorems, Power Analysis: Instantaneous -Average and RMS-Power and Power factor, Introduction Magnetically Coupled Circuits.

UNIT IV APPLICATION OF LAPLACE TRANSFORM TO CIRCUIT ANALYSIS 12

Complex frequency and LT: complex frequency- Damped Sinusoidal forcing function- Introduction to Laplace Transform and Inverse Transform techniques: S-Domain -Impedance and Admittance Application Nodal and Mesh Analysis-Concept of Poles, Zeros and transfer function.

UNIT V NETWORK TOPOLOGY AND TWO PORT NETWORK 12

Graph Theory: Incidence- Tie Set and Cut matrix formulation, Two port Network: One port network Impedance Parameter- Admittance Parameter, Transmission line, Hybrid Parameter and their inter-relationship, Frequency Response: Resonant Frequency of circuits with L and C- Quality Factor and Bandwidth-Frequency and Magnitude scaling.

Total 60 Hrs

h) Learning Resources

Text Books

1. W.H.Hayt and J.E. Kemmerley, Engineering Circuit Analysis, Eight edition, print 2014.
2. Charles K. Alexander, Matthew N.O Sadiku, Fundamentals of Electric Circuits, 4th Edition, McGraw – Hill, 2009.
3. K.V.V.Murthy and M.S. Kamath, Basic Circuit Analysis, 1st edition (reprinted with corrections) Jaico Publishing, 1998.
4. M. E. Van Valkenburg, NETWORK ANALYSIS, 3/E 3rd Edition, 2014.

Reference Books

1. N Balabanian and T.A. Bickart, Linear Network Theory : Analysis, Properties, Design and Synthesis, Matrix Publishers, Inc.
2. L.O. Chua, C.A. Desoer, E.S. Kuh, Linear and Nonlinear Circuits, McGraw - Hill International Edition 1987.
3. Joseph. A.Edminister "Electric circuits "Schaum's outline series, McGraw Hill Book Co. – 1987.
4. M.L.Soni, J.C. Gupta and P.V.Gupta "A course in Electrical Circuits and Fields" Dhanpatrai& sons, New Delhi,1981.

Online Resources

1. www.mit.org
2. www.mooc.org
3. www.nptel.ac.in

Course Code	Course Title	L	T	P	C
1151EC103	**ANALOG ELECTRONICS**	**2**	**2**	**0**	**3**

a) Course Category

Program Core

b) Preamble

This Course provides the basic and design knowledge about electronic circuit analysis using BJT and CMOS which involves feedback, oscillator, high frequency amplifiers and its applications

c) Prerequisite

Basic Electronics Engineering

d) Related Courses

Linear Integrated Circuits, Communication Systems.

e) Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Classify the performance of different biasing types used for transistor operation	K2
CO2	Apply the h parameters for different transistor configuration	K3
CO3	Explain the effect of feedback with respect to transistor applications	
	Describe feedback amplifier and oscillators	K2
CO4	Discuss MOSFET amplifier with different types of load	K2
CO5	Illustrate the applications of transistors with power amplifiers, multi vibrators and CMOS linear applications	K2

f)	**Correlation of COs with POs**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	M	M	L	-	L	-	-	-	-	-	-	L	-	-

CO2	M	M	L	-	L	-	-	-	L	-	-	-	-	-
CO3	M	H	L	M	L	L	-	-	-	-	-	-	L	-
CO4	M	M	L	-	L	-	-	L	-	-	-	-	L	-
CO5	M	M	L	-	M	-	-	-	-	M	M	L	L	-

g) Course Content

UNIT I DC BIASING OF TRANSISTOR 12

Review of Transistor characteristics, Thermal runaway, thermal stability, DC Biasing-BJT: Different types of biasing circuits. Compensation techniques, Design of biasing for MOSFET

UNIT II TRANSISTOR AC ANALYSIS OR SMALL SIGNAL ANALYSIS 12

Amplification in AC Domain, BJT Transistor modeling, re model for CB, CE and CC, Two port system approach, The Hybrid Equivalent model, Approximate Hybrid equivalent circuit, Hybrid Π model: CE, CC and CB configurations. Small signal analysis of MOSFET, Source follower and common gate amplifier.

UNIT III FEEDBACK AMPLIFIER AND OSCILLATORS 12

Basic concept of Feedback, Feedback connection types, Input and output impedance of feedback configurations. Advantages of negative feedback, Oscillators**:** Principles of sinusoidal oscillator, Barkhausen criteria. RC oscillators: phase shift, Wienbridge. LC oscillators: Hartley, Colpitts, Clapp oscillator, crystal oscillator.

UNIT IV IC MOSFET AMPLIFIER 12

IC Amplifiers, IC biasing Current steering circuit using MOSFET: MOSFET current sources, PMOS and NMOS current sources. Amplifier with active loads, enhancement load, Depletion load and PMOS and NMOS current sources load, CMOS common source and source follower, CMOS differential amplifier, CMRR.

UNIT V APPLICATIONS OF TRANSISTORS AND CMOS 12

Tuned amplifier: Analysis of single tuned, double tuned and stagger tuned amplifier. Power amplifiers: Transformer coupled Class A power amplifier, Class B amplifier operation, Transformer coupled Push pull circuits, Complimentary symmetry circuits. Multivibrators :Bistable, Monostable and Astable operation, Schmitt trigger. CMOS Linear Applications - Cascading Amplifiers for Higher Gain.

Total 60 Hrs

h) Learning Resources

Reference Books

1. Bapat K N ,Electronic Devices & Circuits , McGraw Hill,1992
2. J. and Halkias .C., " Integrated Electronics ",2nd Edition, Tata McGraw-Hill, 2001
3. Sedra&Smith, Microelectronic circuits, Oxford University Press, 5th ed
4. Donald L.Schilling and Charles Belove, 'Electronic Circuits', Tata McGraw Hill, 3rd Edition,2003

Text Books

1. Boylestead&Neshelsky ,Electronic Devices & Circuits, Pearson Education/PHI Ltd, 10th edition, 2010.
2. David .A. Bell, Electric Circuits And Electronic Devices Oxford University Press, 2010.
3. BehzadRazavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw-Hill, 2007.

Online Resources

1. www.nptel.ac.in
2. http://bitsavers.trailing-edge.com/pdf/national/_appNotes/AN-0088.pdf

Course Code	Course Title	L	T	P	C
1151EC104	**DIGITAL ELECTRONICS**	**3**	**0**	**0**	**3**

a) Course Category

Program Core

b) Preamble

The primary aim of this course is to understand the fundamental behind digital logic design and gain experience in using them for meeting any design specification. The course includes fundamentals of Boolean algebra, combinational and sequential circuits and introduction to HDL.

c) Prerequisite

Nil

d) Related Courses

Microprocessor and Microcontroller, VLSI design

e) Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Apply the Boolean minimization techniques for combinational circuits such as adder, subtractor, encoder etc.	K3
CO2	Apply the concept of sequential circuits for counters, shift registers etc.	K3
CO3	Write HDL program for combinational and sequential circuits.	K3
CO4	Solve asynchronous sequential circuits for simple application	K3
CO5	Explain the applications of digital electronics	K2

f)	Correlation of COs with POs													
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	L	-	-	-	-	-	-	-	M	M	-
CO2	H	M	L	L	-	-	-	-	-	-	-	M	L	-
CO3	M	H	M	M	H	-	-	L	M	-	M	M	L	M
CO4	H	M	M	L	-	-	-	-	-	-	M	L	M	-
CO5	L	L	M	L	L	L	L	L	M	M	L	-	-	L

g) Course Content

UNIT I DIGITAL FUNDAMENTALS AND COMBINATIONAL CIRCUITS 10

Introduction to Boolean algebra and Switching Functions; Boolean Minimization using K Map and Tabulation method; combinational circuits: Design procedure – Half adder – Full Adder – Half subtractor – Full subtractor – Parallel binary adder, parallel binary Subtractor – Fast Adder - Carry Look Ahead adder – Serial Adder/Subtractor - BCD adder – Binary Multiplier – Binary Divider - Multiplexer/ Demultiplexer – decoder - encoder – parity checker – parity generators – code converters - Magnitude Comparator

UNIT II SEQUENTIAL CIRCUITS 10

Flip Flops and Memory devices: RAM – Static and Dynamic, ROM, PROM, EPROM, EEPROM; Counters and Shift registers: Binary, BCD and programmable modulo counters, Shift register counters; Sequential circuit design: using Mealy and Moore model.

UNIT III INTRODUCTION TO HARDWARE DESCRIPTION LANGUAGE 10

Introduction to Verilog / VHDL- Structural, Dataflow and Behavioral modeling. Structural, Dataflow and Behavioral modeling of combinational logic circuits (Multiplexer, Demultiplexer, decoder and encoder). Structural, Dataflow and Behavioral modeling of sequential logic circuits (counters and shift registers.

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS 10

Analysis Procedure, Circuits with latches; Design Procedure, Reduction of state and flow table; Race free state assignment; Hazards; ASM chart; Design examples

UNIT V APPLICATIONS OF DIGITAL ELECTRONICS 5

Multiplexing displays - Frequency counters - Time measurements - using the ADC0804 - Slope alone operation, span adjust, zero shift, testing - microprocessor compatible A/D converters.

Total 45 Hrs

h) Learning Resources

Reference Books

1. John F.Wakerly, Digital Design, Fourth Edition, Pearson/PHI, 2006
2. Thomas L. Floyd, Digital Fundamentals, 8th Edition, Pearson Education Inc, New Delhi, 2003

Donald D.Givone, Digital Principles and Design, TMH

3. William H. Gothmann, Digital Electronics, 2nd Edition, PHI, 1982.

Text Books

1. M. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India Pvt. Ltd., 2003PearsonEducation (Singapore) Pvt. Ltd., New Delhi, 2003
2. Donald .P.Leach, Digital principles and applications, 7th Edition,McGraw-Hill, 2012

Online Resources

1. http://www.wiley.com/legacy/wileychi/mblin/supp/student/LN08CombinationalLogicModules.pdf
2. http://www.learnabout-electronics.org
3. www.nptel.com/digitalelectronics/iitkanpur/
4. www.mooc.org

Course Code	Course Title	L	T	P	C
1151EC105	**LINEAR INTEGRATED CIRCUITS**	**3**	**0**	**0**	**3**

a) Course Category

Program Core

b) Preamble

Linear Integrated Circuits introduces the basic building blocks of the Integrated circuits along with fundamental concepts of electronic circuits like operational amplifiers, rectifiers & timers and acquire the knowledge in analysis and design IC based circuits.

c) Prerequisite

Nil

d) Related Courses

VLSI Design, Analog Communication Systems, Medical Electronics

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain internal components and characteristics of Op-Amp	K2
CO2	Illustrate the linear, non-linear applications of Op-Amp and active filters.	K3
CO3	Describe Op-Amp based comparators, waveform generators, VCO and PLL operation and its application	K2
CO4	Explain and compare the performance of various types of ADC and DAC using Op-Amp	K2
CO5	Discuss various applications of special function Op-Amp ICs such as 555 IC, Voltage Regulator IC and Amplifier IC	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	M	L	L	-	-	-	-	-	-	-	-	-	-	-
CO2	H	H	M	-	L	L	L	-	-	-	-	-	L	-
CO3	M	M	M	-	L	L	L	-	L	-	-	M	L	-
CO4	M	M	M	-	L	M	L	-	L	-	L	M	L	-
CO5	M	M	M	L	L	M	L	L	M	M	M	M	L	-

g) Course Content

UNIT I INTRODUCTION TO OPERATIONAL AMPLIFIERS 9

BJT differential amplifier - Concept of CMRR - methods to improve CMRR - constant current source - active load - current mirror - Darlington pair differential input impedance - The Ideal Op Amp- Block diagram representation of Op Amp -Voltage Transfer Curve of Op Amp - DC and AC Characteristics of an Op Amp - Frequency Response - Slew Rate.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Active Filters: Low pass, High Pass and band pass filters - Switched capacitor filter Linear Applications: Inverting and Non inverting Amplifiers – Differentiator – Integrator - Voltage to current converter - Instrumentation amplifier Non Linear Applications: Clippers and Clampers - Precision rectifier - Log and Antilog amplifiers.

UNIT III WAVE GENERATORS & PLL 9

Comparators and Wave form Generators: Comparator - Regenerative comparator – Astable Multivibrators – Monstable Multivibrators - Triangular wave generator - Sine wave generators PLL: Voltage Controlled Oscillator- Closed loop analysis of PLL – PLL Applications - Frequency synthesizers

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9

Analog switches- High speed sample and hold circuits and sample and hold ICs- Types of D/A converter- Current driven DAC- Switches for DAC- A/D converter Flash- Single slope- Dual slope- Successive approximation - Delta Sigma Modulation- Voltage to Time converters.

UNIT V SPECIAL FUNCTION ICS 9

555 Timer: Astable and Monostable Multivibrators, Schmitt trigger Voltage regulators using op-amp - linear and switched mode types - Frequency to Voltage converters- Tuned amplifiers- Video amplifiers- ECG using op-amp.

Total 45 Hrs

h) Learning Resources

Text Books

1. D. Roy Choudhry and Shail B. Jain, "Linear Integrated Circuits"- (4/e), New Age International Pvt. Ltd, 2011.
2. R. Gayakwad, Op-amps and Linear Integrated Circuits (4/e), PHID. A. Bell, Solid state Pulse Circuits (4/e), PHI, 2009

Reference Books

1. S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits (3/e) TMH, 2003.
2. R. F. Coughlin & F. F. Driscoll: Operational Amplifiers and Linear Integrated circuits, PHI, 1996.
3. D. A. Bell: Solid State pulse circuits, (4/e), PHI. Milman Gravel: Micro-Electronics, McGraw Hill 1991

Online Resources

1. www.electronicstutorials.ws
2. www.circuitstoday.com
3. www.nptel.com

Course Code	Course Title	L	T	P	C
1151EC106	**ANALOG AND DIGITAL CONTROL SYSTEMS**	**2**	**2**	**0**	**3**

a Course Category

Program Core

b) Preamble

This course aims to provide a basic knowledge about what is a control system, its significance, transfer function, open and closed loop systems, time domain and frequency domain analysis and its specifications, stability, error constants and designing of compensators viz., lag, lead and lag lead compensators, significance of P, PI and PID controllers and stability & state variable analysis.

c) Prerequisite

Nil

d) Related Courses

Linear Integrated Circuits, Analog Communication Systems

e) Course Outcomes

On successful completion of this course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Derive the transfer function of electrical, mechanical and Electromechanical systems Apply the concept of state space for system analysis	K3
CO2	Derive Time response of I order and II order systems Apply the Root locus and Routh - Hurwitz criteria to analyze the stability of the given system	K3
CO3	Determine the system stability by various methods such as Bode plot, Polar plot etc in frequency domain	K3
CO4	Design various controllers and compensators for control systems	K3
CO5	Apply the concept of state space and sampling theorem to digital control system.	K3

f) Correlation of Co's with Po's

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
CO 1	H	H	M	L	L	L	-	-	-	-	-	L	L	-
CO 2	H	H	-	M	L	L	-	-	L	L	-	L	L	-
CO 3	H	H	-	M	-	L	-	-	-	-	-	L	L	-
CO 4	H	H	H	M	L	L	L	L	L	L	L	L	L	L
CO 5	M	M	L	L	L	L	L	L	-	L	-	L	L	-

g) Course Content

UNIT I CONTROL SYSTEM MODELING & STATE VARIABLE ANALYSIS 12

Basic elements of control system – open loop and closed loop systems: differential equation - transfer function, modeling of electric systems, translational and rotational mechanical systems - block diagram reduction techniques - signal flow graph. State space representation of continuous time systems – physical systems and phase variable model.

UNIT II TIME DOMAIN AND STABILITY ANALYSIS 12

Time response analysis: first order systems - impulse and step response analysis of second order systems. Root locus technique: construction of root locus- stability - dominant poles. Routh - Hurwitz criterion: relative stability.

UNIT III FREQUENCY DOMAIN AND STABILITY ANALYSIS 12

Frequency response - correlation between time and frequency responses - bode plot, polar plot - frequency domain specifications from the plots - nyquist plot, nyquist stability criterion.

UNIT IV DESIGN OF COMPENSATORS IN FREQUENCY DOMAIN 12

P, PI, PD and PID controllers: Introduction – transfer function model – characteristics; series, parallel and series - parallel compensation - Lead and Lag networks – series compensator design for desired response using Bode diagrams.

UNIT V DIGITAL CONTROL SYSTEMS **12**

State space representation for discrete time systems – phase variable model Sampled data control systems – Sampling theorem – Sampler and Hold – open loop and closed loop sampled data systems.

Sampled Data Control Systems, Sampling theorem – Sampler and Hold – open loop and closed loop sampled data systems, State space representation for discrete time systems – phase variable model.

Total 60 Hrs

h) Learning Resources

Text Books

1. M. Gopal, "Control System – Principles and Design", Tata McGraw Hill, 2nd Edition, 2002
2. J. Magrath and M. Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007.

Reference Books

1. Ogata, K., "Modern Control Engineering", Prentice Hall of India Ltd., 4th Edition, New Delhi, 2006.

COURSE CODE	COURSE TITLE	L	T	P	C
1151EC107	SIGNALS AND SYSTEMS	2	2	0	3

Course Category:

Program core

a. Preamble:

The signals existing in the real world is analog in nature and hence processing of this signal in continuous mode or discrete mode becomes essential in engineering applications. This course provides the basic knowledge on continuous and discrete time signals and systems. And also covers the applications especially in the area of communication.

b. Prerequisite Courses:

Transforms and Partial Differential Equations

c. Related Courses:

Discrete Time Signal Processing

d. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Classify the continuous and discrete time signals and systems.	K3
CO2	Apply Fourier concepts to analyze the continuous time systems	K3
CO3	Apply DTFT and Z transform for the analysis of discrete time signals	K3
CO4	Determine the discrete time system response using DTFT and Z transform	K3
CO5	Explain the use of discrete time systems in communication applications	K2

e. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M	L			M	L								

CO2	H	M			L									
CO3	M	M			L							M		
CO4	H	M	H	M	L							M	L	
CO5	L		H	M		L				L		M		

f. Course Content:

UNITI: Classification of Signals and Systems **10+3**

Continuous Time signals (CT signals) – Discrete Time signals (DT signals) – Elementary CT signals and DT signals – Classification of CT and DT signals – Basic properties of systems – Classification CT systems and DT systems – Linear time invariant systems and properties.

UNIT II: Continuous Time Signals and Systems **10+3**

Fourier series analysis: Spectrum of Continuous Time signals – Physical meaning of Fourier series. Fourier Transform in signal analysis – Fourier transforms in system analysis: Differential equation – block diagram representation – convolution integral and impulse response.

UNIT III: Representation of Discrete Time Signals **10+3**

Sampling of Continuous Time signals and aliasing – DTFT and properties – z-transform – Properties of z-transform and physical meaning of DTFT – z transform in Discrete Time signal analysis – DFT basics.

UNIT IV: Discrete Time Systems **11+3**

Difference equations – Block diagram representation – Convolution sum and impulse response – LTI systems analysis using DTFT and z-transforms.

UNIT V Applications **7**

Applications in communication system: Complex exponential and sinusoidal amplitude modulation – demodulation for sinusoidal AM – Frequency division multiplexing – Amplitude modulation with pulse train carrier – Pulse amplitude modulation– Discrete time sinusoidal amplitude modulation system.

Total: 60 Periods

f. Learning Resources:

Text Books

1. Allan V. Oppenheim et al, “Signals and Systems”, 2^{nd} edition, Prentice Hall of India Pvt. Ltd, 2004.

References

1. Ashok Ambardar, “Analog and Digital Signal Processing”, Thomson Learning Inc., 1999.
2. Douglas K.Lindner, “Signals and Systems”, McGraw-Hill International, 1999.
3. Simon Haykin and Barry Van Veen, “Signals and Systems”, John Willey & Sons, Inc, second edition 2013.

Online resources

1.www.ee.columbia.edu/~rmcastro/3801/
2.http://services.eng.uts.edu.au/pmcl/ss/
3.http://www.tcyonline.com/tests/

Course Code	Course Title	L	T	P	C
1151EC108	**ELECTROMAGNETIC FIELDS**	**2**	**2**	**0**	**3**

a) Course Category

Program Core

b) Preamble

To familiarize the students with the basic concepts and calculations pertaining to electric, magnetic and time is varying electromagnetic fields so that an in depth understanding of antennas, electronic devices and Waveguides are possible

c) Prerequisite

Nil

d) Related Courses

Waveguides & Antennas

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Solve electrostatic field problems using Coulomb's law and Gauss law with the associated boundary value-conditions.	K3
CO2	Solve magneto static field problems using Biot - Savart law and Ampere's circuit law with the associated boundary conditions.	K3
CO3	Explain time-varying electromagnetic field governed by Maxwell's equations.	K3
CO4	Interpret electromagnetic waves and its propagation in different medium.	K3
CO5	Interpret uniform plane wave and its propagation in different medium.	K3

f) Correlation of COs with POs(Program Outcomes defined by National Board of Accreditation, India)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	H	M	L	-	-	-	-	L	-	-	-	L	L	-
CO2	H	M	L	-	-	-	-	L	-	-	-	L	L	-
CO3	H	M	L	-	-	-	-	L	-	-	-	L	-	-
CO4	H	M	M	L	L	L	L	L	L	L	-	L	-	-
CO5	H	M	M	L	L	L	L	L	L	L	-	L	-	-

g) Course Content

UNIT I STATIC ELECTRIC FIELDS 12

Coordinate Systems and Transformation: Cartesian co-ordinates-Cylindrical Co-ordinates-Spherical coordinates. Vector Calculus: Differential length - area and volume-Line, surface and volume integrals- Del operator-Gradient of a scalar-Divergence of a vector and Divergence theorem-Curl of a vector and Stroke's theorem. Electrostatic Fields: Coulombs law-Electric field intensity-Principle of superposition- field intensity due to point charges and continuous distribution of charges-Energy and Energy Density in Electrostatic Fields. Electrostatic Fields in Material Space: Dielectric strength-Polarization in Dielectrics Permittivity-Boundary Condition. Electrostatic boundary - Value Problems: Capacitance- Poisson and Laplace equation and their application.

UNIT II STATIC MAGNETIC FIELDS 12

Magneto static Fields: Magnetic field intensity and magnetic flux density-Ampere's Circuital law-Biotsavart law-The scalar and vector magnetic potentials. Magnetic Forces, Materials and Devices: Magnetic dipole- Magnetic - Boundary Conditions – Inductance - Energy in an Inductor and Energy density Permeability- Field computation-Hysteresis-Reluctance and Permeance.

UNIT III ELECTROMAGNETIC WAVE PROPAGATION & APPLICATIONS 12

Maxwell's Equations : Faradays law - Concept of Displacement current-General field relations for time varying electric and magnetic fields-Maxwell's equations-Boundary relation for time-varying Fields - Retarded potentials-Phasor representation of a vector- Poynting vector and Poynting theorem.

UNIT IV ELECTROMAGNETIC WAVE PROPAGATION 12

General Wave equations, Electromagnetic waves in free space-Electromagnetic wave equations in phasor form-Electromagnetic waves in perfect or (lossless) dielectric-Electromagnetic waves in lossy dielectric- Electromagnetic waves in good conductors.

UNIT V UNIFORM PLANE WAVES AND PROPAGATION 12

Uniform plane waves in free space, Wave Equation in phasor form, Uniform plane waves in perfect (lossless)dielectric, Uniform plane waves in lossy dielectric, Uniform plane waves in good conductor, Reflection of Uniform plane waves, Oblique Incidence-Polarization of Uniform plane waves, Surface Impedance

Total 60 Hrs

h) Learning Resources

Reference Books

1. Ramo, Whinnery and Van Duzer: " Fields and Waves in Communications Electronics" John Wiley & Sons Third edition, 2003
2. NarayanaRao, N: "Elements of Engineering Electromagnetics" Prentice Hall of India , New Delhi, Fourth Edition, 1998

Text Books

1. Matthew N.O.Sadiku: "Principles of Electro magnetics" Oxford University Press, Sixth edition, 2015
2. E.C. Jordan & K.G. Balmain "Electromagnetic Waves and Radiating Systems." Prentice Hall of India, Second edition, 2003

Online Resources

1. http://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring 2008/
2. http://nptel.ac.in/courses/117103065/1

Course Code	Course Title	L	T	P	C
1151EC109	ANALOG COMMUNICATION SYSTEMS	2	2	0	3

a) Course Category

Program Core

b) Preamble

This course provides introduction about all types of analog modulation and demodulation techniques and applications, also covers random process and noise performance in analog communication systems.

c) Prerequisite

Analog Electronics

d) Related Courses

Wireless Digital communication

e) Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Characterize and design the behavior of amplitude modulation and detection schemes.	K3
CO2	Design the various features of angle modulation and demodulation t Techniques and compare their performances.	K3
CO3	Illustrate the influence of noise over analog modulation schemes through random process and noise theory.	K3
CO4	Discuss the noise performance in AM and FM systems.	K2
CO5	Explain the applications of analog communication techniques.	K2

f) CorrelationofCOswithPOs(ProgramOutcomesdefinedbyNationalBoardofAccreditation,India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	-	M	L	M	-	-	L	-	-	-	-	-
CO2	M	M	-	M	L	M	L	-	L	-	-	-	-	-
CO3	H	M	-	M	H	L	-	L	-	-	-	L	-	-
CO4	L	M	-	-	L	L	-	-	-	-	-	L	L	-
CO5	H	L	L	L	H	M	-	-	-	L	L	L	H	-

g) Course Content

UNITI AMPLITUDE MODULATION 12

Modulation - Need for Modulation, Principles of Amplitude Modulation: AM Envelope - Modulation Index -Frequency Spectrum and Bandwidth, Need for Frequency Translation, AM Modulator: DSBSC-SSB-VSB Modulators, AM Transmitter, Comparison of AM Modulation Systems, AM Demodulators: DSBSC- SSB, AM Receiver: TRF Receiver- Super Heterodyne Receiver-AM Peak Detector.

UNITII ANGLEMODULATION 12

Angle Modulation Types - Phase and Frequency Modulation, Narrow Band FM and Wideband FM, Transmission Bandwidth of FM signals, FM Modulator: Generation of FM by Parameter Variation Method - Armstrong's Indirect Method, PM Modulator, FM Demodulator: Frequency Discriminator - Foster Seeley Discriminator -Balanced Slope Detector, Block Diagram of FM Double Conversion Receiver, PLL as FM Demodulator – PM Demodulator.

UNITIII RANDOMPROCESS/NOISE THEORY 12

Review of Probability Theory, Random Variables / Random Process, Gaussian Process, PSD Sequence of Pulse, PSD Sequence of Digital Data, Transmission of Random Process Through Linear Systems, Weiner Holph Filter, Noise: Shot Noise - Thermal Noise and White Noise - Narrow Band Noise - Noise Equivalent Bandwidth- Noise Temperature- Noise Figure.

UNITIV NOISEPERFORMANCEOFCWMODULATIONSYSTEMS 12

Noise in DSBSC Systems, Noise in SSBSC System, Noise in FM System - FM Threshold Effect, Pre emphasis and De-emphasis in FM: Capture Effect–Threshold Effect, Comparison of Performances.

UNITV APPLICATIONSOFANALOG COMMUNICATIONSYSTEM 12

Radio Transmitter and Receiver, Power Amplifier, Impedance Matching Network, Radio Receiver, Stereophonic FM Broadcasting, Voice Coders, Channel Vocoder, Linear Predictive Coder, Mobile Telephone Communication-Cellular Concept.

Total 60 Hrs

h) Learning Resources

Reference Books

1. R.P Singh and S.D.Sapre "Communication Systems-Analog and Digital" Tata McGraw Hill, 2nd Edition, 2007
2. Bruce Carlson "CommunicationSystems"3rd Edition, Tata McGraw Hill.
3. B.P.Lathi "Modern Digital and Analog Communication Systems"3rd Edition,OxfordPress,2007

4. JohnG. Proakis, Masoud Salehi “Fundamentals of Communication Systems” Pearson Education, 2006

TextBooks

1. Herbert Taub, Donald L Schilling and Goutam soha “Principles of Communication Systems”, 4th Edition, Tata Mc Graw Hill, 2014.
2. Wayne Tomasi“ Electronic Communication Systems”, 5thEdition, Pearson education in south Asia print 2011
3. Simon Haykin,“Communication Systems”,4thEdition, John Wiley & Sons,Inc.2001.

OnlineResources

1. http://www.talkingelectronics.com/Download%20eBooks/Principles%20of%20electronics/CH-16.pdf
2. http://nptel.ac.in/courses/IITMADRAS/Principles_Of_Communication/pdf/Lecture2324_AngleModulation.pdf
3. http://www.daenotes.com/electronics/communication-system/noise.

Course Code	Course Title	L	T	P	C
1151EC110	MICROPROCESSOR AND MICROCONTROLLER	3	0	0	3

a) Course Category

Program core

b) Preamble

The Purpose of the course is to provide students with the Knowledge of Microprocessors and Microcontroller. To solve real world problems in an efficient manner, this course also emphasis on architecture, Programming and system design used in various day to day gadgets.

c) Prerequisite

Digital Electronics

d) Related Courses

Embedded System Design, Embedded Processors, Embedded OS and Device Drivers

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Illustrate the functionalities of 8085 & 8086 architectures and Assembly language programming	K3
CO2	Describe the architecture and functional block of 8051 microcontroller & the interfacing of External Memory, LCD, Keyboard and Real Time Clock.	K2
CO3	Program the functional units of 8051 microcontroller for the given specifications using C and Assembly language.	K3
CO4	Summarize various peripheral devices such as 8255, 8279, 8251, 8253,8259 and 8237	K2
CO5	Explain the various applications of 8051 microcontroller and the basic architectures of PIC, ARM and ATMEGA	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	M	M	H	-	M	L	-	-	-	-	-	M	-	M
CO2	M	M	H	-	M	L	-	-	-	-	-	L	-	-
CO3	M	M	H	-	M	L	-	-	-	-	-	H	-	M
CO4	M	-	L	-	-	-	-	-	-	-	-	M	-	L
CO5	M	-	M	-	M	-	L	-	-	-	M	M	L	L

g) Course Content

UNIT I 8085 AND 8086 MICROPROCESSOR 12

Introduction to 8085 Architecture, Timing Diagram, Addressing Modes, Instruction Formats, Instruction Set. Introduction to 8086 Architecture, Features, Signals, I/O & Memory Interfacing, Addressing Modes, Instruction Formats, Instruction Set, Assembler Directives, Interrupts, Minimum Mode & Maximum Mode Operation, Assembly Language Programming.

UNIT II 8051 ARCHITECTURE 9

Hardware features, Architecture, Internal RAM structure, Special Function Registers, Memory Organization, I/O Ports and Circuits, Timers, Interrupts, Serial Communication, Interfacing of External Memory, Interfacing LCD & Keyboard, Real Time Clock.

UNIT III 8051 PROGRAMMING 9

Addressing Modes, Instruction Set, Assembly Language Programming and C Programming, Timer Counter Programming, Serial Communication Programming, Interrupt Programming.

UNIT IV PERIPHERAL DEVICES 8

Parallel Peripheral Interface (8255), A/D & D/A Interface, Timer / Counter (8253), Keyboard and Display Controller (8279), USART (8251), Interrupt Controller (8259), DMA Controller (8237).

UNIT V MICROCONTROLLER APPLICATIONS & ADVANCED PROCESSOR 7

Temperature Control System, Motor Speed Control System, Traffic light System, Elevator System, Data Acquisitions System, Introduction to Architecture of PIC Microcontroller, ARM Processor, ATMEGA Processor.

Total 45 Hrs

h) Learning Resources

Text Books

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 6th Edition, Penram International Publishing.
2. A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing ", second edition, Tata McGraw-Hill .
3. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D McKinlay, The 8051 microcontroller and embedded systems using assembly and C, second edition Pearson education Asia.

Reference Books

1. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers.

Online Resources

1. https://www.youtube.com/watch?v=liRPtvj7bFU&list=PL0E131A78ABFBFDD0
2. https://www.youtube.com/watch?v=95uGOJ1Ud2c&list=PLJGA4olwzpA-rvcdWULcRuMn2495g0n8j

Course Code	Course Title	L	T	P	C
1151EC111	**DATA COMMUNICATIONNETWORKS**	**2**	**2**	**0**	**3**

a) **Course category**
Program core

b) **Preamble**
The purpose of this course is to provide the knowledge of data communication over inter network based on OSI model and in depth knowledge about the layers and application protocols.

c) **Prerequisite**
Nil

d) **Related courses**
Network Security, Network Management, Internet of Things

e) **Course Outcomes**

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Interpret the concepts, components, standards and topologies. Explain layered architecture of OSI and TCP/IP model	K2
CO2	Outline the concepts of various protocols used in application Layer	K2
CO3	Illustrate about reliable and non-reliable data transfer protocols in transport layer for different applications	K2
CO4	Apply the knowledge of various network layer routing protocols to predict the shortest path between the nodes	K3
CO5	Infer about how error detection flow control and error control is done in data link layer. Explain about different multiple access techniques used in wired and wireless network	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	-	-	L	-	-	-	-	-	L	-	-
CO2	M	-	L	-	-	-	-	-	-	-	-	-	-	-
CO3	L	L	L	-	-	-	-	-	-	-	-	L	-	-
CO4	H	L	H	-	M	-	-	-	-	-	-	-	-	-
CO5	L	M	L	-	-	-	-	L	-	-	-	L	-	-

g) Course Content

UNIT I INTRODUCTION TO NETWORKS 12

Data Communication: Components - Protocols and Standards - Standard making organizations - data rate and Channel capacity, Line configuration, Topology of networks, Transmission modes, Digital Data Transmission, Categories of Networks, Inter-Networks, OSI model, TCP/IP Model, Networking and internetworking devices, Switching: Circuit switching - Packet switching - Message switching.

UNIT II APPLICATION LAYER 12

Web and HTTP: Overview of HTTP - Non Persistent and Persistent - HTTP Message format –Cookies - Web catching - Conditional GET, FTP, Electronic Mail in Internet: SMTP - Comparison with HTTP - Mail Message format - Mail Access Protocol – DNS - Peer to Peer Applications, Concept of Socket in TCP & UDP, Telnet.

UNIT III TRANSPORT LAYER 12

Introduction and Transport Layer Services, Multiplexing and De-multiplexing, Connectionless Transport: UDP, Principles of Reliable Data Transfer, Connection Oriented TCP, Principles of Congestion Control: ATM ABR Congestion Control - TCP Congestion Control.

UNIT IV NETWORK LAYER 12

Inside a Router, Internet Protocol, IPV4 - IPV6 - ICMP, Routing protocols: Distance Vector Routing (RIP) and Link State (OSPF) Routing – BGP - Broadcast and Multicast Routing.

UNIT V DATA LINK LAYER AND WIRELESS NETWORKS 12

Introduction to Data link layer, Error detection: VRC - LRC – CRC - Checksum and Error correction: Hamming Code, Reliable transmission: Flow Control and Error Control - Token bus - Token ring - Medium Access control: TDMA, FDMA – CDMA – Aloha - CSMA/CA - CSMA/CD Wireless Networks: Introduction to Wi-fi – Wimax – MANET – VANET - WSN.

Total 60 Hrs

h) Learning Resources

Text Books

1. James F. Kurose, Keith W. Ross, “Computer Networking: A Top Down Approach”, 5th Edition, Pearson Publications, 2012.
2. Behrouz A. Forouzan, “Data Communicationand Networking” 2nd Edition, McGraw- Hill, 2003.

Reference Books

1. William Stallings, “Data and Computer Communication”, Prentice Hall of India. Eighth edition.
2. Andrew S. Tanenbaum, Computer Networks, Prentice Hall.

Course Code	Course Title	L	T	P	C
1151EC112	**DISCRETE TIME SIGNAL PROCESSING**	**2**	**2**	**0**	**3**

a) Course Category

Program Core

b) Preamble

Digital Signal Processing provides an introduction to the basic concepts of signal processing methods and to acquire knowledge of analysis of systems using various transformation techniques. It provides students to realize about different filter structure and also to develop algorithm for signal processing.

c) Prerequisite

Transforms and partial Differential Equations, Signals and Systems

d) Related Courses

Advanced Digital Signal Processing, Statistical Signal Processing

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Compute Discrete Fourier Transform for the given signals.	K3
CO2	Design the Digital Infinite Impulse Response Filters (IIR) from given Specifications	K3
CO3	Analyze different windowing and sampling techniques to design FIR filter	K4
CO4	a. Analyze the finite word length effects in filters	K4
	b. Explain the basic signal processing concepts in DSP Processor	K2
CO5	Explain the basics of Multirate Signal Processing & its Applications.	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	H	M	L		L									
CO2	H	M	L		L							M		
CO3	H	L	L		L	L						M		
CO4	L	M	L		L	L								L
CO5	M	L										M		

g) Course Contents

UNIT I DISCRETE FOURIER TRANSFORMS 12

Introduction & Properties of DFT – Linear & Circular Convolution Methods, FFT algorithms – Radix-2 FFT algorithms – Decimation in Time – Decimation in Frequency algorithms –Use of FFT algorithms in Linear Filtering and correlation.

UNIT II IIR FILTER DESIGN 12

Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by using Approximation of derivatives – Impulse Invariance – Bilinear transformation, (LPF, HPF, BPF, BRF) filter design using frequency translation.

UNIT III FIR FILTER DESIGN 12

Structures of FIR – Linear phase FIR filter - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.

UNIT IV FINITE WORD LENGTH EFFECTS & DSP PROCESSOR 12

Finite word length effects: Quantization- Truncation and Rounding errors - Quantization noise-coefficient quantization error – Product quantization error - Overflow error – limit cycle oscillations, scaling. **Introduction to DSP architecture** – Harvard architecture - Dedicated MAC unit - Multiple ALUs, Advanced addressing modes, Pipelining, Overview of instruction setC54X.

UNIT V MULTIRATE SIGNAL PROCESSING& APPLICATIONS 12

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Application-Sub band coding, Musical Sound Processing, Digital Audio sampling rate conversion, Oversampling A/D &D/A.

Total 60 Hrs

h) Learning Resources

Text Books

1. John G. Proakis& Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, 4^{th} edition, Pearson Education / Prentice Hall,2007.
2. B. Venkataramani, M. Bhaskar, “Digital Signal Processors: Architecture,Programming and Applications”, 2^{nd} edition, Tata McGraw-Hill Education, 2002.

Reference Books

1. S.Salivahanan, A.Vallavaraj, C Gnanapriya, “Discrete Signal Processing”, Tata McGraw-hill Publication,2002.
2. Emmanuel C..Ifeachor, &Barrie.W.Jervis, “Digital Signal Processing”, 2^{nd} edition, Pearson Education / Prentice Hall,2002.
3. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Tata Mc Graw Hill,2007.
4. A.V.Oppenheim, R.W. Schafer and J.R. Buck, “Discrete-Time Signal Processing”, 8^{th} Indian Reprint, Pearson, 2004.

Online Resources

1. http://nptel.ac.in/courses/117104070/
2. http://nptel.ac.in/courses/117102060/
3. http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video- lectures/
4. http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/study-materials/
5. http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/download-resource-materials/

COURSE CODE	COURSE TITLE	L	T	P	C
1151EC113	**WIRELESS DIGITAL COMMUNICATION**	**3**	**2**	**0**	**4**

a. Course Category:

Program Core

b. Preamble:

This course provides the information about the base band and pass band transmission schemes, enabling the student to determine errors, study different keying techniques, also know about information theory and channel coding.

c. Prerequisite Courses:

Basic Electronics Engineering, Analog Electronics, Analog Communication systems

d. Related Courses:

Mobile communication, Satellite Communication

e. Course Outcomes:

On successful completion of this course the student will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the concept of sampling and various wave form coding schemes	K2
CO2	Apply the baseband transmission techniques using Nyquist criterion	K3
CO3	Identify the performance features of various data transmission schemes in pass band transmission	K3
CO4	Compute the original transmitted code words after the noise introduction in the transmission path	K3
CO5	Explain the concept of channel modeling and fading in wireless communication.	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	L	-	L	-	-	L	-	L	M	M	-
CO2	H	H	M	H	L	-	-	L	-	-	-	M	L	-
CO3	H	H	H	H	H	-	-	-	-	-	L	H	H	-
CO4	H	H	H	M	H	-	-	-	-	L	-	M	L	-
CO5	H	M	M	M	M	-	-	-	L	M	-	M	L	-

g. Course Content:

UNIT I: Sampling process and wave form coding 9L+6T (15 Hrs)

Basic elements of a digital communication system-Sampling Theorem - Sampling and signal recovery -PAM, PCM -Channel noise and error- Quantization Noise-SNR -TDM -DM– ADM- Linear prediction, - DPCM

UNIT II: Baseband Pulse Transmission 9L+6T (15 Hrs)

Discrete PAM signals - Matched filter - Intersymbol Interference- Nyquist's criterion for Distortion less Transmission- Correlative coding –Baseband M-ary PAM systems -Adaptive Equalization-Eye patterns

UNIT III: Pass band transmission 9L+6T (15Hrs)

Gram-Schmidt Orthogonalization Procedure; Geometric Interpretation of Signals; Correlation Receiver- Introduction to digital modulation schemes- Generation, Detection, BW,PSD of ASK, FSK, PSK, DPSK, QPSK, Comparison of digital modulation systems - Carrier and symbol synchronization.

UNIT IV: Error Control Coding 9L+6T (15Hrs)

Channel coding theorem -Linear block codes - Cyclic codes –Convolutional codes - Maximum likelihood decoding - Viterbi Algorithm- Trellis coded modulation.

UNIT V: Wireless Channel Models 9L+6T (15Hrs)

Basic cellular concepts- propagation effects-Fading- Channel models- statistical characterization of multipath channels, Delay spread and Doppler spread, classification of multipath channels, Diversity techniques.

Total: 75 Hrs

h. Learning Resources:

Text Books

1. Simon Haykins, "Communication Systems", John Wiley, 4th Edition, 2009.
2. Sam K.Shanmugam "Analog& Digital Communication" John Wiley.
3. John G.Proakis, "Digital Communication" McGraw Hill 3rd Edition, 1995.
4. Dr J.S Chithode, ‘’ Analog and Digital communication’’ Technical publication, 3rd Edition 2012.
5. Taub & Schilling, "Principles of Digital Communication "Tata McGraw-Hill" 28th reprints, 2003.
6. **Theodore Rappaport, "Wireless Communications – Principles and Practices", 2nd edition, 2008, Prentice Hall of India, New Delhi.**

Online Resources

1. http://nptel.iitm.ac.in/courses/Webcoursecontents/IIScBANG/Data%20Communication/ Learning%20Material%20-%20DataCommunication.pdf
2. http://www.sp4comm.org/docs/chapter12.pdf

COURSE CODE	COURSE TITLE	L	T	P	C
1151EC114	WAVEGUIDES AND ANTENNAS	2	2	0	3

a. **Course Category:**

Program Core

b. **Preamble:**

This course provides an introduction to the basic concepts of propagation of signals to transmission lines, radio Propagation in guided Systems and to learn its application. The quality of signals at receiver depends on type of transmitting and receiving antennas, their orientation, transmitting frequency and geographical terrain. For installation & maintenance of wireless systems, the basic knowledge of wave propagation theory is essential.

c. **Prerequisite courses:**

Electro Magnetic Fields

d. **Related Courses:**

Optical & Microwave Engineering, RF and Microwave Integrated Circuits

e. **Course Outcomes:**

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the propagation characteristics of electromagnetic waves in transmission lines Solve the transmission line parameters using Smith chart.	K2 K3
CO2	Describe the characteristics of guided waves between parallel planes, rectangular waveguide and circular waveguide. Calculate the resonance frequency of cavity resonators and the associated modal field.	K2 K3
CO3	Explain the general parameters to design an antenna. Explain the construction and operation of arrays, short dipole, loop antenna and slot antenna	K2
CO4	Apply the antenna characteristics to design various types of linear and planar antennas.	K3
CO5	Explain the knowledge of the structure of atmosphere, types of communication and propagation methods.	K2

f) Correlation of Co's with Po's

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	L	L	-	L	-	L	L	-	M	L	-
CO2	H	M	M	M	-	-	-	-	-	L	-	L	-	-
CO3	H	H	H	H	H	-	H	L	L	L	L	H	M	-
CO4	H	H	H	H	H	-	H	L	L	L	-	H	M	-
CO5	L	L	-	-	-	L	M	-	-	L	-	L	-	-

g. Course Content :

UNIT I Transmission Line Theory 12

Transmission Line Theory: General theory of Transmission lines - the transmission line - general solution - Waveform distortion - the distortion less line - Loading and different methods of loading - Input and transfer impedance - Open and short circuited lines - reflection factor and reflection loss. Line at High Frequencies: Standing waves and standing wave ratio on a line – One eighth wave line - The quarter wave line and half wave line. Single stub matching and double stub matching.

UNIT II Guided Waves 12

Waves between parallel planes: Transverse electric waves-Transverse magnetic wavesCharacteristic of TE and TM waves-TEM waves. TE waves and TM waves in Rectangular waveguides, TE waves and TM waves in circular waveguides and Microwave cavities.

UNIT III Antennas and Arrays 12

Introduction to Antenna basics and characteristics, Effective aperture, Friis Transmission formula, general concept of dipole antenna. Radiation resistance of a short dipole and loop antenna, Slot antennas, Babinet's principle. Arrays: Broadside array, end fire array and Pattern multiplication: Hansen and Woodyard array, Binomial arrays, Dolph-Chebychev arrays.

UNIT IV Special Antennas 12

Horn antenna, Helical antenna, Yagi-Uda antenna, Corner reflectors, Parabolic reflectors, Lens antenna, Omni directional antennas, MIMO antennas, antennas for satellite, antennas for ground penetrating radars, Ultra wide band antennas, plasma antenna.

UNIT V Propagation of Radio Waves 12

Modes of propagation, Structure of atmosphere, Ground wave propagation, Troposphere propagation, Duct propagation, Troposcatter propagation, Flat earth and Curved earth concept Sky wave propagation – Virtual height, critical frequency, Maximum usable frequency – Skip distance, Fading, Multi hop propagation.

Total 60Hrs

h. Learning Resources

Text Books

1. J.D.Ryder "Networks, Lines and Fields", PHI, New Delhi, 2003.
2. John D Kraus," Antennas for all Applications", 3rd Edition, McGraw Hill, 2005.
3. E.C. Jordan and K.G.Balmain "Electro Magnetic Waves and Radiating System, PHI, New Delhi, 2003.
4. Warren L Stutzman and Gary A Thiele, —Antenna Theory and Design, 2ndEd, John Wiley and Sons Inc. 1998

References

1. Edward C.Jordan and Keith G.Balmain" Electromagnetic Waves and Radiating Systems" Prentice Hall of India, 2006
2. Ramo, Whineery and Van Duzer: "Fields and Waves in Communication Electronics" John Wiley, 2003.
3. Constantine.A.Balanis "Antenna Theory Analysis and Design", Wiley Student Edition, 2006.
4. H.Sizun "Radio Wave Propagation for Telecommunication Applications", First Indian Reprint, Springer Publications, 2007.

Online Resources

1. http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Transmission%20 Lines%20and%20EM%20Waves/TOC.htm
2. http://nptel.ac.in/courses/117101056/
3. www.antenna-theory.com
4. http://www.dxzone.com/catalog/Antennas
5. http://www.engr.sjsu.edu/rkwok/EE172/Antenna_Fundamental.pdf

Course Code	Course Title	L	T	P	C
1151EC115	**VLSI DESIGN**	**3**	**0**	**0**	**3**

a) Course Category

Program Core

b) Preamble

This course introduces the fundamentals of the VLSI and implementation of digital circuit through the CMOS Transistors.

c) Prerequisite

Digital Electronics

d) Related Courses

Low power VLSI

e) Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the design hierarchy and CMOS fabrication techniques	K2
CO2	Describe the physical design of CMOS transistors	K2
CO3	Explain the various characteristics and processing technology of CMOS transistors	K2
CO4	Construct the sequential circuits using CMOS transistors	K2
CO5	Illustrate the arithmetic building blocks and memories using CMOS circuits.	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	M	-	-	-	-	-	-	H	M	-
CO2	H	L	M	H	L	-	-	-	-	-	-	L	H	-

CO3	M	L	H	M	-	M	L	-	-	-	-	L	L	-
CO4	H	H	M	H	L	-	-	-	-	-	-	M	M	-
CO5	M	M	H	H	L	-	-	-	-	-	-	H	L	-

g) Course Content

UNIT I CMOS FABRICATION AND DESIGN 9

Review of MOS Transistors: nMOS, pMOS CMOS Fabrication and Layout: Inverter and Cross Section - Fabrication process - Layout Design Rules - Gate Layout - Stick Diagrams. VLSI Design Flow: Design specifications, Design Entry, Functional Simulation, PPR, Timing Simulation, Fusing/Fabrication into the Chip. Logic gates: CMOS Inverter- CMOS NAND Gate- CMOS Combinational Logic- CMOS OR Gate- Pass Transistor and Transition Gates- Multiplexers -Latches and Flip-Flops.

UNIT II CMOS LOGIC, CIRCUIT AND PHYSICAL DESIGN 9

CMOS Logic Design: Top Level Interface, Block Diagrams, Hierarchy, Hardware Description Language - Circuit Design. Physical Design: Floor Planning, Standard Cells, Pitch Matching, Slice Plans, Arrays, Area Estimation.

UNIT III CMOS THEORY AND PROCESSING TECHNOLOGY 9

Theory: Ideal I-V Characteristics - C-V Characteristics -Non ideal I-V Effects - DC Transfer Characteristics of CMOS Transistor CMOS Processing Technology: Background, Wafer Formation, Photolithography, Well and Channel Formation, SiO_2, Isolation, Gate Oxide, Gate and Source/Drain Formation, Contacts and Metallization, Passivation, Metrology.

UNIT IV SEQUENTIAL CIRCUITS 9

Sequencing Static Circuits- Circuit Design for Latches and Flip-Flops - Static Sequencing Element Methodology- Sequencing Dynamic Circuits- Synchronizer.

UNIT V ARITHMETIC BUILDING BLOCKS AND MEMORY ARCHITECTURES 9

Design of arithmetic building blocks: Adders, Multipliers, Shifters – Comparator– Counters - Memories: SRAM, DRAM.

Total 45 Hrs

h) Learning

Resources Text

Books

1. Neil H.E. Weste and David Money Harris,“CMOS VLSI Design: A Circuits and Systems Perspective”,4th Edition,Pearson Education,2015.
2. Douglas A.Pucknell and Kamran Eshraghian, “Basic VLSI Design”,3rd Edition, PHI,2017.

Reference Books

1. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, Digital Integrated Circuits: A Design

Perspective”, 2nd Edition, Pearson, 2016

Online Resources

1. www.nptelvideos.in/2012/12/digital-vlsi-system-design.html
2. http://www.cmosvlsi.com/coursematerials.html
3. http://freevideolectures.com/Subject/VLSI-and-ASIC-Design

COURSE CODE	COURSE TITLE	L	T	P	C
1151EC116	OPTICAL AND MICROWAVE ENGINEERING	2	2	0	3

Course Category:

Programme Core

a. Preamble:

Fiber optic communication provides the basic concepts of optical fibers, light propagation, effect of losses and dispersion.

Microwave Engineering enlightens the formulation of Scattering matrix for various microwave components and its properties, operation of solid state based devices, O and M tubes for microwave signal generation and illustrating different microwave measurement techniques

b. Prerequisite Courses:

Waveguides and Antennas

c. Related Courses:

RF & MIC, Satellite Communication, Radar and Navigational Aids.

d. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe the basics of optical fibers and its Mode Characteristics.	K2
CO2	Explain different losses, dispersion and distortion of light in optical fibers.	K2
CO3	Apply the properties of S parameters to study the characteristics of microwave components.	K3
CO4	Explain the working principle of different solid state based devices used for generation and amplification of microwave signal.	K2
CO5	Describe the working principle of linear beam and cross field devices for microwave generation and amplification. Explain various techniques used for microwave measurements.	K2

e. Correlation of COs with POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M	M												
CO2		M			M				L		M			
CO3	M	M												
CO4		M												
CO5		M	L								M	L		

H- High; M-Medium; L-Low

f. **Course Content :**

UNIT I: Introduction to Optical Fibers 9 + 3

Introduction to Telecommunications and Fiber Optics: The Evolution of Fiber Optic Systems, Basic Optical Laws and Definitions: Propagation of light inside fiber - Critical-Angle - Numerical Aperture - Acceptance-Angle -Cut-off wavelength, Mode Field Diameter, Mode Theory: V-Number,Fiber Types, Splicing Techniques and Connectors.

UNIT II: Losses and Dispersion in Optical Fibers 9 + 2

Merits and Demerits of Fiber Optics over conventional copper wire systems, Losses: Attenuation Losses - Absorption Losses - Scattering Losses - Bending Losses - Core and Cladding Losses - Total Combined Losses, Dispersion: Group-Delay - Material Dispersion - Waveguide Dispersion - Intermodal Distortion.

UNIT III: Microwave Components and two port networks 9 + 6

Introduction to Microwaves: Microwave frequencies - advantages and applications, Scattering matrix formulation: Concept of N port scattering matrix representation - S parameters properties, Passive microwave devices: bends – corners – attenuators - phase changers, S Matrix Calculations for 2 port Junction: E plane and H plane Tees - Magic Tee - Directional Coupler - Circulator and Isolator- problems.

UNIT IV: Microwave Solid State Devices 9 +2

Transit time limitations in Microwave Bipolar Transistors, Power frequency limitations Microwave Field Effect Transistors, Gunn effect: RWH theory - High-field domain and modes of operation - microwave amplification, Avalanche transit time devices: IMPATT and TRAPATT diodes, Parametric amplifiers.

UNIT V: Microwave tubes and measurements **9 + 2**

Microwave vacuum tube based devices (Qualitative study),Limitations of conventional tubes at UHF & Microwave, Klystron: Two cavity Klystron - velocity modulation - multicavity klystron -Reflex klystron, Traveling wave tube, Magnetron.

Microwave measurements: Measurement of power – wavelength – impedance – SWR – attenuation - Q and Phase shift.

Total: 60 Periods

Learning Resources:

i.Text Books

1. M. Senior , “Optical Fiber Communication”, Second Edition, Pearson Education, 2007
2. Samuel Y Liao, “Microwave Devices & Circuits” Third Edition Prentice Hall of India, 2006.
3. David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.2012.

ii.References

1. J.Gower, "Optical Communication System", Prentice Hall of India, 2001.
2. Gerd Keiser, "Optical Fiber Communication" McGraw -Hill International, 4th Edition., 2010.
3. R.E.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.Citations 2000.
4. Annapurna Das and Sisir K Das, “Microwave Engineering”, Third edition Tata McGraw Hill Inc., 2009.

iii. Online resources

1. https://en.wikipedia.org/wiki/Microwave_engineering
2. http://www.microwaveeng.com
3. http://www.meslmicrowave.com/microwave-integrated-circuits/overview/
4. www.nptelvideos.in/2012/12/advanced-optical-communication.html

Course Code	Course Title	L	T	P	C
1151EC217	**EMBEDDED OS AND DEVICE DRIVERS**	**3**	**0**	**2**	**4**

a) Course Category

Program Core

b) Preamble

This course teaches the fundamental concept of how the operating system schedules the various embedded computational process in real time applications.

c) Prerequisite

Microprocessor and Microcontroller

d) Related Courses

Real Time Operating System, System on Chip, Embedded Processor

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy) / Skill Level (Based on Dave's Taxonomy)
CO1	Discuss the basic concepts of operating system and distributed system	K2
CO2.a	Explain RTOS task scheduling, task synchronization and task communication mechanisms.	K2
CO2.b	Develop and simulate RTX51 Tiny based embedded OS code for 8051 microcontroller using Keil IDE and report on the code execution statistics by identify the time consuming module for optimization.	S3
CO3	Describe the concept of board support package and embedded storage.	K2
CO4.a	Explain various embedded file systems and storage space optimization techniques.	K2
CO4.b	Install Linux for specified configuration, develop Linux C programs and implement Linux file system.	S3
CO5.a	Describe the Linux device driver development process for communication interfaces and basic peripherals.	K2
CO5.b	Implement loadable kernel modules to be run in kernel space and develop Linux drivers for basic devices.	S3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	M	-	M	-	-	-	-	-	-	-	-	L
CO2.a	M	L	M	-	-	-	-	-	-	-	-	H	-	-
CO2.b	-	-	-	M	H	-	-	L	M	M	H	-	H	H
CO3	-	-	L	-	H	-	-	-	-	-	-	-	L	L
CO4.a	M	-	-	-	-	-	-	-	-	-	-	L	-	-
CO4.b	-	-	-	M	H	-	-	L	M	M	H	-	H	H
CO5.a	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5.b	-	-	M	M	H	-	-	L	M	M	H	H	H	H

g) Course Content

UNIT I INTRODUCTION TO OPERATING SYSTEMS 9

Basic Principles, Operating System Structures, System Calls & Types, Processes: Concept – Scheduling - Inter Process Communication, Introduction to Distributed Operating System, Types of network based OS.

UNIT II OVERVIEW OF RTOS 9

RTOS Task and Task State, Preemptive Scheduler, Process Synchronization, Message Queues, Mailboxes, Pipes, Critical Section, Semaphores, Classical Synchronization Problem –Deadlocks.

UNIT III BOARD SUPPORT PACKAGES 9

Inserting BSP in Kernel Build Procedure, Boot loader Interface, Memory Map, Interrupt Management, PCI Subsystem: Timers - UART- Power Management. Embedded Storage: MTD – MTD Architecture - MTD Driver for NOR Flash - Flash Mapping Driver

UNIT IV EMBEDDED KERNEL & COMPONENTS 9

Embedded File System: RAMDisk – RAMFS – CRAMFS, Journaling Flash File Systems: JFFS and JFSS2, NFS: PROC File system, Optimizing storage Space: Kernel space optimization - Application Space Optimization, Applications for Embedded Linux - Tuning kernel memory.

UNIT V LINUX DEVICE DRIVERS 9

Embedded Drivers: Linux Serial Driver - Ethernet Driver - I^2C Subsystem on Linux - USB Gadgets, Watchdog Timer, Kernel Modules.

Total 45 Hrs

Practical Exercises **30 Hrs**

			Skill Level
1	Exploring the features of Keil and RTX51 Tiny	CO2.b	S3
2	Introductory Embedded C Programming	CO2.b	S3
3	Task Creation and Deletion using RTX51 Tiny in Keil	CO2.b	S3
4	Round robin Task scheduling using RTX51 Tiny in Keil	CO2.b	S3
5	Processing Critical Section using RTX51Tiny in Keil	CO2.b	S3
6	Task Synchronization using RTX51Tiny in Keil	CO2.b	S3
7	Task Communication using RTX51 Tiny shared memory in Keil	CO2.b	S3
8	Linux Installation	CO4.b	S3
9	Basic Linux Programming	CO4.b	S3
10	Creating Linux Loadable kernel Modules	CO5.b	S3
11	Linux Serial Driver	CO5.b	S3

Total 75 Hrs

h) Learning Resources

Text Books

1. Silberschatz, Galvin, Gagne, “Operating System Concepts”, 6th edition, John Wiley, 2003.
2. Raj Kamal, “Embedded Systems -Architecture, Programming and Design”, Tata McGrawHill,2006.
3 P. Raghavan, Amol Lad, SriramNeelakandan, “Embedded Linux System Design and development”, Auerbach Publications 2005.
4 Jonathan Corbet, AllesandroRubini& Greg Kroah-Hartman, “Linux Device Drivers”,O’Reilly, 3rdedition, 2005.

Online Resources

1. https://www.youtube.com/watch?v=PEzpOembKNc
2. https://www.youtube.com/watch?v=mCs21yByQqk
3. https://www.youtube.com/watch?v=hDn4hM148V8

Course Code	Course Title	L	T	P	C
1151EC301	**ANALOG INTEGRATED CIRCUITS LAB**	**0**	**0**	**4**	**2**

a) Course Category

Program Core

b) Preamble

The aim of this course is to understand the fundamental and design of Analog electronic circuits using transistor and op-amp.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Dave's Taxonomy)
CO1	Design and construct amplifiers and Oscillators for the given parameters.	S2
CO2	Demonstrate the switching characteristics of transistor in various electronics circuit such as multi-vibrator.	S2
CO3	Design and construct simple mathematical circuits using Opamp.	S2
CO4	Design Opamp based application circuits such as PPL, Schmitt trigger and filters etc.	S2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	M	-	-	-	-	L	-	L	M	-
CO2	H	H	M	M	M	-	-	-	-	L	-	L	M	-
CO3	H	H	-	M	-	-	-	-	-	L	-	L	M	-
CO4	H	H	-	M	-	-	-	-	-	L	-	L	M	-

g) Course Contents

EXP NO	NAME OF THE EXPERIMENT
1	Design and implement Schmitt Trigger using op-amp
2	Design an Instrumentation Amplifier using op-amp and calculate the CMRR.
3	Design an Active Low Pass and High Pass Filter using op-amp.
4	Design a Full wave Rectifier with fixed and variable Voltage Regulator ICs
5	Design an Astable Multivibrator using 555 Timer using buzzer and LDR
6	Design and analyze Voltage Divider Bias and compare its performance with Fixed bias. Justify the same as Phase Splitter.
7	Generate a desired frequency of RC Phase Shift Oscillator using BJT
8	Design a three stage Ring Oscillator using CMOS transistors

Total – 60 Hr

h) Learning ResourcesReferences:

References:

1. Bapat K N , Electronic Devices & Circuits , Mc Graw Hill,1992.
2. J. Millman and Halkias .C, " Integrated Electronics ",2nd Edition, Tata McGraw-Hill, 2001.
3. Donald L.Schilling and Charles Belove, 'Electronic Circuits', Tata McGraw Hill, 3rd Edition, 2003.
4. Yannis Tsividis, "A First Lab in Circuits and Electronics, J.Willy, 2002.

Website:

W1. https://www.coursera.org/lecture/sensors-circuit-interface/4-instrumentation-amplifier-uKGqk
W2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/108101091/lec51.pdf
W3. https://www.coursera.org/lecture/electronics/6-3-cmos-logic-gates-TA8qw
W4. https://www.fairchildsemi.com/application-notes/AN/AN-88.pdf

Course Code	Course Title	L	T	P	C
1151EC302	DIGITAL ELECTRONICS LAB	0	0	2	1

a) Course Category

Program core

b) Preamble

The aim of this course is to understand the fundamental and design of digital circuits using ICs and FPGA. Additionally this course includes design and implementation of combinational and sequential circuits using Verilog HDL and FPGAs.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Program the combinational and sequential circuits using Verilog HDL.	S2
CO2	Build the digital circuits using IC's.	S2
CO3	Demonstrate and implement the real time interfacing using FPGAs.	S3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	H	L	H	-	-	L	M	-	-	M	-	-
CO2	H	H	H	M	H	-	-	L	M	-	-	M	-	-
CO3	H	H	H	H	H	L	M	L	M	-	L	M	H	-

g) Course Content:

List of Experiments

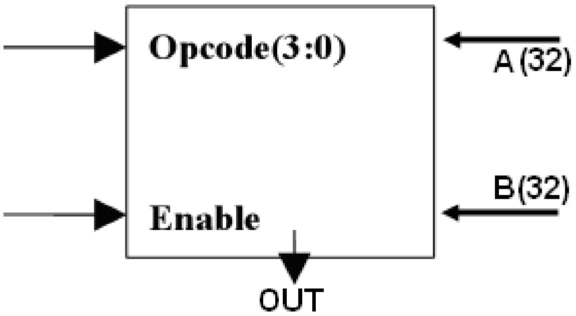
<u>Module 1 – Software</u> (CO1)

1. Write a Verilog program for the following combinational designs (a) Decoder (b) Encoder.

2. Write a Verilog program for the following combinational designs (a) Multiplexer (b) De-multiplexer.

3. Write a HDL code to describe the functions of a full adder using three modeling styles.

4. Write a model for 32 bit ALU using the schematic diagram shown below A(31:0).



   a. ALU should use the combinational logic to calculate an output based on the four bit op-code input.
   b. ALU should pass the result to the out bus when enable line in high, and tri-state the out bus when the enable line is low.
   c. ALU should decode the 4 bit op-code according to the given in example below.

OPCODE	ALU OPERATION
1.	A + B
2.	A – B
3.	A Complement
4.	A * B
5.	A AND B
6.	A OR B
7.	A NAND B
8.	A XOR B

5. Develop the Verilog code for the following flip-flops: SR, D, JK &T.

6. Write a Verilog code for 4 bit binary counter (Synchronous and Asynchronous).

<u>Module 2 – Hardware (</u> CO2)

7. Implementation of Synchronous and Asynchronous Counter using digital logic ICs.

Module 3 – Interfacing (CO3)

8. Write a Verilog code and realize all the logic gates using FPGA

9. Write HDL code to display messages on an alpha numeric LCD display using FPGA.

10. Write HDL code to interface hex key pad and display the key code on seven segment display using FPGA.

11. Write HDL code to accept analog signal from temperature sensor and display the data on LCD panel or seven segment display using FPGA.

12. Write HDL code to control speed, direction of DC/Stepper motor using FPGA.

Course Code	Course Title	L	T	P	C
1151EC303	**MICROPROCESSOR AND MICROCONTROLLER LAB**	**0**	**0**	**2**	**1**

a) Course Category

Program core

b) Preamble

The course objective is to introduce the basic concepts of microprocessor and to develop students in the assembly language programming skills and real time applications of Microprocessor as well as microcontroller.

c) Prerequisite

Nil

d) Related Courses

RTOS Lab, System on Chip

e) Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	a. Use the simulation software tools like 8086 Emulator, KeilC, and MPLAB IDE	S3
	b. Operate 8086 microprocessor, 8051 & PIC microcontrollers and interfacing devices like Keyboard/Display, ADC, DAC, Stepper motor, DC motor, and elevator	
CO2	Simulate/Implement the mathematical operations, string manipulation, and code conversions using 8086 microprocessor	S3

CO3	a. Develop Embedded C programs to interface external devices with 8051 microcontroller for the given specifications like different timer modes, baudrate, and timing delay	S3
	b. Compare and analyze the results of Embedded C programs written with pointers and without pointers	
CO4	Develop an Embedded C program for real time application using microcontroller	S3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	L	-	M	-	-	-	L	-	-	M	-	L
CO2	M	M	H	-	M	-	-	-	L	-	-	M	-	M
CO3	M	M	L	-	L	-	-	-	L	-	-	L	-	M
CO4	M	M	M	-	H	-		-	M	L		H	L	M

g) Course Content:

List of Experiments

EXP NO	EXPERIMENT NAME	CO
1	Write an assembly language program in 8086 microprocessor to perform various arithmetic and logical operations	CO1, CO2
2	Write an assembly language program in 8086 microprocessor to a. Find square root of a number b. Perform string manipulation	CO1, CO2
3	Write an assembly language program in 8086 microprocessor to convert an a. Binary to Gray code b. BCD to Binary code	CO1, CO2
4	Write a C program that reads in characters from the input stream and store it in ascending / descending order using Data Pointers	CO1, CO3

5	Write an assembly language program to interface 8051 chip with HEX keypad input and seven segment display output	CO1, CO3
6	Write a C program to generate a square waveform having equal duty cycles of 20ms using timer1 mode 1 operation with and without the use of pointers. Assume crystal frequency = 24MHz	CO1, CO3
7	Write a C program to transmit/receive the character using timer1 mode2, operating at a baudrate of 9600 and display the character using UART	CO1, CO3
8	Write a C program to a. Generate Sine/Square/Triangular waveforms with different frequency and amplitude using DAC b. Convert a particular analog input to its corresponding digital data	CO1, CO3
9	Write a C program to run a stepper motor in clockwise/anti clockwise motion with different step pattern	CO1, CO3
10	Write a C program to control the speed of a DC motor using pulse width modulation	CO1, CO3
11	Write a C program to interface an elevator using I/O ports to move the elevator to the user desired floor	CO1, CO3
12	Write a C program to generate a square waveform having equal duty cycles of 10ms using PIC16F8778 microcontroller	CO1, CO3
13	Write a C program to get an 8-bit data input through Port A and display it through Port B using PIC16F8778 microcontroller	CO1, CO3
14	Develop an Embedded C program for real time application using microcontroller	CO4

References:

1. Microcomputer Systems: The 8086/8088 Family Architecture Programming and Design, Second Edition, By Yu-Cheng Liu, Glenn A. Gibson,PHI publication.
2. A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing “, second edition, Tata McGraw-Hill .
3. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D McKinlay, The 8051 microcontroller and embedded systems using assembly and C, second edition Pearson education Asia.

Websites:

1. http://www.keil.com/support/man/docs/c51/
2. https://www.youtube.com/watch?v=HTPQb0EsaXg
3. https://www.youtube.com/watch?v=k9qv2M1fIrc
4. https://onlinecourses.nptel.ac.in/noc18_ec03/preview
5. https://nptel.ac.in/courses/108107029/

COURSE CODE	COURSE TITLE	L	T	P	C
1151EC307	SIGNALS AND SYSTEMS LAB	0	0	2	1

Course Category: Program Core

a. Preamble :

Signals & Systems laboratory course uses simulation software to demonstrate the generation, basic operations of signals like shifting, scaling and convolution etc. Students will also understand the applications of transformation techniques.

b. Prerequisite Courses:

Nil.

c. Related Courses:

Discrete Time Signal Processing and Digital Image Processing

d. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Dave's Taxonomy)
CO1	Perform basic signal processing concepts on signals	S2
CO2	Implement transformation techniques to analyze signals & systems	S2

e. Course Content:

List of experiments:

Experiment. No	Experiment Title	CO's
1	Generation of Signals	CO1
2	Basic Operations on Signals	CO1
3	Linear convolution and Correlation of sequences and signals	CO1
4	Properties of systems	CO1
5	Fourier series representation of continuous time signals	CO2
6	Fourier transform of continuous time signals	CO2

7	Sampling theorem	CO1
8	Discrete time Fourier analysis	CO2
9	Computation of DFT	CO2
10	Z transform of discrete time signals	CO2
11	System responses using SIMULINK	CO2
12	Amplitude modulation with sinusoidal and exponential carrier	CO2
13	Analysis of DT LTI systems	CO2

References:

T1. Vinay K. Ingle, John G. Proakis, "Digital Signal Processing Using MATLAB", 3 rd edition, Cedncage learning, 2012
T2. Zahir M. Hussain, Amin Z. Sadik, Peter O'Shea, "Digital Signal Processing: An Introduction with MATLAB and Applications", Springer-Verlag, 2011**.**
T3. John W. Leis, "Digital Signal Processing Using MATLAB for Students and Researchers", Wiley, New Jersey, 2011.
T4. Samuel D. Stearns, Donald R. Hush, "Digital Signal Processing with Examples in MATLAB", Second Edition, CRC Press, New York, 2002.

Website:

W1. https://in.mathworks.com/products/signal.html

W2. https://grader.mathworks.com/

W3. https://in.mathworks.com/products/matlab-grader.html

COURSE CODE	COURSE TITLE	L	T	P	C
1151EC305	COMMUNICATION LAB	0	0	2	1

a. Course Category:

Program Core

b. Preamble:

This course provides to demonstrate about all types of modulation techniques for both analog and digital communication systems

c. Pre-requisites:

Basic Electronics Engineering, Analog Electronics, Analog Communication Systems

d. Related Courses:

Nil

e. Course Outcomes:

Upon the successful completion of the course, students will be able to

CO'S	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Analyze the performance of Analog modulation techniques	S2
CO2	Become aware of sampling, quantization and encoding	S2
CO3	Simulate and analyze the performance of various digital modulation techniques	S2
CO4	Acquire knowledge about the fading channel and channel coding techniques	S2

g) List of Experiments

1. Construct and Implement the amplitude modulation and demodulation.
2. Construct and Implement the frequency modulation and demodulation.
3. Simulate the Sampling and Reconstruction of the analog Signal
4. Simulate the Pulse code modulation for the analog signal.
5. Construct and implement the frequency shift keying circuit.
6. Simulation and performance analysis of binary ASK in AWGN environment
7. Simulation and performance analysis of QPSK in AWGN environment
8. Simulate the quadrature amplitude modulation for the digital Signal.
9. Bit error rate performance analysis - Cyclic code encoding & decoding.
10. Simulation and performance analysis of digital modulation technique in fading channel

Course Code	Course Title	L	T	P	C
1151EC306	**OPTICAL AND MICROWAVE ENGINEERING LAB**	0	0	2	1

a) Course Category

Program core

b) Preamble

Optical and Microwave laboratory provides an opportunity to explore the concepts in optical devices and microwave systems in a laboratory setting with an emphasis on measurement techniques.

c) Prerequisite

Nil

d) Related Courses

Optical & Microwave Engineering.

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	a. Model geometry, assign port and boundary condition, simulate and verify S-Parameter/ Field distribution output using ANSYS HFSS software simulation tool. b. Design, simulate and analyze the characteristics of microstrip transmission line, distributed elements, Tee junctions and couplers using ANSYS HFSS software simulation tool.	S2
CO2	a. Setup microwave bench using Reflex klystron/ Gunn source and study its mode characteristics. b. Operate and Calibrate the microwave measuring equipment like VSWR Meter, Direct frequency meter and slotted section. c. Determine the characteristics of given microwave devices like Horn antenna and Unknown load.	S2
CO3	Design an appropriate length of fibre optic cable with less attenuation and dispersion for the given link budget and simulate the performance of the	S2

	link using Optiperformer tool	
CO4	Know the applications of Microwave Integrated circuits, devices and optical systems.	S2

f) Correlation of Cos with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	-	-	-	-	M	-	-	-	-	-
CO2	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CO3	M	-	-	-	-	-	-	-	M	-	-	-	-	-
CO4	M	M	-	-	-	-	-	-	M	-	-	-	-	-

g) Course Content:

List of Experiments

S.No.	Name of the Experiments	CO mapping of Experiments
1	Design and Analysis of a basic microstrip transmission line using Ansys HFSS	CO1
2	Calculate DC resistance of arbitrary metal structure using Q3D	CO1
3	Create, Simulate and Analysis of a silicon spiral inductor model	CO4
4	Design and Analysis of T – Junction using HFSS	CO1
5	Design of 3db branch line coupler using HFSS	CO1
6	Study of mode characteristics of reflex Klystron	CO2
7	Measurement of gain and Radiation Pattern of Horn Antenna	CO2
8	VSWR Measurement of Unknown Load	CO2
9	Modeling of a basic fiber optic system consisting of a transmitter, fiber and a receiver	CO3
10	Design of an attenuation-limited fiber length based on the power budget equation	CO3
11	Design of a dispersion – limited fiber length for a fiber optic transport system	CO3

Course Code	Course Title	L	T	P	C
1152EC101	**VLSI SIGNAL PROCESSING**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This Course provides the basic and design knowledge about VLSI Signal Processing which involves DSP Technology, algorithmic and Numeric strength reduction and pipelining and parallel processing.

c) Prerequisite

Digital Electronics, Digital Signal Processing, VLSI design

d) Related Courses

Low Power VLSI

e) Course educational objectives

i) To understand the various VLSI architectures for digital signal processing.
ii) To introduce techniques for altering the existing DSP structures to suit VLSI implementations.
iii) To explains how to design high-speed, low-area, and low-power VLSI systems for a broad range of DSP applications.

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Illustrate design architectures for DSP algorithms	K3
CO2	Apply retiming and algorithmic strength reduction technique optimize design parameters	K3
CO3	Apply high level algorithm transformation to optimize design parameters.	K3
CO4	Apply various Bit-level arithmetic architecture to design the multipliers	K3
CO5	Apply numeric strength reduction to reduce area and power in digital	K3

	filters	

g) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	L	-	-	L	-	-	-	-	-	-	-
CO2	M	H	M	M	L	-	-	-	-	-	-	-	-	-
CO3	M	H	M	M	M	-	-	-	L	-	-	-	L	-
CO4	H	M	M	M	H	-	-	-	L	L	-	M	M	-
CO5	M	H	M	-H	M	L	-	L	L	L	L	M	-	-

I) Course Content

UNIT I INTRODUCTION TO DSP SYSTEMS 9

Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, iteration bound, longest path matrix algorithm. Introduction to pipelining and parallel processing.

UNIT II RETIMING, ALGORITHMIC STRENGTH REDUCTION 9

Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction -Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter

UNIT III FAST CONVOLUTION 9

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm – Winograd Algorithm-cyclic convolution – design of fast convolution algorithm by inspection

UNIT IV PIPELINIG AND PARALLEL RECURSIVE AND ADDAPTIVE FILTERS 9

Introduction – pipelined interleaving in digital filters –pipelining in 1st order IIR digital filters and higher order IIR digital filters –parallel processing for IIR filter low power IIR filter design using pipeline and parallel processing – pipelined Adaptive digital filters

UNIT V NUMERICAL STRENGTH REDUCTION 9

Numerical strength reduction – subexpression elimination, multiple constant multiplication, subexpression sharing in digital filters – Additive and multiplicative number splitting

Total 45 Hrs

II Learning Resources

Text Books

1. Keshab K.Parhi, “VLSI Digital Signal Processing Systems, Design and Implementation”, John Wiley, Indian Reprint, 2007.
2. S.Y.Kuang, H.J. White house, T. Kailath, “VLSI and Modern Signal Processing”, Prentice Hall, 1995

Reference Books

1. U. Meyer –Baese, "Digital Signal Processing with Field Programmable Arrays", Springer, Second Edition, Indian Reprint, 2007

Online Resource

1. https://books.google.co.in/books?isbn=8126510986
2. **http://nptel.iitg.ernet.in/**

Practical Aspects.

After implementing design and analyzing implementation results, the following methods to improve design performance prior to programming and configuring your device:

Optimize timing performance, using any of the following methods:

1. Use synthesis techniques, such as proper coding, as described in Using Synthesis Techniques to Improve Timing Performance.
2. Use timing constraints, as described in Optimizing Design Constraints.
3. Floorplan your design, as described in Flo o rplanning with P lanAhead™ So ftware.

Experiment with implementation options, also known as process properties, using any of the following methods:

1. Modify individual process properties, as described in Design Performance Techniques for FPGAs.
2. Use predefined Design Goals and Strategies provided to modify sets of process properties, as described in Using Design Goals and Strategies.
3. Use SmartXplorer to run multiple implementation flows using different sets of process properties, as described in Using SmartXplorer.
4. Use FPGA Editor to make modifications to your FPGA design.
5. You can use FPGA Editor to check that your design was implemented as expected, and then use it to fine-tune your design, as described in Implementation Strategies using FPGA Editor.

Use techniques to reduce area utilization, power consumption, memory use, and runtime and to preserve design results as follows:

1. Use coding techniques to reduce area utilization and power consumption, as described in Using RTL Coding and Synthesis Techniques to Reduce Area Utilization and Power Consumption.
2. Use constraints and process properties to reduce memory use and runtime, as described in Memory Use and Runtime Strategies for FPGAs.
3. Use SmartGuide™ technology to use results from a previous implementation to guide the next implementation. This helps to reduce runtime, preserve logic, and meet timing, as described in Using SmartGuide Technology.
4. Use Partitions to reuse or preserve certain modules in your design during implementation, as described in the Partitions Overview.

Course Code	Course Title	L	T	P	C
1152EC102	**LOW POWER VLSI DESIGN**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course provides the basic and design knowledge about low power VLSI which involvessources of power dissipation, power optimization techniques and power estimation

c) Prerequisite

VLSI Design

d) Related Courses

VLSI Design Techniques, Analog VLSI Design

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the sources of power dissipation in CMOS	K2
CO2	Classify the special techniques to mitigate the power consumption in VLSI circuits	K2
CO3	Summarize the power optimization and trade-off techniques in digital circuits.	K2
CO4	Illustrate the power estimation at logic and circuit level	K2
CO5	Explain the software design for low power in various level	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	H	H	M	L	-	-	-	-	-	-	-	H	M	-
CO2	H	L	M	H	-	-	-	-	-	-	-	L	H	-
CO3	M	L	H	M	-	-	-	-	-	-	-	L	L	-
CO4	H	H	M	H	-	-	-	-	-	-	-	M	M	-
CO5	M	M	H	H	-	-	-	-	-	-	-	H	L	-

g) Course Content

UNIT I POWER DISSIPATION IN CMOS 9

Sources of power dissipation – Physics of power dissipation in MOSFET devices: The MIS structure, long channel MOSFET, Submicron MOSFET , gate induced drain leakage– Power dissipation in CMOS : short circuit dissipation, dynamic dissipation, load capacitance– Low power VLSI design: Limits – principles of low power design, hierarchy of limits, fundamental limit, material limit, device limit, system limit.

UNIT II POWER OPTIMIZATION USING SPECIAL TECHNIQUES 9

Power Reduction in Clock Networks: Clock Gating, Reduced Swing Clock, Oscillator Circuit for Clock Generation, Frequency Division and Multiplication, Other Clock Power Reduction Techniques - CMOS Floating Node: Tristate Keeper Circuit, Blocking Gate, Low Power Bus: Low Swing Bus, Charge Recycling

Bus, Delay Balancing - Low Power Techniques for SRAM: SRAM Cell, Memory Bank Partitioning, Pulsed Word line and reduced bit line Swing

UNIT III DESIGN OF LOW POWER CIRCUITS 9

Transistor and Gate Sizing : Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction - Network Restructuring and Reorganization : Transistor Network Restructuring, Transistor Network Partitioning and Reorganization - Special Latches and Flip-flops : Self-gating Flip-flop, Combinational Flip-flop, Double Edge Triggered Flip-flop - Low Power Digital Cell Library : Cell Sizes and Spacing, Varieties of Boolean Functions, Adjustable Device Threshold Voltage

UNIT IV POWER ESTIMATION 9

Modelling of signals - signal probability calculation - Statistical techniques - estimation of glitching power- Sensitivity analysis-Power estimation using input vector compaction, power dissipation in Domino logic, circuit reliability, power estimation at the circuit level, Estimation of maximum power: test generation based approach, steepest descent, generic based algorithm based approach

UNIT V SOFTWARE DESIGN FOR LOW POWER 9

Sources of software power dissipation - software power estimation: Gate level, architecture level, bus switching activity, instruction level power analysis - software power optimization: minimizing memory access costs, instruction selection and ordering, power management - Automated low power code generation – Co-design for low power.

Total 45 Hrs

i) Learning

Resources Text

Books

1. Kaushik Roy and S.C.Prasad, "Low power CMOS VLSI circuit design", Wiley, 2000
2. A.P.Chandrasekaran and R.W.Broadersen, "Low power digital CMOS design", Kluwer,1995
3. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998

Reference Books

1. DimitriosSoudris, Christians Pignet, Costas Goutis, "Designing CMOS Circuits for Low Power", Kluwer, 2002
2. J.B.Kulo and J.H Lou, "Low voltage CMOS VLSI Circuits", Wiley 1999
3. AbdelatifBelaouar, Mohamed.I.Elmasry, "Low power digital VLSI design", Kluwer, 1995
4. James B.Kulo, Shih-Chia Lin, "Low voltage SOI CMOS VLSI devices and Circuits", John Wiley And sons, inc. 2001
5. Steven M.Rubin, "Computer Aids for VLSI Design", Addison Wesley Publishing

Online Resources

1. http://nptel.ac.in/syllabus/106105034/
2. https://www.youtube.com/watch?v=LjDb6VQlOeQ
3. http://freevideolectures.com/Course/3059/Low-Power-VLSI-Circuits-and-Systems
4. http://www.springer.com/us/book/9788132219361

Course Code	Course Title	L	T	P	C
1152EC103	**SILICON VALIDATION**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

The purpose of this course is to know the basics of testing, test generation of combinational circuits, sequential circuits and design strategies for test and system level test.

c) Prerequisite

VLSI Design.

d) Related Courses

Low Power VLSI, Analog VLSI Design.

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basics of Testing and Fault Modeling	K2
CO2	Illustrate the logical and fault simulation techniques.	K2
CO3	Classify the various test generation algorithms for sequential and combinational circuits.	K2
CO4	Summarize the design strategies for test, system level and memory test.	K2
CO5	Explain the concept of Built In Self Test for digital systems and its methodology.	K2

f) Correlation of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO9	PO10	PO1 1	PO1 2	PSO 1	PSO 2
CO1	H	M	L	-	-	L	L	-	-	-	-	L	L	-

CO2	H	L	M	-	M	-	-	-	L	-	-	L	L	-
CO3	M	H	L	M	-	-	-	-	L	-	-	L	L	-
CO4	H	L	M	-	-	-	-	L	-	L	-	M	L	-
CO5	H	M	M	L	L	-	-	-	L	-	-	M	L	-

g) Course Content

UNIT I BASICS OF TESTING 9

Need for Testing, Testing at Various Levels, Objectives of Testing - VLSI Test process and Test Equipment

- Types of Testing: Functionality Tests, Silicon Debug, Manufacturing Tests, Defect during manufacturing
- Fault Modelling, Observability and Controllability, Fault Coverage, Fault Sampling - ATE, Test economics.

UNIT II LOGICAL AND FAULT SIMULATION 9

Simulation for design verification, Simulation for Test evaluation - logical and fault simulation, Characteristics of Fault Simulation, Classical Fault Simulation Techniques, Modern Fault Simulation for Combinational Circuits - Hardware Approaches to Fault Simulation.

UNIT III COMBINATIONAL AND SEQUENTIAL CIRCUITS TEST GENERATION 9

Combinational Circuits: Algorithms representations, Redundancy Identification (RID), Significant Combinational ATPG Algorithms, Test Generation, Test Compaction - Sequential Circuits: ATPG for single clock synchronous circuits, Time-Frame expansion method, Simulation based sequential circuits.

UNIT IV DESIGN STRATEGIES FOR TEST AND SYSTEM LEVEL TEST 9

Design for Testability, Ad hoc Testing, Scan Based Test Techniques, Memory Testing, IDDQ Testing, IDDQ testing Methods - Boundary Scan, Boundary Scan Architecture, Test Access Port (TAP), TAP Controller, Instruction Registers, Data Register, Boundary Scan Register, Bypass Register.

UNIT V BUILT IN SELF TEST 9

Buit In Self Test, Test Pattern Generation for BIST, Circular BIST, BIST Architectures - Testable Memory Design, Test Algorithms, Test Generation for Embedded RAMs, BIST for Delay Fault Testing.

Total 45 Hrs

h) Learning

Resources Text

Books

1. Weste and Eshraghian, “Principles of CMOS VLSI design”, Pearson Education, 1999
2. M.L. Bushnell and V.D. Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits”, Kluwer Academic Publishers, 2004

3. P.K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002
4. N.K. Jha and S.G. Gupta, “Testing of Digital Systems”, Cambridge University Press, 2003

Reference Books

1. W. W. Wen, “VLSI Test Principles and Architectures Design for Testability”, Morgan Kaufmann
2. A.L.Crouch, “Design Test for Digital IC’s and Embedded Core Systems”, Prentice Hall International, 2002.
3. ZainalabeNavabi, “Digital System Test and Testable Design: Using HDL Models and Architectures”, Springer, 2010
4. A.K Sharma, Semiconductor Memories Technology, Testing and Reliability, IEEE.
5. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House

Online Resources

1. www.nptel.ac.in/courses/106103016

Course Code	Course Title	L	T	P	C
1152EC104	**ANALOG VLSI DESIGN**	3	0	0	3

a) Course Category

Program elective

b) Preamble

The goal of this course is to understand the fundamentals of CMOS analog VLSI design, single-stage, CMOS operational amplifiers, Data Converters and switched Capacitor Circuits

c) Prerequisite

Analog Circuits and VLSI design

d) Related Courses

Low power VLSI

e) Course educational objectives

1. To study the concepts of MOS large signal model and small signal model
2. To understand the characteristics of Data conversion methods and their Performances.
3. To design the CMOS amplifiers.
4. To study about the switched capacitor circuits.

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Identify the mathematical models in CMOS analog electronics circuits	K2
CO2	Discuss the Analog CMOS Sub circuits like reference Current Source and current mirrors.	K2
CO3	Apply the Two Stage and cascade Op Amps in CMOS Circuits	K3
CO4	Explain the Data converters in CMOS Circuits	K2
CO5	Describe the effects of Switched capacitance Amplifier and its characteristics.	K2

g) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	-	-	-	-	-	-	-	-	-	-	-
CO2	L	L	L	-	-	-	-	-	L	-	-	-	-	-
CO3	M	H	H	H	-	-	L	-	-	-	-	L	-	-
CO4	M	L	L	-	L	-	-	L	-	-	L	L	L	-
CO5	M	L	L	-	-	-	-	-	-	L	-	L	-	-

h) Course Content

UNIT I INTRODUCTION AND CMOS DEVICE MODELING 9

Introduction of MOS Devices - Challenges in analog design- characteristics large signal model – small signal model- single stage Amplifier-Source follower-Sub threshold MOS model.

UNIT II ANLOG CMOS SUBCIRCUITS 11

MOS Diode active resistor, Capacitors and resistors, current sinks and sources, Current mirrors, Current and voltage References, Bandgap Reference

UNIT III CMOS OPERATIONAL AMPLIFIER 8

Design of CMOS Op Amps, Compensation of Op Amps, Design Of two stage Op Amps, Power-supply Rejection Ratio of Two stage Op Amps, Cascode Op Amps.

UNIT IV DATA CONVERTERS 8

Characterization of Digital to Analog Converters-static Characteristics of DAC-Differential Non Linearity-Integral Non linearity, Characterization of Analog to Digital Converters- static Characteristics of ADC

UNIT V SWITCHED CAPACITOR CIRCUITS 9

Resistors Emulation, Analysis Method for switched capacitor circuits using two phase non overlapping clocks, Switched capacitor Amplifier-Summing Amplifier, Switched Capacitor Integrator-Continuous time integrator.

Total 45 Hrs

i) Learning Resources

Text Books

1. Philip E. Allen, Douglas R. Halberg, “CMOS Analog Circuit Design”, Oxford University Press, 2nd Edition, 2003
2. Yannis Tsividis,”Mixed Analog-Digital VLSI Devices and Technology”,McGraw-Hill Publication, 2nd Edition, 1999

Reference Books

1. Vineetha P.Gejji Analog and Mixed Mode Design - Prentice Hall, 1st Edition , 2011

2. JeyaGowri Analog and Mixed Mode Design- Sapna publishing House 2011

Online Resources

1. **https://www.google.co.in/search?hl=en-IN&source=hp&biw=&bih=&q=ANALOG+VLSI+DESIGN+.PPT&btnG=Google+Search&gbv=1**

Course Code	Course Title	L	T	P	C
1152EC105	VLSI DESIGN TECHNIQUES	3	0	0	3

a) Course Category

Program Elective

b) Preamble

This course introduces basic techniques and algorithms for physical design and optimization of VLSI circuits. The necessary background in graph theory and mathematical optimization, application of different analytical and algorithmic techniques to physical design of VLSI circuitswill be studied. The students shall emphasize VLSI design issues encountered in deep submicron technology. Throughout the course, students will be exposed to research methodology and to a set of academic and commercial CAD tools for physical design.

c) Prerequisite

VLSI Design

d) Related Courses

Low Power VLSI Design, Analog VLSI Design

e) Course Outcome

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the design automation algorithms and various constraints posed by VLSI fabrication and design technology.	K2
CO2	Illustrate the layout optimization techniques and map them to the algorithms.	K2
CO3	Classify the design algorithms to meet the physical design parameters.	K2
CO4	Summarize VLSI interconnects and routing strategies in deep sub-micron.	K2

CO5	Restate sub-micron challenges and relate them to issues in physical synthesis of ICs.	K2

f) Correlation of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	-	-	-	L	-	-	-	M	M	-
CO2	H	L	M	H	-	-	-	L	-	-	-	L	M	-
CO3	M	L	H	M	-	-	-	L	-	-	-	L	L	-
CO4	H	H	M	H	-	-	-	L	-	-	-	M	M	-
CO5	M	M	H	H	-	-	-	L	-	L	-	M	L	-

g) Course Content

UNIT I DESIGN METHODS AND AUTOMATION TOOLS 9

Design domains and Actions – Design methods and Technologies – Levels of abstractions in Design Automation tools – Graph terminology – data structures for the representation of graphs –Computational complexity – Graph Algorithms: Depth-First Search Algorithm, Breadth-First Search Algorithms and Dijikstra’s Shortest path Algorithms.

UNIT II LAYOUT DESIGN 8

Design Rules – Symbolic Layout – Problem Formulation: Applications of compaction, Informal Problem formulation, Graph theoretical formulation, Maximum design constraints, Algorithms for Constraintgraph compaction.

UNIT III PLACEMENT, PARTITIONING AND PLANNING 10

Circuit Representation – Wire length estimation – Placement Problems – Placement Algorithms: Constructive placement, Iterative improvements – Partitioning: K-Lin Partitioning Algorithms - Floorplanning concepts: Terminology and Floorplan representation, Optimization problems in Floorplanning – Shape functions and Floorplan sizing.

UNIT IV ROUTING 9

Local routing problems – Area routing – Channel routing: Models, The vertical constraint graphs, horizontal constraints and left-edge algorithms, Channel Routing Algorithms – Global Routing: Standard cell layout, Building-block layout and Channel ordering, Algorithms for Global Routing: Problem definition and discussion, efficient rectilinear Steiner-Tree construction, Local transformations for Global Routing.

UNIT V SIMULATION, SYNTHESIS AND VERIFICATION 9

Gate level modelling: Signal Modelling, Gate modelling, Delay modelling, Connectivity modelling, Compiler driven simulation, Event driven simulation – Switch level modelling: Connectivity and Signal Modelling, Simulation Mechanisms – Combinational logic synthesis, Binary Decision Diagrams, Two level logic synthesis.

Total 45 Hrs

h) Learning Resources

Text Books

1. Sabih H. Gerez, “Algorithms for VLSI Design Automation,” Wiley India Pvt Ltd, 2006.
2. Naveed A. Sherwani, “Algorithms for VLSI Physical Design Automation,” Springer, 2005.

Reference Books

1. Charles J Alpert, Dinesh P Mehta, Sachin S Sapatnekar, “Handbook of Algorithms for Physical Design Automation,” CRC Press, 2008.
2. M. Sarrafzadeh and C.K. Wong, “An Introduction to VLSI Physical Design,” McGraw Hill, 1996.

Course Code	Course Title	L	T	P	C
1152EC106	**VLSI FOR WIRELESS COMMUNICATION**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

The purpose of this course is to understand the knowledge of VLSI for Wireless Communication and also emphasis on the fundamentals design of wireless systems as well as Transmitter, Receiver, mixers, frequency synthesizers and Power Amplifier.

c) Prerequisite

VLSI Design, Linear Integrated Circuits, Digital Communication and Communication Systems

d) Related Courses

Wireless Communication Networks and Wireless technologies

e) Course educational objectives

i) To Gain the basic Knowledge of Low noise Amplifier and Power Amplifier.
ii) To Study the Transmitter and receiver architectures of VLSI for wireless Communication.
iii) To understand the various types of mixers designed for wireless communication.
iv) To introduce the application of frequency synthesizers.

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the Low Noise Amplifier which includes wideband, narrow band for impedance matching and Core Amplifier	K2
CO2	Illustrate the Transmitter Architectures and Power Amplifier	K3
CO3	Describe the types of mixer and its parameters	K2
CO4	Explain the application of frequency synthesizers	K2
CO5	Illustrate the Receiver Architectures	K3

g)Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	M	L	-	-	L	L	-	L	-	-
CO2	M	M	L	L	M	L	L	-	L	L	-	L	-	-
CO3	M	L	L	L	M	-	-	-	-	-	-	-	-	-
CO4	M	L	L	L	M	-	-	-	-	-	-	L	-	-
CO5	M	L	L	L	M	L	L	-	L	L	-	L	L	-

h) Course Content

UNIT I OVERVIEW OF WIRELESS COMMUNICATION SYSTEMS 9

Introduction of wireless system, Low Noise Amplifier – Matching Network, Wideband LNA –DC Bias-Gain and frequency Response-Noise Figure, Narrowband LNA - Impedance Matching-Matching of Imaginary and real Part-Interpretation of Power Matching, Core Amplifiers-Noise Figure-Power Dissipation, Trade-Off and Noise contribution from Other Sources

UNIT II TRANSMITTER ARCHITECTURE AND POWER AMPLIFIER 9

Transmitter Back End, Quaderature LO generator-Single ended RC and LC, R-C with Differential stages-Polyphase IQ generator-Divider based generator, Power Amplifier Design.

UNIT III MIXERS 9

Active Mixer: Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion - Analysis of Gilbert Mixer of Low Frequency Case and High-Frequency Case -Noise.

Passive Mixer: Switching Mixer – Distortion, Conversion Gain and Noise in Unbalanced Switching, Conversion Gain, Sampling Mixture,Gain,Distortion and noise in Single Ended Sampling Mixer.

UNIT IV FREQUENCY SYNTHESIZER 9

Phase Locked Loops - Phase Detector - VCO - Dividers - LC Oscillators - Ring Oscillators - Phase Noise – Loop Filter-First order filter-Second order filter, High Order filter , Digital Enhanced Cordless Telecommunication.

UNIT V RECEIVER ARCHITECTURE 9

Receiver Front end-Filter Design-Band selection Filter, Image Rejection Filter, Channel Filter, Rest of receiver front end- non idealities and design parameters, Derivation of Noise Figure(NF) and input third order Intercept points(IIP3) of receiver front end, Partitioning of required NF and IIP3 of receiver front end into individual NF and IIP3

Total 45 Hrs

i) Learning Resources

Text Books

1. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2nd edition, 2002.
2. Carols and M. Stewart, "CMOS Wireless Transceiver Design," Boston, Kluwer Academic Publication, 1997

Reference Books

1. Thomas H.Lee, "The Design of CMOS Radio –Frequency Integrated Circuits', Cambridge University Press ,2003.
2. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI Wireless Design - Circuits and Systems", Kluwer Academic Publishers, 2000.
3. BehzadRazavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 1999.

Online Resource

1. www.nptelvideos.in/2012/12/wireless-communication.html
2. www.springer.com/us/book/9781461409854/.

Course Code	Course Title	L	T	P	C
1152EC238	**RECONFIGURABLE COMPUTING WITH FPGA**	**1**	**0**	**4**	**3**

a) Course Category

Program Elective

b) Preamble

Recent advances in VLSI technology have given upswing to a fresh class of computer architectures which take advantage of application-level parallelism. These reconfigurable computers can be quickly customized at the hardware level to perform exactly the computation required in hardware, overcoming the fixed hardware configurations found in many contemporary microprocessors. In this course, students will understand the state-ofthe-art in reconfigurable computing both from a hardware and software perspective.

c) Prerequisite

VLSI Design

d) Related Courses

System on Chip

e) Course Outcomes

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

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Build reconfigurable system using HDL and FPGAs.	S1
CO2	Perform partial reconfiguration for various applications using peripheral devices.	S2
CO3	Demonstrate an embedded system on FPGA using IP blocks.	S3

f)	Correlation of COs with POs													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	M	M	H	M	H	-	-	-	-	L	-	M	M	-
CO2	M	L	H	M	H	L	L	-	-	L	-	M	M	L
CO3	M	L	H	M	H	L	L	-	L	L	-	M	M	M

g)Examination Scheme for practical dominated course										
Internal evaluation (40M)							**Semester end evaluation (60M)**			
Laboratory experiment (15M)				**Model laboratory test (25M)**			**Part-A (20M)**	**Part-B (40M)**		
Performance in conducting experiment (5)	Result and analysis (3)	Viva Voce (3)	Record (4)	Performance in conducting experiment (15)	Result and analysis (5)	Viva Voce (5)	Theory questions to evaluate the knowledge and understanding (20)	Performance in conducting experiment (25)	Result and analysis (10)	Viva-Voce (5)

h)Course Content

Theory **15 Hours**

Reconfigurable Computing: Reconfigurable Computing Systems, Evolution and Characteristics, Advantages and Issues, Fundamental Concepts and Design Steps, Domain Specific Processors and Application Specific Processors.

Reconfigurable Architectures: Classification of Reconfigurable Architectures, FPGA Technology and Architectures, LUT devices and Mapping, Placement and Partitioning.

Interconnections in Reconfigurable Architectures: Routing and Switching concepts.

Programming Technology: HDL Based Programming and High level Synthesis using C, Partial Reconfiguration.

Intellectual Property Based Design: Soft core, Firm core and Hard Core, Software tools.

i)List of experiments

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	Introduction to Software and Hardware Tools
2.	CO1	Design of VLSI Subsystems using Verilog HDL.
3.	CO1	Implementation of an Arithmetic and Logical Unit on FPGA.
4.	CO1	Design of Finite State Machine using Verilog HDL.
5.	CO2	Implementation and Analysis of VLSI Subsystems in FPGAs.
6.	CO2	Implementation of Filters.
7.	CO2	Interfacing GPIOs and PMODs with FPGA.
8.	CO2	Signal Generation and AD-DA Interfaces.
9.	CO2	Implementation of IP Cores in FPGA.
10.	CO2	Interfacing Sensors and Display Devices with FPGA.
11.	CO3	Study and Implementation of Micro blaze processor.
12.	CO3	Study and Implementation of Zynq Processing system.
13.	CO3	Design and Implementation of an Embedded System in FPGA.

Total 75hrs

j)Learning Resources

Textbooks

1. S. Hauck ,"Reconfigurable Computing: Theory and practice of FPGA based Computation", Morgan Kaufmann, 2008.
2. Simon, "Programming FPGA's : Getting started with Verilog:, McGraw – Hill Education,2016.
3. Wayne Wolf, "FPGA-Based System Design", Pearson Education, 1e, 2005.
4. S. Palnitkar,"Verilog HDL",Pearson Education, 1e, 2003.

List of Major Equipment/ Instrument/Software with Broad Specifications

1. Xilinx VIVADO 2017 (Licensed version)

2. Basys 3
3. Nexys Video
4. ZYBO

List of Software/Learning Websites

1.http://www.verilog.com/ **Online resources**

1. Prof. Ken Eguro, University of Washington, Video lecture on Reconfigurable Computing, Sponsored by Microsoft Research
2. https://www.microsoft.com/en-us/research/video/candidate-talk-reconfigurable-computingarchitectural-and-design-tool-challenges/

Course Code	Course Title	L	T	P	C
1152EC242	**FPGA Architecture Technologies And Tools**	**2**	**0**	**2**	**3**

a) Course Category

Program Elective

b) Preamble

This course discusses the features, programming and applications of Programmable Logic Devices. The students shall emphasize the VLSI architectures such as Altera series Max 5000/7000 series, cypress flash, Virtex-II, Flex architectures, case study. It provides VLSI system design experience using FSM. This course fdintroduce the VHDL models, process, concurrent and sequential statements, loops, delay models, library packages, functions, procedures, test bench and Digital Front End Digital Design Tools

c) Prerequisite

VLSI Design

d) Related Courses

Reconfigurable Computing With FPGA

e) Course Outcome

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Illustrate the features of Programmable Logic Devices, CPLD, performance and its	K2
CO2	Summarize the various FPGA architectures, programmable interconnects and one hot	K2
CO3	Explain the VLSI system design experience using FSM.	K2
CO4	Account for the syntax and behavior of the VHDL language	K2
CO5	Explain the Digital Front End Digital Design Tools for FPGAs & ASICs	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	H	H	M	L	-	-	-	-	-	-	-	H	M	-
CO2	H	L	M	H	-	-	-	-	-	-	-	L	H	-
CO3	M	L	H	M	-	-	-	-	-	-	-	L	L	-
CO4	H	H	M	H	-	-	-	-	-	-	-	M	M	-
CO5	M	M	H	H	-	-	-	-	-	-	-	H	L	-

g) Course Content

UNIT I PROGRAMMABLE LOGIC DEVICE 9

Introduction, ROM, PLD, PLA, PAL, GAL– Features, CPLD- Commercially available CPLD - Altera series – Max 5000/7000 series - Cypres FLASH 370 Device Technology, Lattice LSI's Architectures – 3000 Series –Applications of CPLDs, Speed Performance and in system programmability.

UNIT II FIELD PROGRAMMABLE GATE ARRAYS 9

FPGAs- Logic blocks, Routing architecture, programmable interconnect, Mapping for FPGAs, Xilinx FPGA Architecture: Xilinx XC3000, XC4000 – Altera Architecture: FLEX 8000, One hot encoding, Case studies: Xilinx Virtex II Pro.

UNIT III FINITE STATE MACHINES 9

Top down Approach to Design, State diagram, State Transition Table, State assignments for FPGAs, Case study Mealy & Moore Machines, Pipelining, FSM issues-Starring state, Power on Reset, State diagram optimization, fault Tolerance.

UNIT IV VHDL FOR SYNTHESIS 9

Introduction, data flow, behavioral, structural models, operators, process, concurrent statements, Sequential Statements, Loops, Modeling Delays, Sequential Circuits, FSM Coding, Library, Packages, Functions, Procedures, Test bench.

UNIT V DIGITAL FRONT END DESIGN TOOLS 9

Digital Front End Design Tools for FPGAs & ASICs: Using Mentor Graphics EDA Tool ("FPGA Advantage") – Design Flow Using FPGAs – Guidelines and Case Studies of paraller adder, multiplexers, counters, CMOS design using Mentor graphics Tools.

List of experiments

S. No	Practical Exercises (15 Hours)	COs
1.	Introduction to Software and Hardware Tools	CO1, CO2
2.	CMOS inverter design using Mentor graphics Tools	CO5
3.	Delay Modelling using VHDL	CO4
4.	Implementation of Parallel Adder using VHDL	CO5
5.	Implementation of counters using VHDL	CO3
5.	FSM Coding	CO3

Total: 60 hours

h) Learning Resources

Text Books

1. P.K.Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall (Pte), 1994.
2. M. J. S. Smith, “Application Specific Integrated Circuits,” Addition – Wesley Longman Inc., 1997.
3. VHDL Primer, J. Bhasker, American Telephone and Telegraph Company, Bell Laboratories Division, P T R Prentice Hall, Englewood Cliffs, New Jersey07632
4. Douglas L. Perry, VHDL: Programming by Example, McGraw-Hill Education, Fouth Edition.
5. S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer, Academic Publications, 1994.

Reference

1. Jon F Wakerly, Digital Design: Principles and Practices, Prentice Hall.
2. Kevin Skahil, VHDL for programmable logic, Addison Wesley.
3. J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, 1995.
4. S.Brown, R.Francis, J.Rose, Z.Vransic, Field Programmable Gate Array, Kluwer Pubin, 1992.

Course Code	Course Title	L	T	P	C
1152EC143	**ARCHITECTURAL DESIGN OF DIGITAL INTEGRATED CIRCUITS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course explains the fundamental principles of algorithms available for performing arithmetic operations on digital computers.

c) Prerequisite

Digital Electronics

d) Related Courses

Low power VLSI

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe any algorithm to efficient architecture mapping	K2
CO2	Construct various adder architecture	K2
CO3	Construct various multiplier architecture	K2
CO4	Describe CORDIC architecture with any applications	K2
CO5	Illustrate the timing issues in VLSI	K2

f)	**Correlation of COs with POs**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	H	H	M	L	M							H	M	
CO2	H	L	M	H	L							L	H	

CO3	M	L	H	M		M	L					L	L	
CO4	H	H	M	H	L							M	M	
CO5	M	M	H	H	L							H	L	

g) Course Content

UNIT I ALGORITHM TO EFFICIENT ARCHITECTURE MAPPING 9

One bit incrementer, four bit incrementer, n-bit incrementer, ones' complement, two's complement, sum of N –natural numbers, prioritization, greatest common divisor (GCD).

UNIT II ADDER ARCHITECTURE 9

Single bit addition, Carry – Ripple adder, Carry – Skip adder, Carry-Lookahead adder, Carry –Select adder, Carry – Increment adder, Tree adder.

UNIT III MULTIPLIERARCHITECTURE 9

Tree multiplication, Array multiplication, signed multi-operand addition, squaring, shift and add multiplier, synchronous shift and add multiplier, Booth algorithm.

UNIT IV CORDIC ARCHITECTURE 9

CORDIC method, rotation and vectoring mode, convergence, precision and range, scaling factor and compensation, implementations: word-serial and pipelined, New techniques – Micro rotation to Angel Recoding (MAR), Binary to Bipolar Recoding (BBR).

UNIT V ISSUES IN TIMING CLOSURE 9

Static and Dynamic timing analysis, System Considerations - edge triggered, clock skew, handling asynchronous inputs, sequential machine, clock cycle time, Violation – maximum propagation delay, race through, Re-timings.

Total 45 Hrs

h) Learning Resources

Text Books

1. BehroozParhami, "Computer Arithmetic Algorithms and Hardware Designs", second edition, Oxford University Press, 2010
2. M. D. Ercegovac and T. Lang . "Digital Arithmetic", Elsevier Science (USA).2003

Reference Books

1. Ulrich W. Kulisch . “Advanced Arithmetic for the Digital Computer”, Springer-Verlag Wien, 2002.

Online resources

1. https://www.youtube.com/watch?v=iQHmtEtEggY

Course Code	Course Title	L	T	P	C
1152EC144	**SOLID STATE DEVICES**	**3**	**0**	**0**	**3**

a) Course Category

Programme Elective

b) Preamble

To impart knowledge on physics of semiconductors, transport of carriers in semiconductors and semiconductor based devices.

c) Prerequisite

None

d) Related Courses

Basic Electronics Engineering

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Understand the physics of semiconductors	K2
CO2	Understand the carrier transport mechanisms in semiconductors	K2
CO3	Gain a thorough understanding of PN junctions	K2
CO4	Analyze and understand the physics of operation of bipolar junction transistor	K2
CO5	Analyze and understand the physics of operation of MOS capacitor and MOSFET	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**H**	**M**	-	**L**	-	-	-	-	-	-	-	**M**	-	-
CO2	**H**	**M**	-	**M**	-	-	-	-	-	-	-	**M**	-	-

CO3	**H**	**H**	**-**	**L**	**-**	**-**	**-**	**-L**	**-**	**-**	**-**	**M**	**M**	**-**
CO4	**H**	**H**	**-**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**L**	**M**	**M**	**-**
CO5	**H**	**H**	**-**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**L**	**M**	**M**	**-**

g) Course Content

UNIT I Basics of Semiconductors 9

Energy bands – metals- semiconductors and insulators-direct and indirect semiconductors- Charge carriers in semiconductors: electrons and holes-intrinsic and extrinsic material-n-material and p-material- carrier concentration: fermi level- electron and hole concentrations at equilibrium-temperature dependence.

UNIT II Carrier Transport in Semiconductors 9

Conductivity and mobility- drift and resistance- effect of temperature and doping on mobility-high field effects, generation and recombination mechanisms of excess carriers: direct and indirect recombination-steady state carrier generation-quasi Fermi levels, Diffusion of carriers: diffusion processes- Einstein relations.

UNIT III PN Junctions 9

PN junctions: formation of junction, contact potential, electrical field, potential and charge density at the junction, space charge at a junction, energy band diagram, Ideal diode equation, electron and hole component of current in forward biased p-n junction, Reverse bias breakdown in p-n junctions: zener and avalanche break down.

UNIT IV Bipolar Junction Transistors 9

Bipolar transistor action: Basic principle of operation, modes of operation, amplification with bipolar transistors, minority carrier distributions: forward active mode, other modes of operation.

UNIT V Metal Insulator Semiconductor Devices and MOSFET 9

Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage
MOSFET: Output characteristics, transfer characteristics, sub threshold characteristics, MOSFET scaling, short channel effects.

h) Learning Resources

Reference Books

1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson, 6/e, 2010

2. Pierret, Semiconductor Devices Fundamentals, Pearson, 2006

3. Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005

4. Donald A. Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012

5. Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill,2015

Course Code	Course Title	L	T	P	C
1152EC145	**NANO SCALE TRANSISTORS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

In this subject we are discussing about the essential of MOS transistor scaling and how the short-channel effects can be minimized.

c) Prerequisite

Nil

d) Course educational objectives

To understand the essential of MOS transistor scaling

To introduce the nanoscale MOS transistor concept and performance

To study and analyze the different nano scaled MOS transistors

e) Related Courses

Solid state devices

f) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain about the various novel MOSFETs to tackle short channel effects	K2
CO2	Apply the physics of multigate MOS system	K2
CO3	Identify the performance of Nanowire FETs and transistors at the molecular scale	K2
CO4	Identify thetransistors at the molecular scale and understand about the radiation effects in SOI MOSFETs	K2
CO5	Explain about the concept of circuit design using multigate devices	K2

g)	Correlation of COs with POs													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	-	L	-	-	-	-	-	-	-	M	-	-
CO2	H	M	-	M	-	-	-	-	-	-	-	M	-	-
CO3	H	H	-	L	-	-	-	-L	-	-	-	M	M	-
CO4	H	H	-	L	L	-	-	-	-	-	L	M	M	-
CO5	H	H	-	L	L	-	-	-	-	-	L	M	M	-

h) Course Content

UNIT I INTRODUCTION TO NOVEL MOSFETS 9

MOSFET scaling ,short channel effects-channel engineering - source/drain engineering – high k dielectric - copper interconnects - strain engineering, SOI MOSFET, multigate transistors – single gate – double gate – triple gate – surround gate, quantum effects – volume inversion – mobility – threshold voltage – inter subband scattering, multigate technology – mobility – gate stack

UNIT II PHYSICS OF MULTIGATE MOS SYSTEM 9

MOS Electrostatics – 1D – 2D MOS Electrostatics, MOSFET Current-Voltage Characteristics – CMOS Technology – Ultimate limits, double gate MOS system – gate voltage effect – semiconductor thickness effect – asymmetry effect – oxide thickness effect – electron tunnel current – two dimensional confinement, scattering – mobility.

UNIT III NANOWIRE FETS AND TRANSISTORS AT THE MOLECULAR SCALE 9

Silicon nanowire MOSFETs – Evaluation of I-V characteristics – The I-V characteristics for nondegenerate carrier statistics – The I-V characteristics for degenerate carrier statistics – Carbon nanotubes – Carbon nanotube FETs.Electronic conduction in molecules – General model for ballistic nanotransistors – MOSFETs with 0D, 1D, and 2D channels – Molecular transistors

UNIT IV TRANSISTORS AT THE MOLECULAR SCALERADIATION EFFECTS 9

Electronic conduction in molecules – General model for ballistic nanotransistors – MOSFETs with 0D, 1D, and 2D channels – Molecular transistors -Radiation effects in SOI MOSFETs, total ionizing dose effects – single gate SOI – multigate devices, single event effect, scaling effects

UNIT V CIRCUIT DESIGN USING MULTIGATE DEVICES 9

Digital circuits – impact of device performance on digital circuits – leakage performance trade off – multi VT devices and circuits – SRAM design, analog circuit design – transconductance – intrinsic gain – flicker noise – self heating –band gap voltage reference – operational amplifier – comparator designs, mixed signal – successive approximation DAC, RF circuits

Total 45 Hrs

i) Learning Resources

Text Books

1. J P Colinge, FINFETs and other multi-gate transistors, Springer – Series on integrated circuitsand systems, 2008
2. Mark Lundstrom Jing Guo, Nanoscale Transistors: Device Physics, Modeling and Simulation,Springer,2006

Reference Books

1. M S Lundstorm, Fundamentals of Carrier Transport**,** 2nd Ed., Cambridge University Press, Cambridge UK, 2000

Course Code	Course Title	L	T	P	C
1152EC107	**INTEGRATED PRODUCT DEVELOPMENT**	**3**	**0**	**0**	**3**

a) **Course category**

Program Elective

b) **Preamble**

Understanding the global trends and development methodologies of various types of products and services Conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems.

c) **Prerequisite**

Nil

d) **Related courses**

Nil

e) **Course Outcomes**

On successful completion of this course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Interpret the various global trends to develop the new product.	K3
CO2	Summarize the types of product requirements, product development methodologies and management.	K2
CO3	Conceptualize the product of integrating hardware, software, controls, electronics and mechanical system and detailed product design and testing.	K3
CO4	Develop product test specifications standards, validate the product and confirm its performance as per design specifications.	K3
CO5	Enumerate the end product development process of trade	K2

	off, IPR, security and Configuration management.	

f) Correlation of CO's with PO's

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	H	-	-	M	L	-	-	-	M	L	-	-
CO2	M	-	H	-	M	-	-	-	-	-	-	-	-	-
CO3	H	-	M	-	H	-	-	-	-	M	-	-	-	-
CO4	M	-	L	-	-	M	M	-	-	-	-	M	-	-
CO5	-	-	M	-	M	-	-	H	-	-	-	-	-	-

g) Course Content

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Analysis and Product decision - Social Trends - Technical Trends - Economic Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle - Product Development Planning and Management

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - Traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing-Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL)SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product validation processes and stages - Product Testing standards and Certification - Product Documentation - Sustenance - Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management - Configuration Management - EoL Disposal.

UNIT V BUSINESS DYNAMICS ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product development in Industry versus Academia - The IPD Essentials - Introduction to vertical specific product development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and S/W systems – Product development Trade-offs - Intellectual Property Rights and Confidentiality - Security and configuration management.

Total 45 Hrs

h) Learning Resources

Text Books

1. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", TataMcGraw Hill, Fifth Edition, New Delhi, 2011 2.
2. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill,Eleventh Edition, New Delhi, 2005.

Reference Books

1. Hiriyappa B, "Corporate Strategy – Managing the Business", Authorhouse, USA, 2013
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier],Oxford, UK, 2004.
3. Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning – Conceptsand Practice", Prentice Hall India, New Delhi, 2003
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design",McGraw Hill Education, Seventh Edition, New Delhi, 2013.

Course Code	Course Title	L	T	P	C
1152EC108	**BIOMEDICAL INSTRUMENTATION AND IMAGING**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course is designed to make the student acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance. The fundamental principles of equipment that are actually in use at the present day are introduced

c) Prerequisite

Biology for Engineers, Basic Electronics Engineering

d) Related Courses

Digital Image Processing

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the Nervous system and physiology of the heart, lung, circulation & respiration and transducers for Bio Medical applications.	K2
CO2	Describe the various electrical and non-electrical physiological measurements such as ECG, EEG, pH of blood.	K2
CO3	Describe Medical Imaging Systems such as X-Ray Imaging, computed tomography, CT scan, MRI Imaging, Ultrasound scanner.	K3
CO4	Illustrate various special Imaging techniques such as neutron radiography, Cine angiogram, LASER Imaging.	K2
CO5	Discuss on safety measures and various therapeutic & assisting equipment such as Microwave diathermy, Defibrillators and patient safety measures.	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	M	L	-	-	-	-	-	L	-	L	-	-
CO2	M	M	M	M	M	-	-	-	-	L	-	L	L	-
CO3	M	M	H	H	M	-	M	-	-	L	-	L	L	-
CO4	M	M	H	H	M	-	M	-	-	L	-	L	L	-
CO5	L	L	H	L	L	-	L	-	-	L	-	L	L	-

g) Course Content

UNIT I PHYSIOLOGY AND COMPONENTS 9

Cell and its structure - sources of bioelectric potentials – resting and action potentials – propagation of action potentials nervous system – CNS – PNS – nerve cell – synapse – cardio pulmonary system – physiology of heart and lungs – circulation and respiration- block diagram of biomedical Instrumentation system - transducers for bio medical applications - electrodes - selection criteria.

UNIT II ELECTRICAL AND NON-ELECTRICAL PHYSIOLOGICAL MEASUREMENTS 9

ECG – EEG – EMG – ERG – lead systems and recording methods – typical waveforms. Measurement of blood pressure – cardiac output – cardiac rate – heart sound –respiratory rate - plethysmography – pH of blood, ESR - GSR measurements

UNIT III MEDICAL IMAGING SYSTEMS 9

Picture archiving and communication system (PACS) - Principles of sectional imaging, scanner configuration, detectors - 2D image reconstruction technique, X-Ray imaging- computer Tomography- Ultrasound scanner – PET scan – MRI Imaging.

UNIT IV SPECIAL IMAGING TECHNIQUES 9

Cineradiography, cine fluorography, stereoscopic radiography, magnification radiography, microradiography, tomography, neutron radiography. Cine angiogram – LASER imaging – endoscopy.

UNIT V ASSISTING &THERAPEUTIC EQUIPMENT AND SAFETY MEASURES 9

Physiotherapy and electrotherapy - short ware, microwave diathermy –defibrillators – cardio vector – hearing aid – dialysis machine, pace makers. patient safety & monitoring – electrical safety, patient electrical safety, types of hazards, natural protective mechanism, leakage current, patient isolation, hazards in operation rooms, grounding conditions in hospital environment.

Total 45 Hrs

h) Learning Resources

Text Books

1. Leshie Cromwell, Fred. J. Weibell and Erich. A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, PHI, 2003.
2. R.S. Khandpar, "Hand Book of Biomedical Instrumentation and measurement", McGraw Hill publishing Co., 1990
3. 3. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2006

Reference Books

1. Arumugam, "Biomedical Instrumentation", Anuradha Agencies Publishers, VidayalKaruppar, 612 606, Kumbakonam, R.M.S: 1992
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
3. R. Anandanatarajan, "Biomedical Instrumentaion", PHI Learning, 2009.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc18_ec02/preview
2. https://www.lecturio.com/
3. www.globalspec.com

Course Code	Course Title	L	T	P	C
1152EC109	**OPTO ELECTRONIC DEVICES**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

Optoelectronic devices provide to learn different types of optical emission, detection and optoelectronic integrated circuits and their applications

c) Prerequisite

Nil

d) Related Courses

Optical and microwave engineering, Optical Communication Systems and Networks.

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the fundamentals of optoelectronics	K2
CO2	Discuss the different types of display devices and operating principle of laser	K2
CO3	Classify the different types of photo detectors	K2
CO4	Explain about the modulators and switching devices	K2
CO5	Explain the integration methods, materials, OEIC transmitters receivers, guided wave devices and photonic integrated circuits	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	L	-	-	-	-	--	-	L	-	-
CO2	L	M	M	L	M	-	-	-	-	-	-	M	L	-

CO3	M	M	L	M	-	-	-	-	-	-	-	-	-	-
CO4	L	L	M	M	-	-	-	-	-	-	-	M	-	-
CO5	M	M	L	L	M	-	-	-	M	-	M	M	-	-

g) Course Content

UNIT I FUNDAMENTALS OF OPTOELECTRONICS 9

Nature of Light, Wave Nature of Light: Polarization – Interference - Diffraction, Light Sources: Blackbody Radiation, Units of Light, Generation of Photo electronics, Elements of Solid State Physics - Quantum Mechanical Concept, Energy Bands in Solids, Semiconductors and Semiconductor Junction Devices

UNIT II DISPLAY DEVICES AND LASER 9

Luminescence, Photoluminescence Cathode luminescence, Cathode Ray Tube, Electro Luminescence, Injection Luminescence, LED: Materials - Commercial LED Materials – Construction - Drive circuitry, Plasma Display, Liquid Crystal Displays, Numeric Displays, Emission and Absorption of Radiation, Population Inversion, Laser losses, Laser Modes: Mode Locking- Active Mode Locking - Passive Mode Locking, Laser Applications

UNIT III PHOTO DETECTORS 9

Thermal Detectors - Thermoelectric Detectors - Bolometer - Pneumatic Detectors – Pyro electric Detectors, Photon Devices - Photo Emissive Devices - Vacuum Photodiodes - Photo Multipliers- Photon Counting Techniques - Photo Conductive Detectors, Detector Performance Parameters.

UNIT IV MODULATION AND SWITCHING DEVICES 9

Analog and Digital Modulation, Franz- Keldysh and Stark Effect Modulators**,** Quantum well Electro-Absorption Modulators, Electro-Optic Modulators- Birefringence and Electro- Optic Effect - Kerr Modulators - Magneto Optic Modulators, Optical switching, and logic devices.

UNIT V PHOTONICS & OPTOELECTRONIC INTEGRATED CIRCUITS 9

Hybrid and Monolithic Integration, Applications of Optoelectronic Integrated Circuits, Materials and Processing for OEICs, Integrated Transmitters and Receivers- Front End Photo Receiver - PIN HBT Photo Receiver - OEIC Transmitter, Guided Wave Devices. Photonics, Photonic Integrated Circuits, Recent Developments in Photonic Integrated Circuits.

Total 45 Hrs

h) Learning Resources

Textbooks

1. Pallab Bhattacharya "Semiconductor Opto Electronic Devices", Prentice Hall of India Pvt., Ltd., New Delhi, 2006.
2. J. Wilson and J.Haukes, "Opto Electronics – An Introduction", Prentice Hall, 1995
3. G. Ghione, Semiconductor Devices for High-Speed Optoelectronics, Cambridge University Press (2009)

Reference Books

1. S C Gupta, Opto Electronic Devices and Systems, Prentice Hal of India, 2005.
2. Jasprit Singh, “Opto Electronics – As Introduction to Materials and Devices”, Mc Graw-Hill International Edition, 1998
3. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2nd Ed. (2007).
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communication, Oxford University Press (2007), 6 th Ed.
5. G. Keiser, Optical Fiber Communications, McGraw-Hill Inc., 3 rd Ed. (2000).
6. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).

Online Resources

1. https://nptel.ac.in/courses/115/102/115102103/
2. https://nptel.ac.in/courses/117/101/117101054/

Course Code	Course Title	L	T	P	C
1152EC110	**ELECTRONIC INSTRUMENTATION**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course Electronic Instrumentation provides adequate knowledge in Electronic instruments.

c) Prerequisite

Basic Electronics Engineering.

d) Related Courses

Analog Electronics, Circuit theory.

e) Course Outcome

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the working and measurement of electronic parameters with various types of electronic measurement devices.	K2
CO2	Describe the working principle and measurement techniques of various types of oscillators and signal analyzers.	K2
CO3	Explain the working and measurement techniques of different types of waveform generators.	K2
CO4	Explain the standard forms of interfaces used in electronic instrumentation for various applications.	K2
CO5	Describe the working principle of telemetry modules.	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	-	-	-	-	-	-	-	L	L	-
CO2	M	-	-	-	L	-	-	-	-	-	-	M	L	-
CO3	M	-	-	-	L	-	-	-	L	L	L	L	L	-
CO4	M	-	-	-	-	-	-	-	-	-	-	L	L	-
CO5	M	-	-	-	L	L	L	-	L	L	L	L	-	-

g) Course Content

UNIT I ELECTRONIC INSTRUMENTS 9

Electronic voltmeter and their advantages – types, digital IC tester, source follower, rectifier – True RMS reading voltmeter – electronic multi meter and ohmmeter – current measurement – power measurement - microprocessor based DMM with auto ranging and self-diagnostic features b6

UNIT II CATHODE RAY OSCILLOSCOPE & SIGNAL ANALYZERS 9

General purpose cathode ray oscilloscope – Dual trace, dual beam and sampling oscilloscopes – analog and digital storage oscilloscope - frequency selective and heterodyne wave analyser – harmonic distortion analyser – spectrum analyser.

UNIT III WAVEFORM GENERATORS 9

Wien's bridge and phase shift oscillators – Hartley and crystal oscillators – square wave and pulse generators – triangular wave-shape generator - signal and function generators – Q meter – electronic counters

UNIT IV COMMON INSTRUMENTATION INTERFACES 9

Modern instrumentation and control systems – OSI model – EIA 232 interface standard - EIA 485 interface standard - EIA 422 interface standard – 20 mA current loop – serial interface converters

UNIT V TELEMETRY 9

General telemetry system – voltage, current and position telemetry systems – radio frequency telemetry – frequency modulation, pulse-amplitude modulation and pulse-code modulation telemetry – frequency and time multiplexing.

Total 45 Hrs

h) Learning Resources

Text Books

1. A.K. Sawhney, A Course in “Electrical & Electronic Measurements and Instrumentation”, Nineteenth revised edition, DhanpatRai and Co, New Delhi, 2011

2. David A Bell, “Electronic Instrumentation and Measurements”, Third edition, Oxford University Press, 2013.

3. N. Mathivanan , “PC based Instrumentation”, First edition, Prentice Hall India Private Ltd, Delhi 2007.

Reference Books

1. A.D. Helfrick and W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall India Private Ltd., New Delhi, 2010
2. J.J. Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education India, New Delhi,2011
3. M.M.S. Anand, Electronics Instruments and Instrumentation Technology, Prentice Hall India, New Delhi,2009.

Online Resources

1. http://www.getbookee.org/electrical-measurement-sawhney/
2. http://ebookbrowse.com/measurements-and-instrumentation-pdf- d97159998
   3.http://www.bookpump.com/bwp/pdf-b/2335004b.pdf

Course Code	Course Title	L	T	P	C
1152EC211	**VIRTUAL INSTRUMENTATION**	**1**	**0**	**4**	**3**

a) Course Category

Program Elective

b) Preamble

Virtual instrumentation provides the basics, programming techniques, data acquisition and interfacing techniques of Virtual Instrumentation (VI) and its applications.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcome

Upon the successful completion of the course, students will be able to:

Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1: a) Illustrate and explain the architecture of Virtual instrumentation and analyse its performance in comparison with conventional Instruments. b) Perform the basic VI programming using GUI functions in LabVIEW.	K2 S3
CO2: Apply the graphical programming functions in VI to simulate the application specific analog and digital circuits.	S3
CO3: a) Explain the Interface techniques and standards to connect with DAQ hardware. b) Demonstrate the real time data acquisition using DAQ devices, control and analysis of basic IO devices.	K2 S4

f) Correlation of Cos with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	L	L	-	-	-	M	L	-	L	L	-
CO2	H	M	M	M	M	-	-	-	M	L	-	M	M	-
CO3	H	M	H	H	H	M	L	-	H	L	-	L	H	H

h) Course Content:

Internal Evaluation -40 Marks				**External Evaluation - 60 Marks**			
Laboratory Experiment	**15 Marks**	**Model Lab Exam**	**25 Marks**	**Part - A**	**20 Marks**	**Part- B**	**40 Marks**
Performance in conducting the experiment	5	Performance in conducting the experiment	15	Theoretical analysis for Knowledge in Virtual instrumentation software, hardware and its interfaces	**20**	Procedure and executing the lab experiments	25
Results and analysis	3	Results and analysis	5			Results and analysis	10
Record	4	Viva voce	5			Viva Voce	5
Viva Voce	3						

Theory **15 Hours**

Virtual Instrumentation and its evolution, advantages, block diagram and architecture of a virtual instrument, graphical programming, comparison with conventional programming, development of virtual instrument using GUI.

Programming techniques: creating and Saving VI, front panel controls and indicators, block diagram, Sub VI, Data types, Loops and charts, arrays and graphs, formula nodes, case and sequence structures.

Introduction to data acquisition on PC, software and hardware installation, configuring data acquisition hardware using the drives in application software, Interface standards and PC buses, use of DAQ library functions for different analog and digital input/output operations.

i) List of experiments **60**
Hours

List of Experiments	CO Mapping
Introduction to Graphical Programming 1. Introduction to Graphical programming: Numeric, Boolean and String data types, various types of Controls and Indicators. 2. Build a VI using Numeric controls and indicators to perform various arithmetic operations 3. Build a VI using Boolean controls and indicators to perform various Boolean operations. 4. Build a VI using String controls and indicators to perform various String operations. 5. Create a VI to convert given temperature value from degree Celsius to Fahrenheit and vice versa and display using thermometer.	CO1
Operations using Data Types 6. Create a Sub VI to compute diameter, circumference and area of a circle for a given radius. 7. Build a VI using Sub VI to solve the given quadratic equation $ax^2 + bx + c = 0$. Display whether the roots are real or imaginary. 8. Create a VI to compute whether the given number is even or odd. 9. Perform an arithmetic operation $\frac{aX+bY+cZ}{3}$ using numeric operators and verify the same using formula node. 10. Build a VI to perform half adder and full adder using sub VI.	CO2
Loops 11. Introduction to For loop and While loop. 12. Build a VI to control the level of tank using For loop. 13. Build a VI to control the Speed of a motor system using While loop.	CO2

14. Create a VI to find a factorial of a given number using loop function. 15. Create a VI programming to simulate a dice and display a value only between 1-12. 16. Simulate a VI for charging the battery level. Use appropriate functions to display notification message.	
Arrays 17. Introduction to Arrays and array Operations. 18. Build a VI using to create a 1-D array. Perform the operations such as indexing, insertion, deletion and search of an element. 19. Build a VI to generate Fibonacci series using loop and array functions. 20. Build a VIT to perform sorting of numbers in ascending order using loop and array functions.	CO2
Case Structure 21. Introduction to case structure and switch statements. 22. Build a VI for temperature monitoring system using Case structures. Display the safe and emergency alarms using LEDs of varying colours. 23. Design a VI to display a 7-segment LED using caste structures.	CO2
Charts and Graphs 24. Simulate a sine wave and square of variable amplitude and frequency and display the waveform using graph. Manipulate the waveforms by changing its width and colour. 25. Create a VI to sample an input analog signal with 20 % duty cycle. 26. Develop a VI program to demonstrate Frequency modulation and amplitude modulation using Formula node.	CO2
Sequence Structures 27. Introduction to flat and sequence structures. 28. Build a VI for traffic light control for varying time delays using sequence structures. 29. Design a Ticket vending machine system using the concept of state machine in LabVIEW.	CO2

30. Perform READ/WRITE operations on a file using sequence structures and loops.	
Clusters 31. Introduction to clusters and its operations. 32. Create a student database and display the student details with CGPA above 8.0 using Clusters in LabVIEW. 33. Create a VI to calculate Body Mass Index (BMI) using Clusters and display the BMI status using LED and pop-up message.	CO2
Data Acquisition 34. Introduction to DAQ module and Measurement & Automation Explorer. 35. Develop a VI to export data from DAQ assistant device and to spreadsheet. 36. Build a VI to measure temperature using thermocouple and DAQ. 37. Build a VI for image acquisition and processing using USB camera. 38. Study of Instrument control using Instrument Assistant for READ/WRITE operation using Interface VISA commands. 39. Simulate a Lissajous curve pattern in an XY Graph using Express VI. 40. Create a VI to show the statistics of Gaussian random signal using Express VI.	CO3

Total 75 Hours

j) Learning Resources

Textbooks

1. S.Gupta and J.P Gupta, "PC interfacing for Data Acquisition and Process Control", Instrument society of America, 1994.
2. Peter W. Gofton "Understanding serial communications", Sybex International.
3. Robert H.Bishop, "Learning with Lab VIEW", Prentice Hall, 2003

List of Major Equipment/ Instrument/Software with Broad Specifications

1. DAQ cards
2. NI DAQ Modules
3. Temperature transducers
4. Computer installed with LabVIEW

List of Software/Learning Websites

1. https://www.ni.com/

Online resources

1. http://www.ni.com/training/online
2. http://www.labviewmakerhub.com/doku.php?id=learn:tutorials:labviewbasics.

Course Code	Course Title	L	T	P	C
1152EC112	**DIGITAL TV ENGINEERING**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

Television Technology has now become a vital tool to the information revolution that is sweeping across the countries of the world. The syllabus aims at a comprehensive coverage of Television Systems with all the new developments in Television Engineering

c) Prerequisite

Antenna and wave propagation

d) Related Courses

Communication theory, Digital communication

e) Course educational objectives

1. To study the analysis and synthesis of TV Pictures, Composite Video Signal, Receiver Picture Tubes and Television Camera Tubes
2. To study the principles of Monochrome Television Transmitter and Receiver systems.
3. To study the various Color Television systems with a greater emphasis on PAL system.
4. To study the advanced topics in Television systems and Video Engineering

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain digital TV transmission and reception, processors such as audio and video.	K2
CO2	Discuss the various picture tubes such as camera tubes, cam coder, image orthicon, vidicon etc.	K2
CO3	Summarize the concepts of digital transmission and reception such as MPEG.Digital Video Broadcasting (DVB)	K2
CO4	Discuss the elements of digital TV system.	K2
CO5	Summarize the high definition TV standards and its components.	K2

g) **Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	-	M	M	-	-	-	-	-	-	L	-	-
CO2	M	-	-	-	-	L	-	-	-	-	-	L	-	-
CO3	M	-	-	L	-	-	L	-	-	-	-	L	-	-
CO4	H	L	-	-	L	-	L	-	-	-	-	-	-	-
CO5	-	L	-	-	-	-	M	-	-	-	-	M	-	-

h) **Course Content**

UNIT I DIGITAL TELEVISION 9

Merits of Digital technology, Digital TV signals , Digitized video parameters ,digital transmission and reception, codec Functions ,codec MAA2100 ,Video processor, Audio processor

UNIT II TV CAMERAC AND PICTURE TUBES 9

Principle of camera tubes, camcorder, image orthicon, vidicon, plumbicon, solid-state image scanners, elements of a picture tube, focusing and deflection, EHT ,HOT picture tube controls , Delta gun, PIL, Trinitron, color camera & picture tubes purity & convergence ,automatic degaussing

UNIT III COLOUR SIGNAL TRANSMISSION AND RECEPTION 9

Digital TV: Digitized Video, Source coding of Digitized Video – Compression of Frames – DCT based – (JPED), Compression of Moving Pictures (MPEG). Basic blocks of MPEG2 and MPE4. Digital Video Broadcasting (DVB) – Modulation: QAM – (DVB-S, DVB-C), OFDM for Terrestrial Digital TV (DVB –T). Reception of Digital TV Signals (Cable, Satellite and terrestrial). Digital TV over IP, Digital terrestrial TV for mobile. Display Technologies – basic working of Plasma, LCD and LED Displays.

UNIT IV ELEMENTS OF A DIGITAL TELEVISION SYSTEM 9

Television: Scanning, Blanking and synchronization, Picture signal - composite video signal Vestigial sideband transmission-Principle of CCD Camera - Monochrome picture tube- Monochrome TV receivers- RF tuner ,VHF tuner- Video amplifier, IF section, Vestigial sideband correction- Video detectors, Sound signal separation, AGC, sync separation, horizontal and vertical deflection circuits, EHT generation. Color TV system: Principle of color signal transmission and reception, PAL, NTSC, SECAM (block schematic description), Picture tube – delta gun.

UNIT V HIGH DEFINITION TV 9

Component coding ,MAC signals ,MAC encoding format ,scanning frequencies D2- MAC Packet Signal ,Duo-binary Coding ,HDTV Standards & compatibility ,colorimetric characteristics & parameters of HDTV LCD TV

System : LCD Technology , LCD Matrix types & operations , LCD screen for TV LCD color Receiver Plasma TV System : Plasma & conduction of charge ,Plasma TV screen ,Signal processing in Plasma TV, Plasma colour Receiver Satellite TV, DTH Receiver System ,CCTV, CATV, working of block converter,: IR Remote control

Total 45 Hrs

i) Learning Resources

Text Books

1. Modern Television Practice – Principles, Technology and Service – R.R. Gulati, New Age International Publication, 2002
2. Monochrome and Colour TV – R.R. Gulati, New Age International Publication, 2002.

Reference Books

1. Colour Television Theory and Practice – S.P. Bali, TMH, 1994.
2. ision and Video Engineering - A.M. Dhake, 2nd Edition

COURSE CODE	COURSE TITLE	L	T	P	C
1152EC239	ELECTRONICS CIRCUIT SIMULATION AND PCB DESIGN	1	0	4	3

a. Course Category:

Program Elective

b. Preamble:

The course is aimed at making the students to understand electronic circuit simulation process for better understanding and designing of cost effective Printed Circuit Boards. Emphasizing the students to understand how to design a PCB layout of given circuit using available circuit simulation and PCB layout design CAD tools (free or licensed) .This course helps the student to simulate the circuit, develop the complete hardware circuit on PCB and assemble the components using SMD soldering technique

c. Prerequisite Courses:

Nil

d. Related Courses:

Analog Electronics, Linear Integrated Circuits

e.Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Simulate and perform various analysis for the given Electronic Circuit.	S3
CO2	Design a PCB Layout for the given circuit	S4
CO3	Fabricate the PCB and assemble the components.	S2

f. Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	M	H	-	H	-	-	-	M	-	-	M	H	H
CO2	L	M	H	-	H	-	-	-	M	-	-	M	H	H
CO3	L	M	H	-	H	-	-	-	M	-	-	M	H	H

g. Examination scheme

Examination Scheme for practical dominated course										
Internal evaluation (40M)							**Semester end evaluation (60M)**			
Laboratory experiment (15M)				**Model laboratory test (25M)**			**Part-A (20M)**	**Part-B (40M)**		
Performance in conducting experiment (5)	Result and analysis (3)	Viva Voce (3)	Record (4)	Performance in conducting experiment (15)	Result and analysis (5)	Viva Voce (5)	Theory questions to evaluate the knowledge and understanding (20)	Performance in conducting experiment (25)	Result and analysis (10)	Viva-Voce (5)

h. Course Content :

Theory **15 Hours**

Electronics Circuit Simulation

State the features of different circuit simulation tools (Open source or licensed) used for electronic circuit simulation. Different PCB layout design tools (Open source or License) used for PCB layout design. General terms and elements used in circuit simulation software. Assemble electronics circuit using circuit simulation software. Types of Circuit Analysis-Transient Analysis, Bias Point Analysis, Frequency Response.

PCB Layout Design

Terms used: net list file, back annotation, bill of material, foot print, PTH, track width, mil, etc. used in PCB layout design software. Place, route and generate the layout of given circuit using manual or auto routing using PCB layout design software. Raw Materials - Types of PCBs: Single layer - Double layer - Multi layer – Rigid – Flexible - Flex Rigid -High frequency - Aluminium_Backed - Track Width Calculation - Layout Design - Back Annotation -Gerber File - NC Drill File - Fab and Assembly Drawings – Legend - Bill of Material. Packaging Trends - Package Classifications - Package Type and Characteristics: Through-Hole Mounting - Surface Mounting - Special Packages- Package Symbols and Codes. Symbols-Reference Designators-Values and Attributes-Schematic Design Guidelines-Routing - Nodes – Joints - Design Error Check.

PCB Manufacturing and Assembly

Design to Manufacturing - CAM Editor - Reverse Engineering of PCBs - From File to Film - Printing the Inner layers - Removing the Unwanted Copper - Layer Alignment and Optical Inspection - Layer-up and Bond – Drill Plating- Copper Deposition - Outer Layer Imaging_

Plating- Final Etching - Solder Mask Application - Surface Finish – Silkscreen - Electrical Test - Profiling and V-Scoring - Soldering: Soldering Tools- Assembly and Support Equipment.

i. List of experiments

S.No.	CO's	Practical exercises 60
1.	CO1	Getting acquainted with simulation tool
2.	CO1	Design a Variable Power Supply Circuit using LM338/LM317
3.	CO1	Design a Hartley Oscillators Circuit and simulate its response.
4.	CO1	Design an AstableMultivibrator Circuit and simulate its response.
5.	CO1	Design and simulate response of Active and Passive Filter Circuits.
6.	CO2	Getting acquainted with PCB layout tool
7.	CO2	Design a PCB layout for the given circuit (Basic Level)
8.	CO2	Design a PCB layout for the given circuit (Advanced Level)
9.	CO2	Board to Layout Design (Reverse Engineering)-FM Board.
10.	CO3	Hands on Experience-Soldering and types of Soldering
11.	CO3	THT components- Drilling and Soldering.
12.	CO3	Complete Board Assembly-FM Board

Total 75 hrs

j. Suggested Learning Resources

i) List of textbooks

1. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards,SimonMonk;McGraw Hill Education (1 July 2014)
2. Complete PCB Design Using OrCAD Capture and PCB Editor,KraigMitznerNewnes; Pap/Cdr edition (28 May 2009), 2011, ISBN: 978-1-4493- 9357-1

ii) List of Major Equipment/ Instrument/Software with Broad Specifications

1. Altium Designer (Licensed version)
2. Express PCB (Free version)
3. Eagle (Free version)
4. MultiSim(Student Version)
5. UtilBoard(Student Version)

iii) Online resources

1. www.techdocs.altium.com/
2. www.ni.com (Multisim and Ultiboard - Academic version)
3. www.cadence.com (Orcade - Student version)
4. www.youtube.com (PCB Manufacturing Videos)

Course Code	Course Title	L	T	P	C
1152EC142	**SENSORS AND TRANSDUCERS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

c) Prerequisite

Nil

d) Related Courses

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1.a	Describe various measurement standards and various errors and perform error analysis.	K2
CO1.b	Explain the classification of transducers.	K2
CO2	Explain static characteristics of transducers, obtain and analyze dynamic characteristics of transducer.	K3
CO3	Describe construction, working principle, characteristics and applications of various resistance transducers	K3
CO4	Explain the working principle of various inductance and capacitance transducers	K3
CO5	Discuss the operation and applications of modern industrial transducers	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1.a	M	L	M	H	M	H		L	L	L		H		
CO1.b	L		M	L				L	L	L		L		
CO2	L	H			M			L	L	L		H		
CO3			M	M	L		M	L	L	L		M	H	
CO4			H	M	L		M	L	L	L		M	H	
CO5			H	M	M		M	L	L	L	M	M	H	M

g) Course Content

UNIT I INTRODUCTION TO MEASUREMENTS AND TRANSDUCERS 9

Generalized measurement system - Units and standards – Static calibration – Classification of errors - Limiting error and probable error – Error analysis – Statistical methods – Odds and uncertainty – Classification of transducers – Selection of transducers

UNIT II CHARACTERISTICS OF TRANSDUCERS 9

Static characteristics – Accuracy, precision, resolution, threshold, sensitivity, linearity, repeatability, reproducibility, loading effect, drift, static error, span and range, hysteresis, dead time and dead zone - Dynamic characteristics – Time Response of I order transducer for impulse, step and ramp signals- Time Response of II order transducer for impulse and step signals- Frequency response of transducer.

UNIT III RESISTANCE TRANSDUCERS 9

Principle of operation, construction details, characteristics and applications of potentiometer - Strain gauge – types - Resistance temperature detector (RTD)- Thermistor –Hot-wire anemometer – constant current and constant temperature operation - Resistive humidity sensor

UNIT IV INDUCTANCE AND CAPACITANCE TRANSDUCERS 9

Induction potentiometer – Variable reluctance transducer – Eddy current transducer –Principle of operation, construction details, characteristics and applications of Linear Variable Differential Transducers –Capacitive transducer and types - Differential arrangement – Variation of dielectric constant for measurement of liquid level - Dynamic microphone.

UNIT V MODERN TRANSDUCERS 9

Piezoelectric transducer – Hall Effect transducer – Magneto resistor - Digital displacement transducer– Fiber optic sensor - Introduction to SQUID sensor, Touch screen sensor, Smart Transducer, MEMS and Introduction to linearization of transducer.

Total 45 Hrs

h) Learning Resources

Text Books

1. Ernest O.Doebelin,- Measurement systems‖, 6th Edition, Tata McGraw Hill Education Private Ltd, New Delhi, 2012.
2. A.K. Sawhney,- A course in Electrical & Electronic Measurement and Instrumentation, Dhanpat Rai and Company Private Limited, Reprint: 2014.

Reference Books

1. D. Patranabis, —Sensors and Transducers‖, 2nd Edition, Prentice Hall of India, 2010.
2. John P.Bentley, —Principles of Measurement Systems‖, 4th Edition, Pearson Education, 2004.
3. Neubert H.K.P., —Instrument Transducers – An Introduction to their Performance and Design‖, Oxford University Press, Cambridge, 2003 .
4. Murthy D.V.S., —Transducers and Instrumentation‖, 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2010.
5. S.Renganathan, —Transducer Engineering‖, Allied Publishers, 2005.

Course Code	Course Title	L	T	P	C
1152EC146	**NANOPHOTONICS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course shall introduce the basic principles, applications and latest advances in the area of Nanophotonics. Student shall have a clear view about this excited new area and ready to contribute to the advances of photonic technology in the broad area of applications such as light-matter interactions, lithography, nanophotonic devices, nanophotonics in medicine, etc,.

c) Prerequisite

Basics Electronic engineering, Electromagnetics field.

d) Related Courses

e) Course Outcomes

Upon the successful completion of the course, students will be able to,

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Understand devices and general concepts used in nano-optics, nano-photonics and nano-opto electronics.	K2
CO2	Understand the basics of photonics, Building blocks of photonic circuits and its effects.	K2
CO3	Understand the basic functions, properties and different methods of nanolithography process.	K2
CO4	Describe broadly about the impact of biomedical research in biotechnology.	K2
CO5	Explore the scientific discoveries lead to technological inventions with nanophotonics.	K2

f)	**Correlation of COs with POs**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	M	L	M	-	-	-	-	-	-	-	-	-	-	L

CO2	M	L	M	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	L	-	-	-	-	-	-	-	-	-	M	M
CO4	M	-	-	-	-	-	-	-	-	-	-	-	M	-
CO5	M	-	-	-	-	-	-	-	-	-	-	L	-	M

g) Course Content

UNIT I INTRODUCTION 9

Introduction, Photonics, Nanophotonics, Frontier in Nanotechnology, Impact of Nanophotonics, Trends in Nanophotonics, Opportunities for Basic Research and Development of New Technologies, scope of nanophotonics, electron tunneling, photon tunneling.

UNIT II NANOPHOTONICS FOUNDATION 9

Photons and Electrons, Similarities and Differences - Free-Space Propagation - Confinement of Photons and Electrons. Nanoscale Optical Interactions - Axial Nanoscopic Localization - Lateral Nanoscopic Localization. Nanoscale Confinement of Electronic Interactions - Quantum Confinement Effects, Nanoscopic Interaction Dynamics, New Cooperative Transitions, Nanoscale Electronic Energy Transfer, Cooperative Emission.

UNIT III NANOLITHOGRAPHY 9

Introduction, Lithography, Two Photon Lithography, Near Field Lithography, Near Field Phase Mask, Soft Lithography, Plasmon Printing, Nanosphere Lithography, Dip-Pen Nanolithography, Nanoimprint Lithography, Photonically Aligned Nanoarrays.

UNIT IV NANOPHOTONICS FOR BIOTECHNOLOGY 9

Near-Field Bioimaging, Nanoparticles for Optical Diagnostics and Targeted Therapy, Semiconductor Quantum Dots for Bioimaging, Biosensing - Photonic Crystal Biosensors, Optical Nanofiber Sensors. Nanoclinics for Optical Diagnostics and Targeted Therapy.

UNIT V NANOPHOTONICS AND ITS APPLICATIONS 9

Nanotechnology, Lasers and Photonics: Nanotechnology – Photonics – Nanophotonics, Optical Nanomaterials: Nanoparticle Coatings - Sunscreen Nanoparticles - Self-Cleaning Glass - Fluorescent Quantum Dots – Nanobarcodes - Photonic Crystals - Photonic Crystal Fibers, Quantum-Confined Lasers, Near-Field Microscopy, Nanolithography, Photonics in Future: Power Generation and Conversion - Information Technology - Sensor Technology – Nanomedicine

Total 45 Hrs

h) Learning Resources

Reference Books

1. Paras N. Prasad, “Nanophotonics”, John Wiley & Sons, Inc. 2004. ISBN:9780471649885.
2. Sergey V. Gaponenko, Introduction to Nanophotonics”, Cambridge University Press, 2010.
3. F. Graham Smith, Terry A. King and Dan Wilkins, “Optics and Photonics: An Introduction”, second edition, John Willey Sons limited, 2007.
4. Connelly, Michael J. “Semiconductor Optical Amplifiers” Springer 2002. ISBN: 978-0-306-48156-7.

Course Code	Course Title	L	T	P	C
1152EC147	**FIBER LASERS AND APPLICATIONS**	**3**	**0**	**0**	**3**

a) Course Category

Programme Elective

b) Preamble

To impart knowledge on laser operation, different types of fiber lasers- Continues Wave (CW) and Pulsed lasers- Q-switching - Mode-locking techniques and applications of fiber lasers.

c) Prerequisite

Nil

d) Related Courses

Opto Electronic Devices

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain about the theoretical background of laser operation and types	K2
CO2	Explain about the fabrication of different lasers using the electromagnetic field equations.	K2
CO3	Explain about the various types of laser demonstration with different design parameters	K2
CO4	Analyze the laser characteristics by the modelling of laser cavity. Describe about the split step Fourier method.	K2
CO5	Explain about the various applications of fiber lasers in different fields.	K2

f) **Correlation of COs with POs**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	L	-	-	-	-	-	-	L	-	-
CO2	L	M	M	L	M	-	-	-	-	-	-	M	L	-
CO3	M	M	L	M	-	-	-	-	-	-	-	-	-	-
CO4	L	L	M	M	-	-	-	-	-	-	-	M	-	-
CO5	M	M	L	L	M	-	-	-	M	-	M	M	-	-

g) Course Content

UNIT I Introduction to lasers 9

Introduction to general lasers and their types, Schrodinger wave equation, Atomic systems, emission and absorption processes, Population inversion, gain, optical cavities, three- and four- level lasers, CW and pulsed lasers, Q-switching and mode-locking techniques.

UNIT II Laser systems 9

Atomic, ionic, molecular, excimer and liquid laser systems- Review of Electromagnetic properties - Basic principle of laser action, Fabrication of lasers - Modulation of lasers - Quantum Well and Quantum Dot Lasers - Passive mode locking Lasers.

UNIT III Fiber lasers 9

Basic concepts - cavity design – continuous wave (CW) lasers – ytterbium doped fiber lasers – erbium doped fiber lasers - passive mode-locking - saturable absorber - nonlinear fiber loop mirror- graphene based saturable absorber - nonlinear polarization rotation - role of fiber nonlinearity and dispersion - saturable absorber mode-locking

UNIT IV Numerical modeling of fiber lasers 9

Modeling of passively mode-locked fiber lasers – lumped and distributed modeling - scalar and vector modeling - nonlinear dynamics inside the laser cavity - multiwavelength fiber laser modeling – numerical methods – split step fourier method – variational analysis – finite difference and finite element beam propagation methods – Runge kutta method.

UNIT V Applications 9

Laser applications in medicine and surgery, Materials processing, Optical Communication Lasers, Metrology and LIDAR.

Total 45 Hrs

h) Learning Resources

Reference Books

1. Andrew. M. Weiner, "Ultrafast Optics" Wiley Series in Pure and Applied Optics, 2008.
2. Govind P. Agarwal," Applications of Nonlinear Fiber Optics" Second Edition, 2007.
3. Le Nguyen Binh , Nam Quoc Ngo, "Ultra-Fast Fiber Lasers" Principles and Applications with MATLAB Models", CRC Press, 2011.
4. Jean-Claude Diels, Wolfgang Rudolph," Ultra short Laser Pulse Phenomena, Fundamentals, Techniques, and Applications on a Femtosecond Time Scale" Academic Press ,Second Edition, 2006.

Course Code	Course Title	L	T	P	C
1152EC113	**EMBEDDED SYSTEM DESIGN**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

The course gives introduction to embedded system components, design, safety, reliability and optimization performance analysis of an embedded product and gives the brief view on distributed embedded system

c) Prerequisite

Microprocessor & Microcontroller.

d) Related Courses

Real Time Operating System, Embedded Control System

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Review the functional blocks of an embedded system and its software development process.	K2
CO2	Generalize the design and development of sophisticated embedded systems.	K2
CO3	Associate the importance of safety and reliability in contemporary embedded system.	K2
CO4	Explain various techniques for performance optimization.	K2
CO5	Describe the growing area of distributed embedded systems.	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	M	L	H	-	-	-	L	-	L	M	L	M
CO2	L	M	H	L	M	-	-	-	M	-	-	M	-	-
CO3	-	L	-	M	-	H	-	-	-	-	-	-	M	L
CO4	L	M	H	-	-	-	-	-	-	-	-	-	M	-
CO5	-	-	M	-	H	-	-	-	-	-	-	M	M	L

g) Course Content

UNIT I FUNDAMENTALS OF EMBEDDED SYSTEM 9

Introduction to embedded system: Processor – Memory – Peripherals – Software – Algorithms – Microcontroller - Microprocessor based – board based.
Compilation Process in Embedded System: Compiling code – preprocessor compilation - linking & loading – Symbols - references and relocation - linker/loader.
Debugging Techniques: High Level language simulation – low level simulation – onboard debugger – task level debugging – symbolic debug - Emulation.

UNIT II HARDWARE - SOFTWARE CO-DESIGN 9

Co-design Process: Overview - Development Life cycles - Specification, Modeling Tools and Languages,
Techniques of Hardware Software Codesign: Partitioning - Co-Simulation, Co-Synthesis - Co-Verification

UNIT III SAFETY AND RELIABILITY 9

Safety and Reliability Techniques, Proactive Approach: Software Solutions – Approaches - Hardware Solutions – Approaches, Steps to a Safe Design, Extreme Reliability, Long Life Applications, Critical Components, Dealing with Failure, Specification

UNIT IV OPTIMIZATION AND PERFORMANCE ANALYSIS 9

Introduction, Basic Measures, Real-time Considerations: Hard – Soft – Firm, Time Loading: Simulation – Instrumentation, Response Time, Memory Loading, Performance Evaluation, Performance Optimization, Hardware Accelerators, Hardware Platforms, Microprocessors and FPGAS, Optimizing Power Consumption, Trade-offs.

UNIT V DISTRIBUTED SYSTEMS 9

Introduction to Distributed Systems, Local and Remote Models, Intra and Inter System Communication, Protocols, Error Management: Failure Detection, Reconfiguration, Recovery Idempotent Systems, Pipes, Streams, and Sockets, Remote Services and Procedures, Design Issues, Synchronous and Asynchronous Procedures. **Total 45 Hrs**

h) Learning Resources

Text Books

1. Steve Heath, "Embedded Systems Design", Second Edition, Elsevier.
2. James K.Precol, "Embedded Systems-A Contemporary Design Tool", John Wiley & Sons, Inc-2008.
3. Frank Vahid& Tony Givargis, "Embedded System Design-A Unified Hardware/Software Introduction", Third Edition, John Wiley & Sons Inc., Reprint 2010.
4. Michael Barr & Anthony Massa, "Programming Embedded Systems-with C & GNU Development tools", Second Edition, O'REILLY, Reprint-2007
5. Arnold S.Berger, "Embedded Systems Design", CMP Books.

Reference Books

1. David E.Simon, "An Embedded Software primer", Pearson Publication

Online Resources

1. https://www.youtube.com/watch?v=4CPIjYGIYqc
2. https://www.youtube.com/watch?v=y70V0qHAFNQ
3. https://www.youtube.com/watch?v=yAOfqK1kQso

Course Code	Course Title	L	T	P	C
1152EC214	REAL TIME OPERATING SYSTEM	1	0	4	3

a) Course Category

Program Elective

b) Preamble

This course introduces the embedded hardware design, programming and real-time operating system development principles for real time embedded applications.

c) Prerequisite

Microprocessor and Microcontroller

d) Related Courses

Nil

e) Course Outcome

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

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Review 8051 architecture and Program 8051 based systems using Embedded C.	S4
CO2	Design and demonstrate 8051 based Real-time Systems.	S4
CO3	Design, port and demonstrate an RTOS based system on 8051 architecture.	S4

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	-	L	H	-	L	-	M	L	-	M	H	H
CO2	M	-	H	H	H	-	L	-	H	L	M	H	H	H

CO3	-	-	H	H	H	L	L	L	H	L	-	H	H	H

Examination Scheme for practical dominated course										
Internal evaluation (40M)							**Semester end evaluation (60M)**			
Laboratory experiment (15M)				**Model laboratory test (25M)**			**Part-A (20M)**	**Part-B (40M)**		
Performance in conducting experiment (5)	Result and analysis (3)	Viva Voce (3)	Record (4)	Performance in conducting experiment (15)	Result and analysis (5)	Viva Voce (5)	Theory questions to evaluate the knowledge and understanding (20)	Performance in conducting experiment (25)	Result and analysis (10)	Viva-Voce (5)

g) Course Content :

Theory **15 Hours**

Review of 8051 Architecture – Microarchitecture, RAM Memory Map, Pin Diagram, Instruction Opcodes, timing, PSW, I/O Ports, Interrupts, Memory Interfacing, Timer/Counter, UART.

Embedded C programming – General Structure, Data types.

8051 Software UART Programming.

PCB Design basics.

8051 Development board circuits.

Text LCD and Graphics LCD Interfacing.

GPS and GSM Interfacing.

RTOS fundamentals.

Study of µC/OS-II RTOS features.

8051 Software I2C Programming.

i)List of experiments

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	8051 Port Output C Programming
2.	CO1	8051 Port I/O C Programming
3.	CO1	8051 Interrupt C Programming
4.	CO1	8051 Timer/Counter C Programming
5.	CO1	8051 UART C Programming
6.	CO1	8051 Matrix display and keypad interfacing and programming using C
7.	CO1	8051 frequency and pulse width measurement and UART interfacing and programming using C
8.	CO1	8051 Software UART Programming using C
9.	CO2	8051 development board PCB design
10.	CO2	8051 PCB soldering
11.	CO2	8051 PCB debugging
12.	CO2	8051 Graphic LCD interfacing and programming using C
13.	CO2	8051 non-English LCD display interfacing and programming using C
14.	CO2	8051 GPS and LCD interfacing and programming using C
15.	CO2	8051 GSM and LCD interfacing and programming using C
16.	CO2	8051 GSM, GPS and LCD interfacing and programming using C
17.	CO3	Porting µC/OS-II RTOS on 8051
18.	CO3	Real-time task scheduling with µC/OS-II RTOS on 8051
19.	CO3	Real-time critical section protection with µC/OS-II RTOS on 8051

20.	CO3	Real-time inter task communication with μC/OS-II RTOS on 8051
21.	CO3	8051 Software I2C Port
22.	CO3	8051 I2C EEPROM interfacing and programming using C
23.	CO3	8051 Parking / Toll Automation
24.	CO3	8051 touch screen panel

Total 75 hrs

j)Learning Resources

Textbooks

1. M.A.Mazidi, J.G.Mazidi and R.D.McKinlay-"The 8051 Microcontroller: A Systems Approach"-Pearson-2013.
2. J.J.Labrosse-"MicroC/OS-II; The Real Time Kernel"-Taylor & Francis-2002.
3. G.S.Gupta and S.C.Mukhopadhyay-"Embedded Microcontroller Interfacing: Designing Integrated Projects"-Springer Publications- 2010.
4. J.Parab, V.G.Shelake and R.K.Kamat-"Exploring C for Microcontrollers: A Hands on Approach"-Springer-2007.
5. J.J.Labrosse-"Embedded Systems Building Blocks: Complete and Ready-to-use Modules in C"Taylor& Francis-2000.

List of Major Equipment/ Instrument/Software with Broad Specifications

1.Personal Computer (Windows or Linux) = 10 Nos.
2. DC RPS = 10 Nos.
3. 8051 development tools.
4. PCB design software.
5. μC/OS-II RTOS Library files.
6. Text LCD modules = 2 Nos.
7. Graphic LCD modules = 2 Nos.
10. GPS module = 2 Nos.
11. GSM module = 2 Nos.
12. General purpose Copper board.
13. PCB etching solution.
14. PCB soldering kit = 10 Nos.
15. 89C51RD2 IC = 10 Nos.
16. 7805 IC = 10 Nos.
17. MAX232 IC = 10 Nos.
18. 24C01 I2C EEPROM IC = 2 Nos.
19. IR sensor = 100 Nos.
20. IR LED = 100 Nos.
21. 8051 Programmer = 1 No.
22. Other interfacing ICs.

23. 11.0592 MHz crystal = 10 Nos.
24. Electronic Consumables like resistor and capacitor.

Course Code	Course Title	L	T	P	C
1152EC215	**SYSTEM ON CHIP (SOC)**	**1**	**0**	**4**	**3**

a) Course Category

Program Elective

b) Preamble

The primary focus of this integrated course “System on Chip” is the development of an embedded system using a current-day system on a chip (SoC) which consists of several different microprocessor subsystems together with memories and I/O interfaces. Students will also get an opportunity to design and implement the algorithms that are specific to real time systems/applications.

c) Prerequisite

Nil

d) Related Courses

Embedded System Design, Reconfigurable Computing with FPGA

e) Course Outcome

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Based on Dave’s Taxonomy)
CO1	Recreate the functionality of soft core and hard cores	S4
CO2	Enact the sub modules of Programmable SoC	S4
CO3	Demonstrate the programmable system on Chip interfacing with Peripheral devices	S4

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	H	L	H	L	L	-	-	-	-	M	M	-
CO2	M	M	H	L	H	L	L	-	-	-	-	M	M	M
CO3	M	L	H	L	H	L	L	L	-	-	-	M	M	M

g)Examination Scheme for practical dominated course										
Internal evaluation (40M)							Semester end evaluation (60M)			
Laboratory experiment (15M)				Model laboratory test (25M)			Part-A (20M)	Part-B (40M)		
Performance in conducting experiment (5)	Result and analysis (3)	Viva Voce (3)	Record (4)	Performance in conducting experiment (15)	Result and analysis (5)	Viva Voce (5)	Theory questions to evaluate the knowledge and understanding (20)	Performance in conducting experiment (25)	Result and analysis (10)	Viva-Voce (5)

h) Course Content :

Theory **15 Hours**

Introduction to System on Chip – Architecture – Components – Hardware and Software – Interconnections – Customization.
ARM architecture – Organization and Implementation – Instructions – Assembly Language Programming – Processor Cores.
PSoC Architecture – Structure – Modules – Interconnects – Memory Management – Multiple Configurations – Project Running.
APSoC Architecture – IP Creation – IP Integration – Implementation.
Embedded System on SoC – Application – Automation.

i) List of experiments

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	Introduction to Vivado Design Suite environment

2.	CO1	Synthesis and Implementation of Microblaze Processor.
3.	CO1	Creation of Custom IP Cores with the IP Integrator Utility.
4.	CO1	Creation of an Embedded Programmable System on Chip.
5.	CO2	Analog GPIO Driving using PSoC
6.	CO2	Digital GPIO Driving using PSoC
7.	CO2	Design and implementation of OpAmps for ADC using PSoC.
8.	CO2	Generation of PWM signal to drive servo motor using PSoC.
9.	CO2	Filter Design and Implementation using PSoC.
10.	CO2	Design and Implementation of DMA Controller using PSoC.
11.	CO2	Dynamic Reconfiguration using PSoC.
12.	CO3	Implementation of Arithmetic and Logical Unit in APSoC Architecture.
13.	CO3	Develop a System to Control the Speed of Motor in APSoC Architecture
14.	CO3	Interface a Temperature Sensor Module with APSoC architecture
15.	CO3	Design and Implementation of Embedded System on a Chip for Real Time Application

Total 75 hrs

j) Learning Resources

Textbooks

1. Michael J. Flynn, Wayne Luk, "Computer System Design: System-on-Chip", Wiley Publishers, OCT 2011.
2. Steve Furber, "ARM System-on-Chip Architecture" (2nd Edition) 2nd Edition, Pearson Education Limited, 2000.
3. Robert Ashby, "Designer's Guide to the Cypress PSoC (Embedded Technology)" Elsevier, 2005.
4. Louise Crockett, Ross A Elliot, Martin A Enderwitz, "The Zynq Book Tutorials for Zybo and ZedBoard Paperback", University of Strathclyde Glasgow, 2015
5. Nurmi J, "Processor Design System-On-Chip Computing for ASICs and FPGAs", Springer 2007

List of Major Equipment/ Instrument/Software with Broad Specifications

1. Vivado Compiler (Licensed version)
2. Cypress PSoC Board
3. Xilinx Zybo Board

List of Software/Learning Websites

1. https://www.xilinx.com/
2. http://www.cypress.com/
3. https://www.arm.com/

Online resources

1.http://nptel.ac.in/courses/108102045/10

Course Code	Course Title	L	T	P	C
1152EC116	**EMBEDDED PROCESSORS**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

This course covers application and design of ARM (Advanced RISC Machine) systems. Topics include assembly and C language programming and an introduction to the control and interfacing of ARM based systems

c) Prerequisite

Microprocessor and Microcontroller

d) Related Courses

Embedded Control System, Embedded Processors, Embedded Networking

e) Course educational objectives

1. Understand the basics of ARM processor and the architecture
2. Study the instruction sets of ARM
3. Understand the Cache concepts of embedded processor
4. Understand the memory management concepts
5. Explain real time operating systems, inter-task communication and an exemplary case of RTOS.

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Use the fundamentals of ARM processor with various registers and RISC architecture	K2
CO2	Apply various instructions and interrupt concept with the priority system to write a C program on basic problems.	K2
CO3	Study the cache concept dedicated to ARM	K2
CO4	Use the memory management involved in ARM	K2
CO5	Compare the IPC, Kernel Synchronization and scheduling concepts with multitasking	K2

g) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	-	-	-	-	-	-	-	-	-	L	-	-
CO2	L	-	-	-	M	-	-	-	-	-	-	-	L	M
CO3	L	M	-	-	-	-	-	-	-	-	-	M	-	M
CO4	-	-	-	-	L	-	-	-	-	-	-	L	-	M
CO5	-	M	L	-	-	-	-	M	-	-	-	-	-	-

h) Course Content

UNIT I ARM PROCESSOR FUNDAMENTALS 9

Data Flow model, Registers, modes of operation, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table ARM nomenclature and families. Big Endian and Little Endian

UNIT II ARM INSTRUCTIONS , INTERRUPTS, EXCEPTIONS 9

ARM and Thumb Instruction Sets, Data Processing Instructions, Branch Instructions, Load- Store Instructions, Software Interrupt Instruction, Program Status Register Instructions, Conditional Execution, Stack Instructions, Software Interrupt Instruction.vector table, priorities, link Register offsets, interrupts, and IRQ / FIQ exceptions interrupt stack design and implementation Assembly language programming

UNIT III ARM CACHE MECHANISM 9

Introduction to cache memory, memory hierarchy and cache memory, Cache architecture and cache policies flushing and Cleaning ARM cache core locking Code and Data in CacheCache and write buffer

UNIT IV ARM MEMORY MANAGEMENT UNIT 9

MEMORY PROTECTION AND MANAGEMENT UNIT: Introduction to protection unit, Protected Regions, and Demonstration of an MPU system. Virtual Memory working principle

UNIT V REAL TIME SCHEDULING 9

Fundamental Components to Embedded OS, Simple Little Operating System: Initialization, memory model, interrupts and exceptions handling, Scheduler, and context switch .Introduction to Semaphores and types. Inter process communication: pipes and message box.
CASE STUDY: Smart phone, Smart TV, Global positioning System.

Total 45 Hrs

I) Learning Resources

Text Books

1. ARM System Developer's Guide Designing and Optimizing" by Andrew N.Sloss Elsevier publication, 2004.
2. "MicroC/OS – II" second edition The Real Time Kernel Jean J. Labrosse Publisher: Viva Books Private Ltd (Feb 2002)

Reference Books

1. Embedded systems" B.Kanta Rao PHI publishers, Eastern Economy Edition, 2011
2. Embedded Systems Architecture" - Tammy Noergaard, Newness edition, 2005
3. ARM System-on-Chip Architecture" 2nd Edition, Steve Furbe, Pearson Education, 2000
4. Embedded/Real Time Systems" Dr. K.V.K.K PRASAD Dream tech press, 2009

Online Resource

1. www.mit.org
2. www.nptel.ac.in

Course Code	Course Title	L	T	P	C
1152EC117	**EMBEDDED NETWORKING**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course introduces the embedded communication protocol.

c) Prerequisite

Nil

d) Related Courses

Embedded Control System, Embedded Processors, Internet of things.

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the serial and parallel communication protocol related to embedded networking.	K2
CO2	Discuss the concepts of USB & CAN bus.	K2
CO3	Familiarize the basics of Ethernet communication	K2
CO4	Explain the concepts of Embedded Ethernet.	K2
CO5	Recognize the need for wireless protocols to indulge in Real world interfacing.	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	L	-	-	-	-	M	-	-	-	M	L	-
CO2	M	M	M	-	M	-	-	-	-	-	-	M	M	-

CO3	M	L	M	-	L	-	-	-	-	-	-	-	L	-
CO4	M	-	L	-	M	-	-	-	-	-	-	-	M	-
CO5	M	L	-	-	M	-	-	-	-	-	-	H	-	-

g) Course Content

UNIT I EMBEDDED COMMUNICATION PROTOCOLS 9

Introduction , Serial/Parallel communication: Serial communication protocols -RS232 standard – RS485, – Synchronous Serial Protocols: Serial Peripheral Interface (SPI) , Inter Integrated Circuits (I2C) , PC Parallel port programming , ISA/PCI Bus protocols ,Fire wire.

UNIT II USB AND CAN BUS 9

USB bus : Introduction – Speed Identification on the bus – USB States , USB bus communication :Packets –Data flow types , A simple application with USB: Inkjet printer, CAN Bus:– Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing –CAN Interface –A simple application with CAN: Telephone exchange.

UNIT III ETHERNET BASICS 9

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol.

UNIT IV EMBEDDED ETHERNET 9

Exchanging messages using UDP and TCP, Serving web pages with Dynamic Data, Serving web pages that respond to user Input , Email for Embedded Systems , Using FTP ,Keeping Devices and Network secure.

UNIT V WIRELESS EMBEDDED NETWORKING 9

Wireless sensor networks: Introduction – Applications – Network Topology – Localization –Time Synchronization, Energy efficient MAC protocols: SMAC , Energy efficient and robust routing, Data Centric routing.

Total 45 Hrs

h) Learning Resources

Text Books

1. Weste and Eshraghian, “Principles of CMOS VLSI design”, Pearson Education, 1999
2. M.L. Bushnell and V.D. Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits”, Kluwer Academic Publishers, 2004

3. P.K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002
4. N.K. Jha and S.G. Gupta, “Testing of Digital Systems”, Cambridge University Press, 2003

Reference Books

1. W. W. Wen, “VLSI Test Principles and Architectures Design for Testability”, Morgan Kaufmann
2. A.L.Crouch, “Design Test for Digital IC’s and Embedded Core Systems”, Prentice Hall International, 2002.
3. ZainalabeNavabi, “Digital System Test and Testable Design: Using HDL Models and Architectures”, Springer, 2010
4. A.K Sharma, Semiconductor Memories Technology, Testing and Reliability, IEEE.
5. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House

Online Resources

1. www.nptel.ac.in/courses/106103016

Course Code	Course Title	L	T	P	C
1152EC118	**EMBEDDED CONTROL SYSTEM**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

To enable the student to get a detailed knowledge of all the hardware components and to understand the different interfaces required for connecting these hardware devices

c) Prerequisite

Microprocessor and Microcontroller

d) Related Courses

Embedded system Design, embedded processor, System on chip, Embedded networking

e) Course educational objectives

1. To study about the basics of data lines, address lines, control lines and ports of both hard ware and software system.
2. To learn various input and output devices.
3. To study of A / D converters and D / A converters.
4. To study the various types of serial communication.
5. To learn about Telephonic systems – Stepper control – Digital voltmeter - PWM motor speed controller- Robot system -Washing Machine –Automotive System –Auto Focusing Digital Camera – Air Conditioner.

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basics of embedded control system	K2
CO2	Discuss various input and output devices which will satisfy to develop embedded applications	K2
CO3	Explain A/D and D/A process to build the embedded system	K2
CO4	Discuss different types of asynchronous serial communication for	K2

	embedded system.	
CO5	Develop the embedded control system model for various application such as Telephonic systems – Stepper control – Digital voltmeter - PWM motor speed controller- Robot system etc.	K3

e)	**Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	L	-	-	-	L	-	-	-	-	-	-	-	-	-
CO2	M	M	-	-	M	-	-	-	-	-	-	-	-	-
CO3	H	H	L	-	-	-	-	-	-	-	-	-	L	-
CO4	L	-	M	-	-	L	-	-	-	-	-	M	-	-
CO5	M	H	M	-	M	-	L	-	L	-	-	L	-	L

f) Course Content

UNIT I INTRODUCTION 9

Controlling the hardware with software – Data lines, Address lines, Ports – Schematic representation – Bit masking – Programmable peripheral interface – Switch input detection – 74 LS 244

UNIT II INPUT-OUTPUT DEVICES 9

Keyboard basics – Keyboard scanning algorithm – Multiplexed LED displays –Character LCD modules, LCD module display, Configuration – Time-of-day clock – Timer manager - Interrupts - Interrupt service routines, IRQ, ISR, Interrupt vector or dispatch table multiple-point - Interrupt-driven pulse width modulation.

UNIT III D/A AND A/D CONVERSION 9

R to 2R ladder - Resistor network analysis - Port offsets - Triangle waves analog vs. digital values - ADC0809 – Auto port detect - Recording and playing back voice – Capturing analog information in the timer interrupt service routine - Automatic, multiple channel analog to digital data acquisition

UNIT IV ASYNCHRONOUS SERIAL COMMUNICATION 9

Asynchronous serial communication – RS-232, RS-485 – Sending and receiving data – Serial ports on PC – Low-level PC serial I/O module, buffered serial I/O.

UNIT V **EMBEDDED CONTROL APPLICATIONS** **9**

Telephonic systems – Stepper control – Digital voltmeter - PWM motor speed controller- Robot system - Washing Machine –Automotive System –Auto Focusing Digital Camera – Air Conditioner.

Total 45 Hrs

g) Learning Resources

Text Books

1. Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", The publisher, Paul Temme, 2003
2. Ball S.R., 'Embedded microprocessor Systems – Real World Design', Prentice Hall, 2001
3. Chattopadhyay, "Embedded System Design",PHI Learning, 2011.
4. Steven F.Barrett,DanielJ.Pack,"Embedded Systems-Design & Application with the 68HC12 & HCS12", Pearson Education,2008

Reference Books

1. Herma K, "Real Time Systems – Design for distributed Embedded Applications", Kluwer Academic, 2003
2. Daniel W. Lewis, "Fundamentals of Embedded Software where C and Assembly meet", PHI, 2002.

Course Code	Course Title	L	T	P	C
1152EC237	**EMBEDDED SYSTEMS AND ROBOTICS**	**1**	**0**	**4**	**3**

a) Course Category

Program Elective

b) Preamble

This course introduces the embedded hardware design, programming and introduction of robotics, electronic components, electronic processors and controllers, circuit development with practical knowledge of each modules to give our student the best of robotics training for real-time applications.

c) Prerequisite

Microprocessor and Microcontroller

d) Related Courses

Nil

e) Course Outcome

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Demonstrate PIC based embedded systems	S3
CO2	Design and demonstrate real time systems using Arduino	S3
CO3	Design robots using Webots based on e-puck for the given specification and demonstrate it	S3

f) Correlation of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	-	L	H	-	L	-	M	L	-	M	H	H
CO2	M	-	H	H	H	-	L	-	H	L	M	H	H	H
CO3	-	-	H	H	H	L	L	L	H	L	-	H	H	H

g) Examination Scheme for practical dominated course										
Internal evaluation							**Semester end evaluation**			
(40M)							**(60M)**			
Laboratory experiment (15M)				**Model laboratory test (25M)**			**Part-A (20M)**	**Part-B (40M)**		
Performance in conducting experiment (5)	Result and analysis (3)	Viva Voce (3)	Record (4)	Performance in conducting experiment (15)	Result and analysis (5)	Viva Voce (5)	Theory questions to evaluate the knowledge and understanding (20)	Performance in conducting experiment (25)	Result and analysis (10)	Viva-Voce (5)

h)Course Content :

Theory **15 Hours**

PIC-Architecture, pin diagram, ports, on chip peripherals Embedded C programming – General Structure, Data types.

Embedded C programming – General Structure, Data types.

Arduino- introduction, IDE, different arduino, Boards & shields.

Analog I/O & o/p.Serial and Parallel Communication

Microcontroller ATMEGA 328

Seven Segment and LCD Display

Driving motors

Manual Robots and Autonomous Robots - fundamentals and its applications

Gear assembly and calculations Different

types of chassis designing

RTOS fundamentals.

i) List of experiments

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	Exploring the features of MPLAB X IDE
2.	CO1	Exploring the features of Proteus
3.	CO1	LED and seven segment display using PIC
4.	CO1	Keypad interface using PIC
5.	CO1	Serial communication using PIC
6.	CO1	PWM generation using PIC
7.	CO1	Motor speed control using PIC
8.	CO2	Exploring the features of Arduino IDE and Boards
9.	CO2	LED Interfacing using Arduino
10.	CO2	RGB LED interface using Arduino
11.	CO2	LCD Interfacing using Arduino.
12.	CO2	LDR Interfacing using Arduino.
13.	CO2	IR sensor interfacing using Arduino
14.	CO2	Ultrasonic sensor interface using Arduino
15.	CO2	Temperature sensor interfacing using Arduino.

16.	CO2	Motor interface using Arduino
17.	CO2	Bluetooth Interfacing using Arduino
18.	CO2	GSM module Interfacing using Arduino
19.	CO2	WiFi Interfacing using Arduino
20.	CO3	Building a Robot Car
21.	CO3	Programming the Robot Car using Arduino
22.	CO3	Exploring the features of Webots
23.	CO3	LED Control of e-puck Robot in Webots
24.	CO3	Motor Control of e-puck Robot in Webots
25.	CO3	LED and Motor Control of e-puck Robot using keyboard in Webots
26.	CO3	Line Follower e-puck Robot in Webots

Total 75hrs

j) Learning Resources

Textbooks

1. Massimo Banzi, "Getting Started with Arduino" 2 nd edition. O'Reilly, 2011.
2. Udayakumar, G.Kulkarni, " Arduino: A Begineer's Guide" 2017
3. DoganIbrahi, "Advanced PIC Microcontroller Projects in C", Newnes, 2008.
4. MykePredko, "Programming and customizing the PIC", 3 rd edition.
5. Parab, V.G.Shelake and R.K.Kamat-"Exploring C for Microcontrollers: A Hands on Approach"-Springer-2007.
6. M. ShohamA Textbook of Robotics 1: Basic Concepts Springer-1984.
7. By Kevin M. Lynch, Frank C. Park "Modern Robotics mechanics, planning, controls" Cambridge university press-2017.
8. Cameron Hughes, Tracey Hughes "Robot Programming: A Guide to Controlling Autonomous Robots", 1/e First Edition-2016.
9. John-David Warren, Josh Adams, HaraldMolle, "Arduino Robotics" apress.

Online Resources

1. https://www.arduino.cc//
2. https://www.tutorialspoint.com/arduino/index.html

3. http://microcontrollerslab.com/pic-microcontroller-compiler/
4. http://bobblick.com/techref/techref.html
5. http://www.microcontrollerboard.com/pic-microcontroller-books.html
6. http://www.nex-robotics.com/products/microcontroller-development-boards/atmega2560-microcontroller-socket.html
7. http://www.avr-asm-download.de/beginner_en

Course Code	Course Title	L	T	P	C
1152EC148	VIDEO SURVEILLANCE SYSTEM	3	0	0	3

a) Course Category

Program Elective

b) Preamble

This course delivers camera classification, hardware, video management system, and video networking and CCTV systems.

c) Prerequisite

Nil

d) Related Courses

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Discuss different types of camera.	K2
CO2	Explain digital video hardware	K2
CO3	Describe video management system.	K2
CO4	Familiarize the video networking concepts.	K2
CO5	Explain CCTV characteristics, components and system design.	K2

f)	Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	L	L	L	M
CO2	L	L	L	-	-	-	-	-	-	-	-	-	-	L
CO3	-	M	-	L	-	L	-	-	-	-	-	-	L	-
CO4	L	L	-	-	-	L	-	-	-	-	-	M	M	M

CO5	M	M	L	-	-	-	-	-	-	-	-	-	M	M

g) Course Content

UNIT I CAMERA CLASSIFICATION 9

Introduction, Analog camera, Digital Camera, Wired Camera, Wireless camera , HD Camera , IP/Network Cameras, Indoor/Outdoor Cameras, Pan/Tilt/Zoom Cameras and smart cameras.

UNIT II DIGITAL VIDEO HARDWARE 9

Evolution of Video Surveillance Hardware, selection of Right Cameras, PTZ Protocols and Communications, Two-Way Audio, Configuring and Commissioning Digital Video Encoders, Digital Video Cables and Connectors.

UNIT III VIDEO MANAGEMENT SYSTEMS (VMS) 9

Introduction to VMS, Dual VMS, Video Analytics, Troubleshooting .VMS Requirements, ,Portable Observation Device (POD), Edge Recording, storage and Security.

UNIT IV VIDEO NETWORKING 9

Introduction, Power of the Network, Networked Video Delivery Methods, Interference, Line of Sight (LOS), Wireless Mesh Networking, Wireless Security Options and Troubleshooting.

UNIT V CLOSED-CIRCUIT TELEVISION (CCTV) SYSTEMS 9

Characteristics of CCTV System Design, Components of CCTV, CCTV system design, case studies of ATM and Vehicle parking system.

Total 45 Hrs

h) Learning Resources

Text Books

1. Anthony Caputo ,"Digital Video Surveillance and Security IInd edition" , Elsevier 2014
2. Q. Huihuan, X. Wu, Y. Xu, "Intelligent Surveillance Systems", Springer Publication, 2011.
3. H. Aghajan and A. Cavallaro (Ed.), Multi-Camera Network: Principles and Applications", Elsevier, 2009.
4. Murat A. Tekalp, "Digital Video Processing", Prentice Hall, 1995.
5. Y. Ma and G. Qian (Ed.), "Intelligent Video Surveillance: Systems and Technology", CRC Press, 2009.
6. A senior (Ed.), "Privacy Protection in Video Surveillance", Elsevier, 2009.
7. Dr. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Publication, 2010.

COURSE CODE	COURSE TITLE	L	T	P	C
1152EC255	EMBEDDED C PROGRAMMING	3	0	2	4

a. Course Category:

Program Elective

b. Preamble

The main aim of this course is to provide learners with practical skills and a strong foundation that they can build upon to start producing well written code from the scratch. This course assumes no prior knowledge of neither cortex-m nor embedded-c programming. This Course will provide an ideal platform for the applications, and has been developed to be fully programmable in C making it widely accessible to embedded software engineers.

c. Course Educational Objective

On completion of this course,

- Successful participants will be able to perform effectively as entry level Embedded Systems professionals.
- Develop and maintain applications written using Embedded C.
- Independently design and develop a hardware platform encompassing a microcontroller and peripherals.

d. Prerequisite Courses

Microprocessor and Microcontroller

e. Related Courses

Embedded OS and Device Drivers
Embedded Processor
Real Time Operating System
System on Chip
Internet of Things

f. Course Outcome:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcome	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explores the Embedded System development life cycle and identify various ARM Cortex architecture.	K2
CO2	Discover Embedded C programming components and concepts.	K3

CO3	Associate Embedded C programming concepts with basic peripherals of ARM and its programming techniques.	K3
CO4	Associate Embedded C programming concepts with communication peripherals of ARM and its programming techniques.	K3
CO5	Apply Embedded C programming concepts for the desired application with ARM.	K3
CO6	Develop, simulate and implement Embedded C programs for ARM based systems for the given specifications.	S3

g. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M	L			L							M		H
CO2	M	H	M	M	H			L	M	M	H	H	H	H
CO3	M			M	H									
CO4	M			M	H									
CO5			L											
CO6			M	M	H				M	M	H	H	H	H

H- High; M-Medium; L-Low

h. Course Content:

UNIT 1: Introduction to Embedded System

Embedded System Overview: Design flow, Introduction to C, Software development process – **ARM Hardware architecture overview and Selection:** ARM Classic, Secure Core, Cortex M Series, Cortex R Series, Cortex A Series. Introduction to Cortex M0.

UNIT 2: Introduction to Embedded C Programming

Embedded C Programming: Basic Structure, Data Types, Operators and Expressions, Identifiers, Name space & Scope, Flow controls, Loops – **Components:** Comments, Global Variables, Local Variables, Main Function.

UNIT 3: Basic Peripherals Programming

Interrupt programming, General Purpose Digital Interfacing, General Purpose Analog Interfacing: A-D interfacing, D-A interfacing, Timers control, Signal generators, PWM.

UNIT 4: Advanced Peripherals Programming

Serial Communication: Universal Asynchronous Receiver Transmitter, Serial Peripheral Interface, Inter Integrated Circuits, Direct Memory Addressing.

UNIT 5: Interfacings and Applications

Tone Generation, Pseudo Code Generation, Event Recorder, Watchdog timer, Interfacing

Digital & Analog Sensor, Actuator Control.

TEXT BOOK

1. Jonathan W Valvano “Introduction to ARM Cortex M microcontroller” Fifth Edition 2014.
2. Cortex-M0+ Devices Generic User Guide, ARM Limited.
3. Cortex-M0+ Technical Reference Manual, ARM Limited.

REFERENCE

1. Keil uVision MDK : http://www.keil.com/arm/mdk.asp
2. Getting started with Keil uVision: http://www.keil.com/product/brochures/uv4.pdf
3. Useful links to other user manuals: http://www.keil.com/arm/man/arm.htm

LIST OF EXPERIMENTS

Write an embedded C code to

1. Demonstration of Proteus IDE
2. Demonstration of KEIL IDE
3. Introduction to ARM Development Board
4. LED, 7-Segment Interface
5. Switch, Keypad Interface
6. LCD Interface
7. ADC Interface
8. DAC Interface
9. PWM, Sine Wave Generation
10. UAT Interface
11. Stepper Motor Interface
12. Implement watch dog timer
13. Develop a Real Time Clock

Course Code	Course Title	L	T	P	C
1152EC119	**MOBILE COMMUNICATION**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

This course provides an introduction to the basic concepts and techniques of cellular radio Communication, Mathematically analyze mobile radio propagation mechanisms, design Base Station (BS), Mobile Station (MS) parameters, analyze the antenna configurations and types, to study the recent trends adopted in cellular and wireless systems and standards

c) Prerequisite

Nil

d) Related Courses

Wireless Ad Hoc & sensor networks

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic concepts of cellular radio and capacity improvements techniques.	K2
CO2	Apply the concepts of mobile radio propagation models to solve problems for the given specification	K3
CO3	a. Describe fading mechanism b. Explain the design parameters required for Base and mobile station	K2
CO4	Explain the multiple access techniques with its comparison.	K2
CO5	Describe the latest wireless technologies and standards.	K2

f) **Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	-	-
CO2	H	M	M	-	-	-	-	-	-	-	-	-	-	-
CO3	M	L	L	-	-	-	-	-	-	-	-	-	-	-
CO4	H	L	-	-	M	-	-	-	-	-	-	L	-	-
CO5	M	L	-	-	-	-	-	-	-	-	-	M	-	-

g) Course Content

UNIT I Introduction to Wireless Communication 9

History and evolution of mobile radio communication-Mobile radio systems around the world-Examples of wireless communication-Generations –Frequency reuse – Channel Assignment strategies – Handoff strategies – Interference- Trucking and Grade of service-Improving Coverage and capacity of cellular system

UNIT II MOBILE RADIO PROPAGATION 9

Radio wave propagation-Free space propagation model – Basic propagation mechanism-Ground reflection model-Knife edge diffraction model-radar cross section model-Practical Link budget design. Indoor and outdoor propagation model.

UNIT III FADING AND DESIGN PARAMETERS OF BASE AND MOBILE STATION 9

Fading. Multipath propagation. Statistical characterization of multipath fading. Diversity Techniques. Design parameters at the base station: Antenna location-Spacing-height configuration. Design parameters at the Mobile unit: Directional antennas -Antenna Connection and Location

UNIT IV MULTIPLE ACCESS SCHEMES 9

Operation principle and working of FDMA-TDMA-CDMA-WCDMA-OFDM -MC-CDMA –SDMA and its comparison

UNIT V WIRELESS SYSTEMS AND STANDARDS 9

GSM, CDMA - 3G-4G (LTE) - NFC systems-WLAN technology- WLL- Ad hoc networks- Bluetooth-WIFI

Total 45 Hrs

h) Learning Resources

Text Books

1. T.S.Rappaport, "Wireless Communications: Principles and Practice, Second Edition, Pearson Education/ Prentice Hall of India, Third Indian Reprint 2003.
2. W.C.Y.Lee,"Mobile Communication Design Fundamentals",secondedition,john Wiley & sons,1993

Reference Books

1. P. MuthuChidambara Nathan, Wireless Communications, PHI, 1st edition 2008.
2. Goldsmith, Wireless Communications, Cambridge University Press, 1st edition 2005.
3. R. Blake, " Wireless Communication Technology", Thomson Delmar, 1st edition 2000.
4. W.C.Y.Lee, "Mobile Communications Engineering: Theory and applications, Second Edition, McGraw-Hill International, 1998.

Online Resources

1. http://www.see.ed.ac.uk/~hxh/ADCCourseMaterial/4.rc.2.pdf
2. http://www.diva-portal.org/smash/get/diva2:501119/FULLTEXT01.pdf
3. http://www.durofy.com/multiple-access-techniques-fdma-tdma-cdma/

Course Code	Course Title	L	T	P	C
1152EC120	**SATELLITE COMMUNICATION**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

The principles of radio communication have wider applications, but the unique attributes of orbiting satellites and the techniques used for communication via these satellites requires a specialized course. This course gives students a broad treatment of the diverse subsystems that make up a complete satellite communication system

c) Prerequisite

Nil

d) Related Courses

Wireless Digital Communication, Cellular Mobile Communication.

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic concepts of orbit mechanics and satellite Launching	K2
CO2	Describe about link design between earth station and satellite	K2
CO3	Explain the basic concepts of earth station technology	K2
CO4	Classify various access methods in space segment	K2
CO5	Describe the services rendered by the satellite and its future applications	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	M	-	L	L	-	-	-	-	-	-	-
CO2	M	M	M	-	L	-	-	-	L	-	-	-	-	-
CO3	L	L	M	-	M	L	L	L	-	L	L	-	L	-
CO4	L	M	M	-	-	L	L	-	-	-	-	-	-	-
CO5	L	M	M	-	L	-	-	-	L	-	-	L	L	-

g) Course Content

UNIT I INTRODUCTION TO SATELLITE COMMUNICATION 9

Orbital mechanisms: Origin and Brief History - Basic laws (Kepler's law & Newton's law), Orbital mechanics: Equation of Orbit- Geostationary Orbit- Location of Satellite in Orbit- Orbital Elements, Orbital Perturbations, Look Angle Determination: Elevation and Azimuthal Calculation, Launching Techniques. Satellite subsystems: Attitude and orbit control subsystem, power subsystem, telemetry tracking and command systems, communication subsystems

UNIT II SATELLITE LINK DESIGN 9

Basic transmission theory, Equivalent isotropic radiated power – Transmission losses – Free-space transmission – Feeder losses – Antenna misalignment losses – Fixed atmospheric and ionospheric losses – Link power budget equation, System Noise: Noise Temperature and Noise Figure – G/T Ratio, Downlink and uplink system design, Design of satellite links for specified C/N.

UNIT III EARTH SEGMENT 9

Introduction – Receive – Only home TV systems – Outdoor unit – Indoor unit for analog (FM) TV, Master antenna TV system, Community antenna TV system, Transmit – Receive earth stations

UNIT IV SATELLITE ACCESS 9

Analog – digital transmission system- Modulation and Multiplexing, Digital video Broadcast, Types of multiple access: FDMA concepts - Inter modulation and back off - SPADE system- TDMA concept- frame and burst structure - CDMA concept, Comparison of multiple access schemes

UNIT V SATELLITE APPLICATIONS 9

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS) - Direct to home Broadcast (DTH), Digital audio broadcast (DAB)- World space services, Business TV(BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet.

Total 45 Hrs

h) Learning Resources

Text Books

1. Dennis Roddy, “Satellite Communication”, McGraw Hill, Fourth Edition, 2006.
2. Pratt and Bostian, “Satellite communication”, John Wiley and Sons, 2007

Reference Books

1. Tri. T. Ha, “Digital satellite communication system”, McGraw Hill.
2. Pritchend and Sciulli, “Satellite communication systems engineering”, PHI Learning, 1986.
3. Robert M. Gagliendi, “Satellite communication”, John Wiley and Sons, 1988.
4. M. Richharia, “Satellite communication system design and analysis”, Mc-Millan, 1996.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc17_ec14
2. https://www.coursera.org/learn/satellite-communications
3. https://www.class-central.com/tag/satellite%20communications
4. https://ep.jhu.edu/programs-and-courses/525.440-satellite-communications-systems

Practice Aspects

1. Tool**:** Satellite Network Simulator 3 (SNS3).

Course Code	Course Title	L	T	P	C
1152EC221	**ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY**	**2**	**0**	**2**	**3**

a) Course Category

Program elective

b) Preamble

This course provides basic information on the different electromagnetic Interference problems occurring in Intersystem, their possible mitigation techniques in Electronic design, also to understand EMI sources, EMI problems, their solutions at PCB level, as well as to understand sub system level design and to measure the emission, immunity level from different systems to couple with the prescribed EMC standards.

c) Prerequisite

Electromagnetic Fields

d) Related Courses

Waveguides& Antennas

e) Course educational objectives

Introduce the concepts of electromagnetic interference and electromagnetic interference compatibility

Study the electromagnetic interferencecoupling principles

Study the electromagnetic interference control techniques

Learn electromagnetic compatibility design of PCBS

Discuss electromagnetic interference measurements and standards

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the concept of EMI / EMC related to product design & development.	K2
CO2	Analyze the different EM coupling principles and its impact on performance of electronic system.	K3
CO3	Analyze the electromagnetic interference, highlighting the	K3

	concepts of both susceptibility and immunity.	
CO4	Analyze various EM compatibility issues with regard to the design of PCBs and ways to improve the overall system performance.	K3
CO5	Describe various EM radiation measurement techniques and the present leading edge industry standards in different countries	K2

g)	Correlation of COs with POs													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO 1	H	H	M	L	L	-	-	L	-	-	-	L	-	-
CO 2	H	H	M	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	H	-	-	M	-	-	-	-	-	-	-	L	-
CO 4	M	H	-	-	L	-	-	-	-	-	-	-	L	-
CO 5	M	-	-	L	L	L	-	-	-	L	L	-	L	-

h) Course Content

UNIT I EMI/EMC CONCEPTS 9

EMI-EMC definitions and Units of Parameters; Sources and Victim of EMI; Conducted and Radiated EMI Emission and Susceptibility; Transient EMI, ESD; Radiation Hazards.

UNIT II EMI COUPLING PRINCIPLES 9

Conducted, Radiated and Transient coupling; Common ground impedance coupling; Common mode and Ground loop coupling; Differential mode coupling; Near field cable to Cable coupling, Cross talk; Field to Cable coupling; Power mains and Power supply coupling.

UNIT III EMI CONTROL TECHNIQUES 9

Shielding Material- Characteristics of Filters-Impedance and Lumped element filters-Filter installation and Evaluation; Grounding, Bonding, Isolation transformer, Transient suppressors, EMC Gaskets.

UNIT IV EMC DESIGN OF PCBS 9

EMI Suppression Cables-Devices-Transient protection hybrid circuits; PCB Trace impedance; Routing; - Electromagnetic Pulse-Noise from Relays and Switches, Power distribution decoupling; Zoning; Grounding

UNIT V EMI MEASUREMENTS AND STANDARDS 9

Open area test site; TEM cell; EMI Test Shielded chamber and Shielded Ferrite Lined anechoic chamber; Tx /Rx Antennas, Sensors, Injectors / Couplers, and Coupling factors; EMI Rx and Spectrum analyzer; Civilian Standards-CISPR, FCC, IEC, EN; Military Standards –Frequency Allocation and Spectrum Utilization - Comparisons.

List of experiments

S. No	Practical Exercises (15 Hours)	COs
1.	Concept of Self-Induction Board	CO1
2.	Concept of Lenz Law	CO1
3.	EMI effects on Co-axial Cable	CO2,CO3
4.	Concept of Cross Talk Basic Phenomena	CO2,CO4
5.	EMI effects on Cross Talk problem	CO2,CO4
6.	EMI effects on Inductance and Capacitance with various VIAs and	CO4
7.	EMI effects on Inductance and Capacitance with Radial and SMD components	CO4
8.	EMI effects on Ground Bounce for Symmetric IC Power Pins	CO4
9.	EMI effects on Ground Bounce with Difference Between Symmetric and Asymmetric IC Power Pins	CO4

Total 60 Hours

i) Learning Resources Text Books

1. V.P.Kodali,"EngineeringEMCPrinciples,MeasurementsandTechnologies",IEEEPress, Newyork, 1996.
2. HenryW.Ott.,"NoiseReductionTechniquesinElectronicSystems",AWileyInter SciencePublications,JohnWileyandSons,Newyork,1988.

Reference Books

1. BemhardKeiser,"PrinciplesofElectromagneticCompatibility",3rd Ed,Artechhouse,Norwood, 1986
2. C.R.Paul, "Introduction to ElectromagneticCompatibility",JohnWileyandSons,Inc, 1992.

Online Resources

1. http://www.metlabs.com/blog/emc/electromagnetic-compatibility-compliance-engineers-use-
these-emc-resources/
2. http://www.intertek.com/emc/

Course Code	Course Title	L	T	P	C
1152EC122	**RF AND MICROWAVE INTEGRATED CIRCUITS**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

RF & Microwave Engineering Circuits is a course designed for introducing the field of Microwave Engineering to students, engineers and academics. Practical design issues of microwave circuits will be emphasized and fabrication techniques of microwave integrated circuits will also be treated. Further new numerical analysis techniques as well as radio architectures are also introduced

c) Prerequisite

Transmission Lines and Waveguides, Antenna and Wave Propagation

d) Related Courses

Microwave Engineering

e) Course educational objectives

1. To understand the characteristics of transmission lines and waveguides.
2. To study and design of planar transmission lines for RF circuits.
3. To understand the MIC fabrication and measurement techniques.
4. To learn the design concepts of RF & MIC using various numerical analysis technique.
5. To study the concept of various radio architectures and applications

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the propagation characteristics of electromagnetic waves in transmission lines.	K2
CO2	Explain the different planar strip line techniques.	K2
CO3	Explain the fabrication method of MIC and different measurement setups.	K2
CO4	Analyze the RF & microwave circuits using various numerical techniques.	K4
CO5	Describe some basic properties of different radio architectures. Explain the applications of RF & MIC.	K2

g) Correlation of Cos with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	-	M	H	-	-	-	L	L	-	-	-	-
CO2	H	M	M	M	H	M	L	-	L	L	L	M	L	-
CO3	L	L	L	L	-	L	-	-	L	L	L	H	H	-
CO4	H	M	-	M	L	-	L	-	L	L	L	-	L	-
CO5	M	M	-	M	L	-	-	-	L	L	-	M	H	-

h) Course Content

UNIT I REVIEW OF BASIC MICROWAVE THEORY 9

Transmission Lines and waveguides-Concepts of characteristic impedance, reflection coefficient, standing and propagating waves, Modes and evanescent waves

UNIT II PLANAR TRANSMISSION LINES 9

Planar transmission lines-strip line, microstrip line, coplanar waveguide, coplanar strips slot line, fin line and characteristics, properties; design parameters and its applications

UNIT III MIC FABRICATION AND MEASUREMENT TECHNIQUES 9

Introduction to MICs-Fabrication technology, Advantages and applications. Measurement techniques: Test fixture measurements, probe station measurements, thermal and cryogenic measurements, experimental field probing techniques and anechoic chamber measurements

UNIT IV NUMERICAL ANALYSIS 9

FDM, FDTD, FEM Analysis in 1D & 2D, Solution of integral equations using MoM, comparison of FDM, FDTD, FEM, and MoM.

UNIT V RADIO ARCHITECTURES AND APPLICATIONS 9

GSM radio architectures, UMTS radio architectures, Software defined radio. Radar sensors for traffic surveillance, cognitive radio applications, healthcare applications, space applications, defense and Wireless applications

Total 45 Hrs

i) Learning Resources

Text Books

1. D.M.Pozar, "Microwave Engineering", John Wiley, 3rd ed., 2004
2. B.Bhat and S.Koul, "Stripline Like transmission lines for MICS", John Wiley, 1989
3. T. Itoh, editor, Numerical Techniques for Microwave and Millimeter-wave Passive Structures Wiley, NY, 1989
4. Habil. MBA Frank Ellinger, "Radio frequency integrated circuits and technologies", Springer-Varlag Berlin Heidelberg, 2007.

Reference Books

1. Ramesh Garg, "Analytical and Computational Methods in Electromagnetics" Artech House, 2008
2. Gupta. K.C and R. Garg, " Microstrip line and slot line" Artech House, Boston, 1996
3. Ravender Goyal, "Monolithic MIC; Technology & Design", Artech House, 1989
4. Robert Caverly, "CMOS RFIC Design Principles" Artech House, 2007.

Online Resource

1. http://bulletin.engineering.nyu.edu/preview_course_nopop.php?catoid=4&coid=6687
2. http://home.sandiego.edu/~ekim/e194rfs01/
3. http://www.ece.mcmaster.ca/faculty/nikolova/4FJ4_6FJ4.htm
4. https://apps.ep.jhu.edu/course-homepages/2602-525.787-microwave-monolithic-integrated-circuit-mmic-design-penn-thompson
5. http://www.ece.ucsb.edu/Faculty/rodwell/Classes/ECE218a/ECE218a.htm

Practical Aspects

1. Available interactive software such as IE3D, HFSS, CST & FEKO.: To visualize the impedance matching and calculate the characteristics of RF & microwave devices.

Course Code	Course Title	L	T	P	C
1152EC123	**RADAR AND ELECTRONIC NAVIGATION SYSTEMS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course Radar and Electronic Navigation Systems provides an introduction to radar systems and to acquire knowledge about various advanced electronic navigation systems.

c) Prerequisite

Analog Communication Systems

d) Related Courses

Optical and Microwave Engineering, Waveguides and Antenna ,Wireless Digital Communication

e) Course Outcome

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the principles and characteristics of basic radar system and applications	K2
CO2	Describe principles of MTI radar system , CW pulse Doppler radar and FMCW radar	K2
CO3	Describe the principles of various tracking techniques and radar	K2
CO4	Describe the characteristics of radar clutter and conventional navigational methods	K2
CO5	Explain various advanced navigation techniques and systems	K2

f) Correlation of COs with POs

g)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	M	L	-	-	L	-	-	-	-	-	-	-
CO2	M	M	L	M	-	-	-	-	-	-	-	-	-	-
CO3	M	M	L	-	-	-	-	-	-	-	-	-	-	-
CO4	M	M	M	-	-	-	-	L	H	M	L	-	-	-
CO5	M	M	M	H	M	-	L	-	-	-	-	L	-	-

h) Course Content

UNIT I BASIC CONCEPTS AND RADAR EQUATIONS **9**

Introduction to radar, Radar equation, Radar Block diagram and Operation, Radar Frequencies- millimeter and sub millimeterwaves , Application of Radars, Range performance of radars, System losses and propagation effects.

UNIT II CW, FM CW AND MTI RADAR **9**

Introduction to MTI and Doppler radar : Delay Line canceller - Moving Target Detector- Pulse Doppler Radar-CW Radar – FMCW Radar- Multiple or staggered Pulse Repetition Frequencies, MTI radar Processor, Types of MTI.

UNIT III TRACKING RADAR **9**

Tracking Radar and its types- Conical scan and Sequential lobbing, Monopulse Tracking, Tracking in range, Automatic tracking with surveillance Radar (ADT)

UNIT IV RADAR CLUTTER AND BASIC NAVIGATIONAL RADAR SYSTEM **9**

Introduction to Radar Clutter - Types, Surface clutter radar equation, Four Methods of navigation, Radio direction Finding, Types of Radar Antennas, Automatic directional finders, VHF Omni directional Range (VOR).

UNIT V ADVANCED NAVIGATIONAL SYSTEM **9**

Hyperbolic system of Navigation , LORAN (Long Range Navigation) , Decca navigation system, DME (Distance Measurement Equipment) , TACAN (Tactical Air Navigation), Omega Navigation system, Navistar Global positioning system.

Total 45 Hrs

h) Learning Resources

Text Books

1. Skolnik, M., "Introduction to Radar Systems", Tata McGraw-Hill, Third Edition, 2001
2. G S N Raju ,"Radar Engineering and Fundamentals of Navigational Aids" IK International Publishers, 2008
3. N. S. Nagaraju, "Elements of Electronic Navigation Systems", Tata McGraw-Hill, Second Edition, 2000

Reference Books

1. Peyton Z. Peebles:, "Radar Principles", John Wiley, 2004.
2. J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004.
3. NadowLevanon: "Radar Principals" John Wiley and Sons, 1989.
4. Brookener, "Radar Technology", ArtechHons, 1986.
5. Sen, A.K. & Bhattacharya, A.B. "Radar System and Radar Aids to Navigation", Khanna Publishers, 1988.
6. Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.

Online Resources

1. www.Nptel.ac.in
2. https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems
3. www.radartutorial.eu/index.en.html
4. https://pe.gatech.edu/courses/basic-radar-concepts
5. http://www.geo.uzh.ch/microsite/rsldocuments/research/SARlab/GMTILiterature/PDF/Skolnik90.pdf

Course Code	Course Title	L	T	P	C
1152EC224	MIMO WIRELESS COMMUNICATION	2	0	2	3

a) Course Category

Program Elective

b) Preamble

This course covers the fundamentals of Multiple Input Multiple Output (MIMO) antenna based wireless communication systems. MIMO is now an essential part of modern wireless communication systems, such as 3G, 4G, WLAN / Wifi, LTE, WiMax, etc. MIMO brings to the domain of wireless communications, spectral efficiency and reliability gains. With multiple antennas at the transmitter and receiver it helps design wireless communication systems that can use the additional spatial dimension over and above the well investigated time frequency dimensions to fetch myriads of new gains. MIMO is expected to be one of the enabler of 5G communication systems.

c) Prerequisite

Nil

d) Related Courses

Wireless Digital Communication

e) Course Outcomes

On successful completion of the course, the students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Classify and explain the diversity schemes involved in MIMO with advantages, applications, channel models and power allocation	K2
CO2	Calculate the capacity of deterministic and random MIMO channels and fading channels	K3
CO3	Explain the different space time coding techniques like STBCs, STTCs and Space time turbo codes	K2
CO4	Describe various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE	K2
CO5	Discuss the advances in MIMO Communication Systems	K2

f) Correlation of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	M	M	-	-	L	-	-	-	-	-	-	-	-	-
CO2	M	M	L	-	M	L	-	-	M	M	-	M	-	-
CO3	M	M	L	-	H	-	-	-	-	-	-	M	-	M
CO4	M	M	M	-	H	-	-	-	H	H	-	M	-	M
CO5	M	M	M	-	H	L	L	L	-	-	M	M	-	-

g) Course Content

UNIT I INTRODUCTIONTO MIMO CHANNEL MODELS 9

Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation

UNIT II MIMO CHANNEL CAPACITY 9

Capacity for deterministic MIMO Channels: SISO – SIMO – MISO – MIMO, Capacity of random MIMO channels: SISO – SIMO – MISO - MIMO(Unity Channel Matrix, Identity Channel Matrix), Capacity of independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels,Capacity of keyhole Rayleigh fading MIMO channel

UNIT III SPACE-TIME CODES 9

Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space-time codes over separately correlated MIMO channel, Space-time turbo codes, BLAST Architectures: VBLAST – HBLAST – SCBLAST - DBLAST.

UNIT IV MIMO DETECTION TECHNIQUES 9

Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection

UNIT V ADVANCES IN MIMO 9

Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO, cognitive-femtocells and large MIMO systems for 5G wireless, MIMO Applications in RADAR, Satellite Communication, Wi-Fi

h) Practical Exercises 15

1	Performance analysis of 2 x 2 MIMO system using different modulation techniques with ML detection algorithm
2	Performance analysis of 2 x 2 MIMO system using different modulation techniques with ML detection algorithm in correlated and uncorrelated channel conditions
3	Performance analysis of 2 x 2 MIMO system using different modulation techniques with ML detection algorithm
4	Performance analysis of 2 x 2 MIMO system using different modulation techniques with V-Blast detection algorithm
5	Performance analysis of 2 x 2 MIMO system using different space time coding techniques with ML detection algorithm
6	Performance analysis of 2 x 2 MIMO system using different space time coding techniques with V-Blast detection algorithm
7	Performance analysis of Multi-user MIMO system using BPSK modulation technique with SIC and V-Blast detection algorithm

Total 60 Hrs

i) Learning Resources

Text Books

1. TolgaM.Duman and Ali Ghrayeb, “Coding for MIMO Communication Systems”, John Wiley & Sons Ltd.,2007.
2. EzioBiglieri, Robert Calderbank and Anthony Constantinides. “MIMO Wireless Communications”
3. R. S. Kshetrimayum, “Fundamentals of MIMO Wireless Communications”, Cambridge University Press, 2017.

Reference Books

1. B. Kumbhani and R. S. Kshetrimayum, “MIMO Wireless Communications over Generalized Fading Channels”, CRC Press, 2017
2. T. L. Marze_a, E. G. Larsson, H. Yang and H. Q. Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press, 2016.

Online Resources

1. http://nptel.ac.in/courses/117105132

Course Code	Course Title	L	T	P	C
1152EC227	**Software Defined Radio**	**2**	**0**	**2**	**3**

a) Course Category

Program elective

b) Preamble

With the rapid emergence of new standards and protocols in wireless communication, many functions of traditional radio receivers are being implemented in software. This course provides an overview of software defined radio systems and the technologies necessary for their successful implementation.

c) Prerequisite

Analog Communication Systems, Wireless Digital Communication

d) Related Courses

Internet of Things, Virtual Instrumentation

e) Course educational objectives

i) Give students a knowledge about the traditional hardware radio and software defined radio architectures
ii) Know about the various signal processing hardware components
iii) knowledge of wireless RF hardware design
iv) Understand the basics of designing antenna systems to accommodate the needs of a software defined radio
v) Students were able to transmit the actual communication waveforms and received across the wireless channel.
vi) Learn how to implement the communication techniques and algorithm

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the radio architecture and hardware used for signal Processing. Discuss about the complexity, challenges and issues regarding the implementation of SDR.	K2
CO2	Analyze the functions of software defined radio architecture.	K2
CO3	Interpret the various signal processing components in Software architecture	K2
CO4	Apply the knowledge of wireless communication systems in software Defined Radio.	K2
CO5	Explain how software radio principles can be applied to smart antenna systems	K2

CO6	Demonstrate the source coding and channel coding for effective transmission of OFDM signals using USRP.	S3
CO7	Estimate the Wireless Channel Characteristics and Analyze the performance of Wireless Communication System	S3
CO8	Evaluate the performances by implementing the Transceiver system using USRP	S3

e)	Correlation of COs with Pos													
	PO1	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	L	-	-	-	-	L	-	-	-	-	-	L	-	-
CO2	L	L	-	-	-	-	-	-	-	-	-	-	-	-
CO3	L	-	-	-	-	-	-	-	-	-	-	H	-	-
CO4	L	H	-	M		-	-	-	-	-	-	H	-	-
CO5	-	L	-	-	H	-	-	-	-	-	H	-	-	
CO6	-	-	L	-	M	-	-		-	-	-	-	L	-
CO7	-	-	L	-	-	-	-	H	-	-	-	-	L	-
CO8	-	-	L	-	-	-	-	H	-	-	-	-	-	L

f) Course Content

UNIT I Introduction to Software Defined Radio **6**

Introduction –Need for Software Defined Radio – Traditional Hardware Radio Architecture – Characteristics and Benefits of a Software Radio, Design Principles - Challenges and issues for the implementation of SDR – Technology Tradeoff

UNIT II Functional blocks in Software Defined Radio Architecture and Issues **6**

Overview of 3G/4G/5G Radio Architectures-Hybrid Radio Architecture- Software Defined Radio Block Diagram-System Level Functioning -Partitioning-Direct Digital synthesis –- Power Management Issues- RF Design issues - ADC/DAC issues in SDR

UNIT III **Signal Processing in Software Architecture** **6**

Introduction-SDR requirements for processing the signals —Reconfigurable processors —Specific Architecture and standards for Software Radio-Software Design Patterns- Multirate signal Processing: Sample Rate Conversion principles , Polyphase Filters , Digital Filter banks –Timing recovery in digital receivers

Unit –IV **SDR for wireless Communication** **6**

Baseband processor for RF Transceiver, Enhanced Flexibility of RF chain design with SDR , Characteristics of SDR in terms of baseband processing – Noise and Distortion – Multicarrier Communication - OFDM Transceiver-Massive MIMO

UNIT V Smart Antennas **6**

Introduction-5G smart Antenna Requirements-Phased Antenna Array Theory-Using Software Radio Principles to Antenna Systems-Smart Antenna Architectures-Optimum Combining/ Adaptive Arrays-DOA Arrays -Beam Forming for CDMA-Downlink Beam Forming

Total 30 Hrs

a) Practical Exercises **30**

Experiments using USRP

Name of the experiment	**CO level**	**Skill Level**
Develop the baseband digital transmission and reception	CO8	S3
Implement the baseband QAM modulation and Demodulation	CO8	S3
Pulse Shaping and Matched Filtering	CO8	S3
Synchronization	CO8	S3
Channel estimation and Equalization	CO7	S3
Frame Detection and Frequency Offset Correction	CO7	S3
OFDM Modulation and Frequency Domain Equalisation	CO6	S3
Synchronization in OFDM systems	CO6	S3
Channel Coding in OFDM Systems	CO6	S3
Implementation and Testing of Channel coded Transceiver	CO6	S3
Synchronization , Frequency offset	CO8	S3
OFDM Modulation and Frequency Domain Correction	CO8	S3

Total 60 Hrs

g) Learning Resources

Text Books

1. Paul Burns, Software Defined Radio for 3G, Artech House, 2002.
2. Software Radio: A Modern Approach to Radio Engineering By Jeffrey H. Reed Pearson Education Low Price Edition .
3. Tony J Rouphael, " RF and DSP for SDR ," Elsevier Newnes Press, 2008.
4. Robert M.Heath "Digital Communication,Physical Layer Exploration Lab using the NI USRP" National Technology and Science Press.

Reference Books

1. Ramesh Garg, “Analytical and Computational Methods in Electromagnetics” Artech House, 2008
2. Gupta. K.C and R. Garg, “ Microstrip line and slot line” Artech House, Boston, 1996
3. Ravender Goyal, “Monolithic MIC; Technology & Design”, Artech House, 1989
4. Robert Caverly, “CMOS RFIC Design Principles” Artech House, 2007.
5. P.Kennington, “ RF and Baseband Techniques for Software Defined Radio,” Artech House, 2005.

Online Resource

1. http://morse.colorado.edu/sdr/
2. *http://gnuradio.org/*
3. http://openhpsdr.org/
4. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee22/
5. https://www.ni.com/de-de/innovations/white-papers/14/overview-of-the-ni-usrp-rio-software-defined-radio.html

Practical Aspects

The implementation will give experience in designing, building, and debugging a wireless system. Matlab or C++ or LabVIEW can be used for USRP software defined radios.

Course Code	Course Title	L	T	P	C
1152EC140	**CELLULAR MOBILE COMMUNICATION**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course provides an introduction to the basic concepts and techniques of cellular radio Communication, Mathematically analyze mobile radio propagation mechanisms, design Base Station (BS), Mobile Station (MS) parameters, analyze the antenna configurations and types, to study the recent trends adopted in cellular and wireless systems and standards.

c) Prerequisite

Nil

d) Related Courses

Wireless Ad Hoc & sensor networks

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic concepts of cellular radio and capacity improvement techniques.	K2
CO2	Apply the concepts of mobile radio propagation models.	K3
CO3	Illustrate fading mechanism, equalization techniques and Diversity concepts.	K2
CO4	Classify Speech coding techniques and multiple access techniques.	K2
CO5	Describe the latest wireless technologies and standards.	K2

f) **Correlation of COs with POs**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	-	L	L	-	L	-	-	-	-	-
CO2	H	M	M	-	-	-	-	L	L	-	L	-	-	-
CO3	M	H	-	-	-	-	-	-	L	-	-	-	-	-
CO4	H	H	L	L	M	-	-	-	L	-	-	L	-	-
CO5	L	H	-	-	-	-	-	-	L	-	-	M	-	-

f) Course Content

UNIT I INTRODUCTION TO WIRELESS COMMUNICATION 9

History and evolution of mobile radio communication-Examples of wireless communication-Generations –Frequency reuse – Channel Assignment strategies – Handoff strategies – Interference- Trucking and Grade of service-Improving Coverage and capacity of cellular system .

UNIT II MOBILE RADIO PROPAGATION 9

Radio wave propagation-Free space propagation model – Basic propagation mechanism-Ground reflection model, Knife edge diffraction model, radar cross section model-Practical Link budget design - Indoor and outdoor propagation model.

UNIT III SMALL-SCALE FADING AND EQUALIZATION 9

Small-Scale Fading: Small scale multipath propagation - Small scale Multipath measurements - parameters of mobile multipath channels - types of small scale fading - statistical models for multipath fading channels.

Equalization: Survey of Equalization Techniques, Linear Equalization, Non-Linear Equalization - Algorithms for Adaptive Equalization – Diversity Techniques – Rake Receiver.

UNIT IV CODING AND MULTIPLE ACCESS TECHNIQUES 9

Coding: RS codes for CDPD – Vocoders – Linear Predictive Coders – Selection of Speech Coders for Mobile Communications – GSM Codec. Multiple Access Techniques: FDMA, TDMA, CDMA, SDMA

UNIT V WIRELESS SYSTEMS AND STANDARDS. 9

GSM - CDMA - 3G-4G (LTE) - NFC systems-WLAN technology- WLL- Ad hoc networks- Bluetooth-WIFI.

Total 45 Hrs

g) Learning Resources

Text Books

1. T.S.Rappaport, "Wireless Communications: Principles and Practice, Second Edition, Pearson Education/ Prentice Hall of India, Third Indian Reprint 2003.
2. W.C.Y.Lee,"Mobile Communication Design Fundamentals",secondedition,john Wiley & sons,1993

Reference Books

1. MuthuChidambara Nathan, Wireless Communications, PHI, 1st edition 2008.
2. Goldsmith, Wireless Communications, Cambridge University Press, 1st edition 2005.
3. R. Blake, " Wireless Communication Technology", Thomson Delmar, 1st edition 2000.
4. W.C.Y.Lee, "Mobile Communications Engineering: Theory and applications, Second Edition, McGraw-Hill International, 1998.

Online Resources

1. http://www.see.ed.ac.uk/~hxh/ADCCourseMaterial/4.rc.2.pdf

2. http://www.diva-portal.org/smash/get/diva2:501119/FULLTEXT01.pdf
3. http://www.durofy.com/multiple-access-techniques-fdma-tdma-cdma/
4. www.nptel.in

Course Code	Course Title	L	T	P	C
1152EC149	**RADIO OVER FIBER SYSTEMS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course provides the basic and concepts of Radio over Fiber systems, link design and mm wave signal generation and also enable the students to implement RoF concepts in cellular application

c) Prerequisite

Nil

d) Related Courses

Optical and Microwave Engineering

e) Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Discuss the basic concepts of radio over fiber systems and their applications in real time.	K2
CO2	Identify the noise measures and distortions measures.	K2
CO3	Discuss radio over fiber link design and tradeoffs link parameter and amplifier.	K2
CO4	Describe the techniques for transporting RF signals over optical fibre	K2
CO5	Identify the cellular and UMTS architecture, Micro and Macro diversity	K2

f)	Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	L	L	M	L	L	-	-	L	-	-	-	L	-	-
CO2	L	L	M	-	-	-	-	-	-	-	-	-	-	-
CO3	-	L	-	-	M	-	-	-	-	-	-	-	L	-
CO4	M	L	-	-	L	-	-	-	-	-	-	-	L	-
CO5	M	-	-	L	L	L	-	-	-	L	L	-	L	-

g) Course content

UNIT I Introduction to Radio Over Fiber 9

Trends in wireless communication, Transmission problems and solutions, Regulation and Standardization, Concept of RoF systems, Categories of RoF: types of transport-types of modulation-types of fiber- Subcarrier Multiplexing, Performance RoF systems: system performance characterization-system component effects- Improving system performance, Benefits, Limitations and Applications of RoF

UNIT II Noise and Distortions 9

Insertion loss and Noise figure concepts, Directed modulated optical links- Noise Figure of passive optical microwave devices, improving performance with low noise preamplifier, Optical links operating with external intensity modulators, Noise Figure of externally modulated links, Effect of fiber dispersion, Countermeasures to the dispersion-induced suppression of modulation

UNIT III Link Design and Tradeoffs 9

Introduction - Radio over Fiber link design issues- Link design examples - Link design tradeoffs: introduction - tradeoffs among intrinsic link parameters- Tradeoffs between intrinsic link and link with amplifiers.

UNIT IV Techniques for Transporting RF Signals over Optical Fibre 9

RF Signal Generation by Intensity Modulation and Direct Detection-Advantages-Disadvantages, Principle of Optical Heterodyning: Optical FM Filter System- Optical Frequency/Phase Locked-Loops-Optical Injection Locking, Techniques Based on Harmonics Generation-The FM IM Conversion - Modulation Sideband -Interferometer based Mixing, RoF Multiplexing Techniques-Sub-Carrier Multiplexing, Wavelength Division Multiplexing

UNIT V ROF Technology for Cellular Applications 9

Cellular systems, cellular architecture, UMTS architecture, WCDMA RoF systems, Micro diversity, Macro diversity, Traffic estimation, Spectral efficiency, power level, multiple user interference, RoF for Hyper LAN2, Micro cellular communication networks.

Total 45 Hrs

h) Learning Resources

Text Books

1. Nathan J. Gomes, Paulo P. Monteiro and AtilioGameiro "Next Generation wireless communications using Radio over Fiber" John Wiley & Sons, Ltd, 2012.
2. Hameed Al-Raweshidy, Shozo Komaki, "Radio Over fiber technologies for mobile communication networks" Artech House publications, London. 2002.

Reference Books

1. CHARLES H. COX, III, "Analog optical Links,Theory and Practice" Cambridge University Press, 2004.
2. Igor Minin, "Microwave and millimeter wave technologies modern UWB antennas and equipment" In-Tech publication, 2010.

Course Code	Course Title	L	T	P	C
1152EC225	WIRELESS ADHOC AND SENSOR NETWORKS	2	0	2	3

a. Course Category

Program Elective

b. Preamble

This course will provide students with an understanding of wireless adhoc and sensor networks enable them to recognize the wide range of applicability of these networks and provide them with an understanding of the major design issues including topics such as protocol mechanisms and resource constraints

c. Prerequisite

Nil.

d. Related Courses

Data Communication Networks, Internet of Things

e. Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the Fundamental Concepts and applications of ad hoc and wireless sensor networks	K2
CO2	Describe the MAC protocol issues of ad hoc networks	K2
CO3	Describe routing protocols for ad hoc wireless networks with respect to TCP design issues	K2
CO4	Explain the concepts of network architecture and MAC layer protocol for WSN	K2

CO5	Discuss the WSN routing issues by considering QoS measurements	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PS02
CO1	H	L	L	M	**-**	**-**	**L**	-	--	-	-	-	-	-
CO2	L	-	-	M	-	-	-	L	-	-	-	-	-	-
CO3	H	L	L	M	-	-	-	L	-	-	-	-	L	L
CO4	M	-	-	L	-	-	-	-	-	-	-	-	-	-
CO5	M	-	-	-	-	L	-	-	-	-	-	-	-	-

g. Course Content

UNIT I INTRODUCTION 9

Fundamentals of Wireless Communication Technology -The Electromagnetic Spectrum - Radio propagation Mechanisms - Characteristics of the Wireless channel mobile ad hoc networks (MANETs) - Wireless Sensor Networks (WSNs): concepts and architectures - Applications of Ad Hoc and Sensor Networks - Design Challenges in Ad hoc and Sensor Networks.

UNIT II MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS 9

Issues in designing a MAC Protocol - Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks - Design Goals of a MAC Protocol for Ad Hoc Wireless Networks - Classification of MAC Protocols - Contention based protocols - Contention based protocols with Reservation Mechanisms - Contention based protocols with Scheduling Mechanisms - Multi channel MAC - IEEE 802.11.

UNIT III ROUTING PROTOCOLS AND TRANSPORT LAYER IN AD HOC WIRELESS NETWORKS 9

Routing Protocol: Issues in designing a routing protocol for Ad hoc networks - Classification- proactive routing - reactive routing (on-demand) - hybrid routing - Transport Layer protocol for Ad hoc networks - Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks -Classification of Transport Layer solutions-TCP over Ad hoc wireless - Network Security - Security in Ad Hoc Wireless Networks - Network Security Requirements.

UNIT IV WIRELESS SENSOR NETWORKS (WSNS) AND MAC PROTOCOLS 6

Single node architecture: hardware and software components of a sensor node -WSN Network architecture: typical network architectures -data relaying and aggregation strategies -MAC layer protocols: self-organizing - Hybrid TDMA/FDMA and CSMA based MAC -IEEE 802.15.4.

UNIT V WSN ROUTING, LOCALIZATION & QOS 9

Issues in WSN routing –OLSR - Localization –Indoor and Sensor Network Localization - absolute and relative localization - triangulation - QOS in WSN - Energy Efficient Design – Synchronization.

List of experiments:(Using MATLAB/NS3)

S.No.	List of experiment	Co's	Skill level
1	Node creation and deployment	**CO4**	**SO3**
2	Cluster formation	**CO4**	**SO3**
3	Cluster head selection using LEACH protocol	**CO4**	**SO3**
4	Routing in wireless sensor network using AODV protocol	**CO5**	**SO3**
5	Localization using TOA	**CO5**	**SO3**
6	Security in WSN using RSA algorithm	**CO5**	**SO3**
7	Creating attacks in WSN	**CO5**	**SO3**

Total hours: 60

h) Learning Resources

Text Books

1. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ", Pearson Education, 2008.
2. Labiod. H, "Wireless Adhoc and Sensor Networks", Wiley, 2008.
3. Li, X, "Wireless ad -hoc and sensor Networks: theory and applications", Cambridge University Press, 2008.

Reference Books

1. Carlos De Morais Cordeiro, Dharma Prakash Agrawal "Ad Hoc & Sensor Networks: Theory and Applications", World Scientific Publishing Company, 2nd edition, 2011.
2. Feng Zhao and Leonides Guibas, "Wireless Sensor Networks", Elsevier Publication
3. Holger Karl and Andreas Willig "Protocols and Architectures for Wireless Sensor Networks", Wiley, 2005 (soft copy available)
4. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley, 2007. (soft copy available)
5. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.(soft copy available)

Online Resources

1. www.wirelessnetworksonline.com
2. www.securityinwireless.com
3. www.ida.liu.se/~petel71/SN/lecture-notes/sn.pdf

Practice Aspects

1. NS2 Simulator tool

Course Code	Course Title	L	T	P	C
1152EC126	**NETWORK SECURITY**	3	0	0	3

a) Course Category

Program Elective

b) Preamble

The course deals with the underlying principles of cryptography and network security. It develops the mathematical tools required to understand the topic of cryptography. It aims to introduce students to the fundamental techniques used in implementing secure network communications, and to give them an understanding of common threats and attacks.

c) Prerequisite

Data Communication Networks

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain about the OSI Security architecture and various Crytographic techniques	K2
CO2	Describe about the data encryption standard, block ciphers and block ciphers mode of operation.	K2
CO3	Describe the principles of various public key cryptosystems	K2
CO4	Explain the need for authentication and various authentication system methods	K2
CO5	Illustrate the different types of threats and attacks in data networks and explain about Internet and Mobile security	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	L	-	-	L	-	-	-	-	-	-	-	-
CO2	M	-	M	-	M	-	-	L	-	-	-	-	-	-
CO3	M	-	M	-	M	-	M	-	-	-	-	L	-	-
CO4	M	-	M	-	M	L	M	-	-	-	-	-	-	-
CO5	M	-	-	-	-	-	-	-	-	-	-	L	-	-

g) Course Content

UNIT I BASIC CIPHERS 9

Services, Mechanisms and Attacks-The OSI Security Architecture – Network Security Model – Classical Encryption Techniques, Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography.

UNIT II BLOCK CIPHERS 9

Block Ciphers- Simplified Data Encryption Standard -Data Encryption Standard– Block cipher principlesblock cipher modes of operation – Triple DES-Simplified Advanced Encryption Standard-Advanced Encryption Standard(AES)

UNIT III PUBLIC KEY SYSTEM 9

Public key cryptography: Principles of public key cryptosystems – The RSA algorithm-Key management – Diffie Hellman Key exchange - Elliptic curve arithmetic – Elliptic curve cryptography- Elliptic curve digital signature algorithm.

UNIT IV AUTHENTICATION SYSTEM 9

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

UNIT V INTERNET AND MOBILE SECURITY 9

Internet Firewalls for Trusted System: Roles of Firewalls – Firewall related terminology – Types of Firewalls-Intrusion detection system – Virus and related threats – Countermeasures -Trusted systems, Email Security: Security Services for E-mail – attacks possible through E-mail – establishing keys privacyauthentication of the source – Message Integrity – Non-repudiation , mobile device security.

Total 45 Hrs

h) Learning Resources

Text Books

1. William Stallings, Cryptography and Network Security, 7th edition, Pearson Education
2. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security, Prentice Hall of India -2002

Reference Books

1. Behrouz A Ferouzan, Cryptography & Network Security, Tata McGraw Hill-2007
2. Man Young Rhee, Internet Security: Cryptographic Principles", "Algorithms and Protocols, Wiley Publications-2003
3. Charles Pfleeger, Security in Computing, Prentice Hall of India -2006
4. Ulysess Black, Internet Security Protocols, Pearson Education Asia -2000

Online Resources

1. http://www.herongyang.com/crypto/
2. http://www.cryptographyworld.com/what.htm
3. http://www.cryptography-tutorial.com
4. http://www.sans.org/reading-room/whitepapers/modeling/network-security-model-32843
5. http://searchsecurity.techtarget.com/definition/Diffie-Hellman-key-exchange
6. https://www.paloaltonetworks.com/resources/learning-center/what-is-an-intrusiondetectionsystem-ids.html
7. https://lyle.smu.edu/~nair/courses/7349/SET.ppt

Practical Aspects

1. The students shall practice the different attacks in virtual environment using kali Linux

Course Code	Course Title	L	T	P	C
1152EC128	OPTICAL COMMUNICATION SYSTEMS AND NETWORKS	3	0	0	3

a) Course Category

Program Elective

b) Preamble

Fiber optic communication systems and networks provide the basic concepts of optical networks, components, optical sources, detectors and amplifiers also it relates the different networking topologies.

c) Prerequisite

Analog communication system

d) Related Courses

Mobile Communication, Optical and microwave communication

e) Course Outcome

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the passive and active components of optical communication	K2
CO2	Describe the principle and operation of the optical sources and detectors such as LASER & APD	K2
CO3	Summarize the basic concepts of optical networks	K2
CO4	Describe about the SONET/SDH and architecture of Optical Transport Network	K2
CO5	Discuss the elements of WDM networks and its potential applications	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	-	-	-	-	-	-	-	-	-	-

CO2	L	M	M	L	-	-	-	-	-	-	-	-	-	-
CO3	M	M	L	M	-	-	-	-	-	-	-	-	-	-
CO4	L	L	M	M	-	-	-	-	-	-	-	M	L	-
CO5	M	M	L	L	M	-	-	-	M	-	M	M	L	-

g) Course Content

UNIT I OPTICAL COMPONENTS 9

Couplers, Isolators and Circulators, Multiplexers and Filters: Grating - Diffraction Pattern - Bragg Gratings Fiber - Fabry- Perot Filters. Multilayer Dielectric Thin-Film Filters – Mach - Zehnder Arrayed Waveguide Grating - Acousto-Optic Tunable Filter, High Channel Count Multiplexer Architectures, Optical Amplifier: Stimulated Emission - Spontaneous Emission - Erbium-Doped Fiber Amplifiers, Raman Amplifiers - Semiconductor Optical Amplifiers, Switches, Wavelength Converters.

UNIT II SOURCES AND DETECTORS 9

Direct and indirect Band gap materials, LED structures -Light source materials -Quantum efficiency and LED power - Modulation of a LED, Laser Diodes: Modes and Threshold condition - Rate equations - External Quantum efficiency - Resonant frequencies - Laser Diodes - Temperature effects, Introduction to Quantum laser, Physical Principles of Photodiodes: PIN Photo detector - Avalanche Photodiodes(APD) - Signal-to-Noise Ratio - Comparison of Photo detectors.

UNIT III INTRODUCTION TO OPTICAL NETWORKS 9

Telecommunications Network Architecture – Services - Circuit Switching - Packet Switching, Optical Networks-Multiplexing Techniques - Generation of optical Networks - The Optical Layer - Transparency and All-Optical Networks, Optical Packet Switching – Wavelengths - Frequencies and Channel Spacing - Wavelength Standards, Optical Power and Loss, Network Evolution, Nonlinear Effects: Self-phase Modulation - Cross-phase Modulation - Four Wave mixing, Solitons.

UNIT IV SONET/SDH 9

SONET, SDH and Optical Transport Networks (OTNs): SONET and SDH - SONET multiplexing hierarchy - Frame structure - Functional Component - problem detection – concatenation, Architecture of Optical Transport Networks (OTNs): Digital wrapper - in-band and out-of band control signaling - Importance of Multiplexing and multiplexing hierarchies - SONET multiplexing hierarchies - SDH multiplexing hierarchies - New Optical Transport, OTN layered Model, Generic Framing Procedure (GFP).

UNIT V WDM NETWORK ELEMENTS 9

Optical Line Terminals, Optical Line Amplifiers, Optical Add/Drop Multiplexers - OADM Architectures - Reconfigurable OADMs, Optical Cross connects, All-Optical OXC Configurations, WDM-MUX/DEMUX Routed Networks, Ultra High Capacity Networks, Photonic Switching, Potential applications of optical networks.

Total 45 Hrs

h) Learning Resources

Text Books

1. Rajiv Ramaswami and Kumar Sivarajan, "Optical Networks Practical Perspective", 2nd Edition, Morgan - Kaufmann Publishers.
2. Uyless N. Black, Front Royal, Virginia, “Optical Networks, Third Generation Transport Systems”, Prentice Hall Publishers.

Reference Books

1. Achyut K. Dutta, Niloy K. Dutta, Masahiko Fujiwara, “WDM Technologies: Optical Networks” Elsevier Academic Press
2. Mukherjee, Biswanath, “Optical WDM Networks”, Springer Books, 2006
3. Joseph C Patios, "Fiber Optical Communications", Prentice Hall International 2004, 5th Edition
4. G.P.Agrawal: `Nonlinear Fiber Optics’, Academic Press. 2001 ,3rd Edition

Online Resources

1. **http://nptel.ac.in/downloads/117101054/**
2. www.nptel.iitm.ac.in/foc.
3. http://www.rp-photonics.com,
4. http://electronicsforu.com
5. www.utdallas.edu/~torlak/courses/ee4367/lectures/FIBEROPTICS.pdf
6. http://nptel.ac.in/courses/117101002/downloads/Lec01.pdf
7. https://onlinecourses.nptel.ac.in/noc17_ph01/preview

Practice Aspects

1. TOOL TO BE USED: Optispice, Optisystems

COURSE CODE	COURSE TITLE	L	T	P	C
1152EC229	**INTERNET OF THINGS**	**1**	**0**	**4**	**3**

a. Course Category:

Program Elective

b. Preamble:

Internet of Things (IoT) is presently a hot technology worldwide. IoT cuts across different application domain verticals ranging from civilian to defence sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IoT. Today it is possible to envision pervasive connectivity, storage, and computation, which, in turn, gives rise to building different IoT solutions.

c. Prerequisite Courses:

Data Communication Networks

d. Related Courses:

Software Defined Radio

e. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Explain about the IoT Architecture, Protocols, IoT6 and the hardware/software used to design an IoT device	K2
CO2	Program MSP430 wireless microcontroller unit for various IoT applications	S4
CO3	Program Raspberry PI wireless microcontroller unit for various IoT applications	S4

f. Correlation of CO's with PO's

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	M	-	-	-	-	-	-	-	-	L	-	-
CO2	M	M	H	L	L	L	L	L	-	-	-	L	-	-
CO3	M	-	-	-	L	-	-	-	M	L	L	-	M	M

g. Examination scheme

<table>
<tr><th colspan="11">Examination Scheme for practical dominated course</th></tr>
<tr><th colspan="7">Internal evaluation
(40M)</th><th colspan="4">Semester end evaluation
(60M)</th></tr>
<tr><th colspan="4">Laboratory experiment
(15M)</th><th colspan="3">Model laboratory test
(25M)</th><th>Part-A
(20M)</th><th colspan="3">Part-B
(40M)</th></tr>
<tr><td>Performance in conducting experiment
(5)</td><td>Result and analysis
(3)</td><td>Viva Voce
(3)</td><td>Record
(4)</td><td>Performance in conducting experiment
(15)</td><td>Result and analysis
(5)</td><td>Viva Voce
(5)</td><td>Theory questions to evaluate the knowledge and understanding
(20)</td><td>Performance in conducting experiment
(25)</td><td>Result and analysis
(10)</td><td>Viva-Voce
(5)</td></tr>
</table>

h. Course Content :

Theory **15 Hours**

Internet of Things – Introduction and Applications

Internet of Things Vision – IoT Applications and Use Case Scenarios – IoT Functional View – IoT Smart-X Applications: Smart Cities, Smart Energy and Smart Grid, Smart Mobility and Transport, Smart Home, Buildings and Infrastructure, Smart Factory and Manufacturing, Smart Health, Smart Logistics and Retail

IoT Protocols Convergence

Message Queue Telemetry Transport (MQTT) – Constrained Applications Protocol (CoAP) – Advanced Message Queuing Protocol (AMQP) – Java Message Service API (JMS) – Data

Distribution Service (DDS) – Representational State Transfer (REST) – Extensible Messaging and Presence Protocol (XMPP)

Scalable Integration Framework for Heterogeneous Smart Objects, Applications and Services

Introduction - IPv6 Potential – IoT6 – IPv6 for IoT – Adapting IPv6 to IoT Requirements – IoT6 Architecture – DigCovery – IoT6 Integration with the Cloud and EPICS – Enabling Heterogeneous Integration – IoT6 Smart Office Use-Case – Scalability Perspective

Hardware and Software

Introduction to Raspberry Pi, MSP430 – Raspbian OS – Code Composer Studio - Python Programming

i. **List of experiments**

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	Study of various connection policies for Wi-Fi connectivity
2.	CO2	Programming Wireless MCU to blink LED using GPIO
3.	CO2	Program to Interface Temperature Sensor using I2C Communication Interface
4.	CO2	Program to Interface accelerometer sensor using SPI communication Interface
5.	CO2	Experimenting with Wireless MCU in WLAN AP mode
6.	CO2	Experimenting with Wireless MCU in WLAN station mode
7.	CO2	Program Wireless MCU to connect to a website
8.	CO2	Program Wireless MCU to upload sensor Data to cloud (BLYNK)
9.	CO2	Program Wireless MCU for File download Application
10.	CO2	Program Wireless MCU for Email Sending Application
11.	CO2	Program Wireless MCU to behave as a HTTP Web server
12.	CO2	Program Wireless MCU for Wi-Fi Direct Application
13.	CO3	Setting up a Raspberry Pi
14.	CO3	Using Python, PHP, and MySQL
15.	CO3	Interfacing various sensors with Raspberry PI
16.	CO3	Setting up and working with a web server to store data and run other applications
17.	CO3	Using Google Cloud Messaging (GCM) service to send sensor data notification to an Android app when the situation arises and to display stored data
18.	CO3	Configure IPv6 on Raspberry PI

19.	CO3	Hosting a Website on Raspberry PI
20.	CO3	Wireless Sensor Network using Raspberry PI

j. Suggested Learning Resources

i) List of textbooks

1. Ovidiu Vermesan & Peter Friess, Internet of Things Applications - From Research and Innovation to Market Deployment, River Publishers Series in Communications, 2014
2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013
4. Cuno Pfister, Getting Started with the Internet of Things, O‟Reilly Media, 2011, ISBN: 978-1-4493- 9357-1

ii) List of Major Equipment/ Instrument/Software with Broad Specifications

- MSP430G2xx Launch-Pad Development Board
- MSP430F5529 Launch Pad
- TM4C129X IOT Connected Development Kit
- TIVA Launchpad EK-TM4C123Gx2
- MSP432P401R Launch pad
- CC3200 Simple Link Wi-Fi Launchpad
- Groove starter Kit for TIVA Launchpad EK-TM4C123Gx2
- Raspberry PI
- Sensors and Actuators
- Computers
- Code Composer Studio, Python, PHP, HTML, SQL

iii) List of Software/Learning Websites

1. https://github.com/connectIOT/iottoolkit
2. https://pythonprogramming.net/

iv) Online resources

1. Dr.Sudip Misra, Video lecture on Internet of Things, Centre for Educational Technology, IIT Kharagpur Sponsored by National Programme on Technology Enhanced Learning (NPTEL) https://onlinecourses.nptel.ac.in/noc17_cs22/preview

Course Code	Course Title	L	T	P	C
1152EC130	**NETWORK MANAGEMENT**	**3**	**0**	**0**	**3**

a) Course Category

Programme elective

b) Preamble

This course provides the information about data communication, network management, SNMP, network management tools, systems, engineering and applications. Also highlights information on broadband access networks.

c) Prerequisite

Nil

d) Related Courses

Data communication and networks

e) Course Outcomes

On successful completion of this course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the concept of data communications, communication protocols and networks architecture	K2
CO2	Discuss the Network management organization models and functional models	K2
CO3	Describe the network management tools, system utilities and design	K2
CO4	Outline the network management architecture and its applications	K2
CO5	Infer about ATM and HFC technologies under broad band access in network management systems	K2

a) **Correlation of COs with POs**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	-	-	-	-	-	-	-	-	L	-	-
CO2	M	-	L	L	-	-	-	-	-	-	-	-	-	-
CO3	L	M	L	L	M	-	-	-	-	-	-	-	-	-
CO4	L	-	-	-	M	-	-	-	-	-	-	-	-	-
CO5	M	L	-	-	-	-	-	-	-	-	-	L	-	-

f) **Course Content**

UNIT I DATA COMMUNICATIONS AND NETWORK MANAGEMENT 9

Data communications and network management overview: Analogy of telephone network management - Data and telecommunication network - Distributed computing - TCP/IP based networks - communication protocols and standards - network systems and services [with case histories]- Network management goals , organization architecture and perspectives

UNIT II SNMP AND NETWORK MANAGEMENT 9

Review of information network and technology - SNMP and network management - basic foundations: Standards, models and languages - network management organization and information models - communication and functional models

UNIT III NETWORK MANAGEMENT TOOLS , SYSTEMS AND ENGINEERING 9

System utilities management: basic tools - SNMP tools - Protocol analyzer - Network statistics measurement systems - MIB engineering - NMS design - Network management systems

UNIT IV NETWORK MANAGEMENT AND APPLICATIONS 9

TMN - TMN conceptual model - standards - architecture - management service architecture - integrated view and implementation.
Network management applications: configuration management - fault management - performance management - event correlation techniques – security management

UNIT V ATM AND BROADBAND NETWORK MANAGEMENT 9

ATM Technology - ATM network management - cable modem technology - cable access network management - DOCSIS standards - fixed broad band wireless access networks - mobile wireless networks.

Total 45 Hrs

g) Learning Resources

Text Books

1. M. Subramanian, "Network management: principles and practice", Adison-Wesley, 2000

Reference Books

1. James F. Kurose and Keith W. Rose, "Computer networking", Pearson Education, LPE, 2003
2. J. Burke, "Network management concepts and practice, A Hands-on approach", Pearson Education, 2000.
3. Larry L. Peterson and Bruce S. Davie, "Computer networks, a system approach", 3rd edition, Elsevier.

Websites.

1. http://www.networkcomputing.com/
2. http://www.networkonlineresources.com/

Course Code	Course Title	L	T	P	C
1152EC241	**Software Defined Networking**	**2**	**0**	**2**	**3**

a) Course Category

Program Elective

b) Preamble

This course introduces about software defined networking, an emerging paradigm in computer networking that allows a logically centralized software program to control the behavior of an entire network.

c) Prerequisite

Data Communication Networks

d) Related Courses

Network Management, Internet of Things

e) Course Outcomes

On successful completion of the course, the students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the key benefits of SDN by the separation of data and control planes	K2
CO2	Interpret the SDN data plane devices and Openflow Protocols	K2
CO3	Implement the operation of SDN control plane with different controllers	K2
CO4	Apply techniques that enable applications to control the underlying network using SDN	K2
CO5	Describe Network Functions Virtualization components and their roles in SDN	K2

f) **Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	L	-	-	L	-	-	-	-	-	-	-	-
CO2	M	-	L	-	-	-	-	-	-	-	-	L	-	-
CO3	L	L	L	-	-	-	-	-	-	-	-	-	-	-
CO4	L	-	M	-	M	-	-	-	-	-	-	-	-	-
CO5	L	M	-	L	L	-	-	-	-	-	L	L	-	-

g) Course Content

UNIT I SDN BACKGROUND AND MOTIVATION 9

Evolving network requirements-The SDN Approach: Requirements, SDN Architecture, Characteristics of Software-Defined Networking, SDN and NFV-Related Standards: Standards-Developing Organizations, Industry Consortia, Open Development Initiatives.

UNIT II SDN DATA PLANE AND OPENFLOW 9

SDN data plane: Data plane Functions, Data plane protocols, Openflow logical network Device: Flow table Structure, Flow Table Pipeline, The Use of Multiple Tables, Group Table- Open Flow Protocol.

UNIT III SDN CONTROL PLANE 9

SDN Control Plane Architecture: Control Plane Functions, Southbound Interface, Northbound Interface, Routing, ITU-T Model- Open Daylight-REST- Cooperation and Coordination Among Controllers.

UNIT IV SDN APPLICATION PLANE 9

SDN Application Plane Architecture: Northbound Interface, Network Applications, User Interface- Network Services Abstraction Layer: Abstractions in SDN, Frenetic- Traffic Engineering Measurement and Monitoring- Security- Data Center Networking- Mobility and Wireless.

UNIT V NETWORK FUNCTIONS VIRTUALIZATION 9

Background and Motivation for NFV- Virtual Machines- NFV Concepts: Simple Example of the Use of NFV, NFV Principles, High-Level NFV Framework, NFV Benefits and Requirements- NFV Reference Architecture: NFV Management and Orchestration.

h) Practical Exercises 15

The Experiments using Mininet

1 Network Toplology creation and REST API introduction.

2 Influencing flows via cURL commands.

3 Create a network and run a simple performance test.

4 Use “ovs-vsctl” command to directly control open v switch.

5 Dynamically change the network parameters—link delay analysis.

6 Dynamically change the forwarding rules.

7 Mininet Random Topology Generator.

Total 60 Hrs

i) Learning Resources

Text Books

1. William Stallings, “Foundations of Modern Networking”, Pearson Ltd., 2016.

2. Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black,Morgan Kaufmann Publications, 2014

3. SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013.

Reference Books

1. Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98.

2. Kreutz, Diego, et al. "Software-defined networking: A comprehensive survey." Proceedings of the IEEE 103.1 (2015): 14-76.

Online Resources

1. https://www.coursera.org/learn/sdn

Course Code	Course Title	L	T	P	C
1152EC250	**Cognitive Radio Networks**	**2**	**0**	**2**	**3**

a) Course Category

Program elective

b) Preamble

This course introduces an intelligent wireless communication system that is aware of its surrounding environment, learns from the environment and adapts its internal states to statistical variations in order to achieve predefined objectives.

c) Prerequisite

Data Communication Networks

d) Related Courses

Software Defined Networking,Network Security, Network Management

e) Course educational objectives

i) Provide highly reliable communications whenever and wherever needed and to utilize the radio spectrum efficiently by intelligently exploiting licensed spectrum.
ii) To obtain useful information about their surrounding environment with the primary users and the appearance of spectrum holes.
iii) To maximize probability of detection,throughput and false alarm and to minimize sensing time.
iv) To find the optimal path from the source of data to its destination and to improve the throughput and QOS metrics.
v) To address the attacks and categorize the attacks according to the layers.

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Understand the basics of SDR and how it evolves from Software Defined Radio to Cognitive Radio.	K2
CO2	Interpret the basics of various spectrum sensing techniques and	K3

	algorithms	
CO3	Recognize the concepts of cooperative spectrum sensing and handoff process	K2
CO4	Understand the functions of MAC layer and Network layer and its various protocols	K2
CO5	Interpret the basics of security management and the various attacks & its countermeasures.	K2

g) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	-	-	-	L	-	-	-	-	-	L	-	-
CO2	L	L	L	-	-	-	-	-	-	-	-	-	-	-
CO3	L	-	-	-	-	-	-	-	-	-	-	L	-	-
CO4	L	L	L	-	L	-	-	-	-	-	-	-	-	-
CO5	L	-	-	-	L	-	-	L	-	-	L	L	L	L

I) Course Content

UNIT I Introduction to Cognitive Radio 9

Introduction –Software Defined Radio: Architecture–Digital Signal Processor and SDR Baseband architecture – Reconfigurable Wireless Communication Systems – Digital Radio Processing –Cognitive Radio: Cognitive radio Framework – Functions – Paradigms of Cognitive Radio

UNIT II Spectrum Sensing 9

Introduction –Spectrum Sensing – Multiband Spectrum Sensing – Sensing Techniques – Other algorithms – Comparison – Performance Measure & Design Trade-Offs : Receiver operating characteristics – Throughput Performance measure –Fundamental limits and trade-offs

UNIT III Cooperative Spectrum Acquisition 9

Basics of cooperative spectrum sensing–Examples of spectrum acquisition techniques – cooperative transmission techniques – sensing strategies– Acquisition in the Presence of Interference: Chase-combining HARQ –Regenerative cooperative Diversity– spectrum overlay– spectrum handoff

UNIT IV MAC Protocols and Network Layer Design 9

Functionality of MAC protocol in spectrum access –classification –Interframe spacing and MAC challenges – QOS – Spectrum sharing in CRAHN –CRAHN models – CSMA/CA based MAC protocols for CRAHN – Routing in CRN– Centralized and Distributed protocols – Geographical Protocol

UNIT V Trusted Cognitive Radio Networks 9

Trust for CRN: Fundamentals – Models – Effects of Trust Management –Security properties in CRN –Route Disruption attacks –Jamming attacks –PU Emulation attacks.

II) Practical Exercises
15

Name of the experiment	CO level	Skill Level
Simulate Cognitive radio network in MATLAB	CO1	SO2
Simulate combination of maximum-minimum eigenvalue (CMME) based spectrum sensing using MATLAB	CO2	SO3
Simulate energy detection in Cognitive radio network using MATLAB	CO2	SO3
Comparison of various non cooperative sensing techniques in cognitive radio networks using MATLAB	CO3	SO3
Centralized cooperative spectrum sensing in cognitive radio networks using NS3	CO3	SO3
Spectrum Handoff model based on Hidden Markov model in cognitive radio networks using NS3	CO3	SO3
Security Reliability in cognitive radio networks using NS3	CO5	S03

Total 60 Hrs

II Learning Resources

Text Books

1. Mohamed Ibnkahla, “Cooperative Cognitive Radio Networks:The complete Spectrum Cycle” I edition.
2. AhamedKhattab, Dmitri Perkins,BagdyByoumi,“Cognitive Radio Networks from Theory to practice” 2013th edition.

Reference Books

1. Kwang– Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks, Wiley Pub
2. Alexander M.Wyglinski,MaziarNekovee, ThomasHou,” Cognitive Radio Communications and Networks”.I edition.

Online Resource

www.vtt.fi/.../muut/2008/CHESS_Research_Report.pdf www.cs.cmu.edu/~prs/NSF_CRN_Report_Final.pdf

Course Code	Course Title	L	T	P	C
1152EC151	**NEXT GENERATION MOBILE NETWORKS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course gives a comprehensive overview of the current state of the 5G landscape, covering everything from the most likely use cases, to a wide range of technology options and potential 5G system architectures, to spectrum issues.

c) Prerequisite

Nil

d) Related Courses

Internet of Things, Software Defined Networking

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe and explain the evolution of 5G, system concepts and spectrum challenges	K2
CO2	Illustrate and explain the 5G functional and physical architecture and its requirements Explain the architecture, Beamforming and hardware technologies for mmW communications	K2
CO3	Describe and explain the requirements and fundamental techniques for MTC and D2D Communication	K2
CO4	Compare and explain various radio access technologies for 5G networks	K2
CO5	Illustrate and explain the fundamentals, resource allocation and transceiver algorithms for Massive MIMO	K2

f) **Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L											H		
CO2	M		M									M		
CO3	M		M											
CO4	M		M									M		
CO5	H		M									H		

g) Course Content

UNIT I DRIVERS FOR 5G 9

Historical Trend for Wireless Communication - Mobile Communications Generations: 1G to 4G – Evolution of LTE Technology to Beyond 4G – Pillars of 5G – Standardization Activities -Use cases and Requirements – System Concept – Spectrum and Regulations: Spectrum for 4G – Spectrum Challenges in 5G – Spectrum Landscape and Requirements – Spectrum Access Modes and Sharing Scenarios

UNIT II 5G ARCHITECTURE AND MILLIMETER WAVE COMMUNICATION 9

5G Architecture: Software Defined Networking – Network Function Virtualization – Basics about RAN Architecture –High-Level Requirements for 5G Architecture – Functional Architecture and 5G Flexibility – Physical Architecture and 5G Deployment

Millimeter Wave Communication: Channel Propagation – Hardware Technologies for mmW Systems – Deployment Scenarios – Architecture and Mobility – Beamforming – Physical layer Techniques.

UNIT III MACHINE TYPE AND D2D COMMUNICATION 9

MTC: Use cases and Categorization – MTC Requirements – Fundamental Techniques for MTC – Massive MTC – Ultra-reliable Low-latency MTC

D2D: from 4G to 5G – Radio Resource Management for Mobile Broadband D2D – Multi-hop D2D Communications for Proximity and Emergency Services – Multi-operator D2D Communication

UNIT IV 5G RADIO ACCESS TECHNOLOGIES 9

Access Design Principles for Multi-user Communications – Multi-carrier with Filtering – Non-orthogonal Schemes for Efficient Multiple Access – Radio Access for Dense Deployments – Radio Access for V2X Communication – Radio Access for Massive Machine-type Communication.

UNIT V MASSIVE MULTIPLE-INPUT MULTIPLE –OUTPUT SYSTEMS 9

MIMO in LTE – Single-user MIMO – Multi-user MIMO – Capacity of Massive MIMO – Pilot Design of Massive MIMO – Resource Allocation and Transceiver Algorithms for Massive MIMO – Fundamentals of Baseband and RF Implementation in Massive MIMO – Channel Models

Total 45 Hrs

h) Learning Resources

Reference Books

1. Asif Oseiran, Jose F.Monserrat and Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016.

2. Jonathan Rodriquez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015

3. Patrick Marsch, Omer Bulakci, Olav Queseth and Mauro Boldi, “5G System Design – Architectural and Functional Considerations and Long Term Research”, Wiley, 2018

Course Code	Course Title	L	T	P	C
1152EC131	**ADVANCED DIGITAL SIGNAL PROCESSING**	**2**	**2**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

Advanced digital signal processing courses includes theoretical and design aspects of multirate signal processing techniques. It includes spectrum estimation, linear prediction and adaptive filtering techniques. This course also introduces wavelet transform in signal processing applications

c) Prerequisite

Discrete Time Signal Processing.

d) Related Courses

DSP algorithms and architecture, Statistical Signal Processing

e) Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Design of decimator, interpolator and FIR filter structure	K3
CO2	Explain the parametric and nonparametric power spectrum estimation techniques	K2
CO3	Explain the concepts of linear estimation and prediction of discrete time signals	K2
CO4	Describe the various adaptive filter algorithms	K2
CO5	Apply wavelet transform concept in signal processing	K3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	M	M	-	-	-	-	-	-	L	L	-
CO2	H	L	-	-	M	-	-	-	L	-	-	L	-	-
CO3	H	L	-	L	M	-	-	-	-	-	-	L	-	-
CO4	M	M	M	-	M	L	-	-	L	-	-	M	L	-
CO5	M	M	L	-	M	-	-	-	-	-	-	M	M	-

g) Course Content

UNIT I MULTIRATE DIGITAL SIGNAL PROCESSING 12

Introduction - sampling rate conversion by rational factor - Filter design and implementation for sampling rate conversion - Direct form FIR filter structures – Polyphase filter structure

UNIT II POWER SPECTRUM ESTIMATION 12

Parametric Methods for Power Spectrum Estimation: Relationship between Auto Correlation and Model Parameters - The Yule Walker method for the AR model parameters - the Burg method for the AR model parameters. Non-Parametric Methods: Bartlett - Welch and Blackman -Tukey method - Model based approach – AR – MA - ARMA Signal modeling.

UNIT III LINEAR ESTIMATION AND PREDICTION 12

Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion - Wiener filter - Discrete Wiener Hoff equations - Recursive estimators - Forward and backward linear prediction - Prediction error - Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT IV ADAPTIVE FILTERS 12

FIR Adaptive filters - Adaptive filters based on steepest descent method - LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - Adaptive recursive filters - Recursive least squares

UNIT V INTRODUCTION TO WAVELET TRANSFORMS 12

Short Time Fourier Transform - Wavelet Transform: Continuous Wavelet Transform- Wavelet Transform Ideal Case - Haar Wavelet – Daubechies Wavelet - Applications to sub band coding - Wavelet transform and filter bank implementation.

Total 60 Hrs

h) Learning Resources

Text Books

1. John G. Proakis and Dimitris rd G. Manolkis, “Digital Signal Processing, Principles, Algorithms and Applications”, 3 edition, Prentice Hall of India, 2001.
2. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, Wiley, 2002.

Reference Books

1. S.Haykin, “Adaptive Filter Theory”, 2nd Edition, Prentice Hall, 2001
2. Roberto Crist, “Modern Digital Signal Processing”, Thomson Brooks/ Cole, 2004.
3. Raghuveer. M. Rao and Ajit S.Bopardikar, “Wavelet Transforms: Introduction to Theory and Applications”, Pearson Education, Asia, 2000.
4. S.Haykin, “Adaptive Filter Theory”, 2nd Edition, Prentice Hall, 2001

Online Resources

1. www.redcedar.com/**resources**.htm
2. eleceng.dit.ie/dorran/moodle/
3. ocw.mit.edu › Supplemental Resources
4. www.ifp.illinois.edu/~minhdo/teaching/wavelets.html

Course Code	Course Title	L	T	P	C
1152EC132	**STATISTICAL SIGNAL PROCESSING**	**2**	**2**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course provides an introduction to random variables, parameter estimation in presence of noise and the different types of optimum filtering algorithms based on the probabilistic and stochastic processes. It also covers signal modeling, adaptive filtering & its applications

c) Prerequisite

Discrete Time Signal Processing

d) Related Courses

Signal Processing Techniques for Speech Recognition

e) Course Outcomes

On successful completion of the course, the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain basic constituents of a random variables	K2
CO2	Describe the concepts related to Parameter Estimation techniques	K2
CO3	Apply the LMMSE and Wiener filtering techniques	K3
CO4	Explain the importance of lattice filters and linear prediction	K2
CO5	Explain the appropriate adaptive filtering techniques	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	-	H	M	-	-	-	-	-	-	L	-	-
CO2	H	H	-	M	M	-	-	-	-	-	-	L	-	-
CO3	H	H	M	L	M	-	-	-	-	-	-	L	L	-
CO4	H	M	L	L	M	-	-	-	-	-	-	L	-	-
CO5	H	H	H	L	H	-	-	-	L	-	-	L	L	-

g) Course Content

UNIT I REVIEW OF RANDOM VARIABLES 12

Basic introduction to random variables, Spectral representation of random signals, Wiener Khinchine theorem, Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, Innovation process and Whitening filter, Random signal modelling: MA, AR, ARMA models.

UNIT II PARAMETER ESTIMATION THEORY 12

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer-Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties; Bayesian estimation: Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.

UNIT III GAUSSIAN NOISE SIGNAL ESTIMATION 12

Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter – Filtering, Linear Prediction, Noise Cancellation, Lattice Representation for the FIR Wiener Filter, IIR Weiner Filter - Causal IIR Wiener filter, Non-causal IIR Wiener filter, Wiener Deconvolution, Causal LinearPrediction.

UNIT IV LEVINSON RECURSION AND LATTICE FILTERS 12

Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Levinson Recursion, FIR Lattice filter, Split Lattice filter, IIR Lattice filter, Lattice Methods for All-pole signal modelling, Stochastic modelling

UNIT V ADAPTIVE FILTERING ALGORITHMS 12

Principle and Application, Steepest Descent Algorithm, Convergence characteristics: LMS algorithm, Convergence, Excess mean square error, Leaky LMS algorithm, Application of Adaptive filters, RLS algorithm, Derivation, Matrix inversion Lemma, Initialization, Tracking of non-stationarity

Total 60 Hrs

h) Learning Resources

Text Books

1. Monson H.Hayes, “Statistical Digital Signal Processing and Modeling,” John Wiley & Sons, 2008.
2. H. Stark and J. Woods, “Probability and Random Processes with Applications to SignalProcessing”, 3rd edition, Pearson Education, 2001.
3. S. M. Kay, “Fundamentals of Statistical Signal Processing”, 1st edition, Volume 1, PrenticeHall, 1993.

Reference Books

1. John G. Proakis “Algorithms for Statistical Signal Processing”, Pearson Education Education, 2002.
2. DimitrisG.Manolakis “Statistical and Adaptive Signal Processing”, Tata McGraw Hill, 2000.
3. Papoulis and S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.

Online Resources

1. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/
2. http://www.nptel.ac.in/syllabus/117103019

Course Code	Course Title	L	T	P	C
1152EC133	**DSP ALGORITHMS AND ARCHITECTURE**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

DSP algorithms and Architecture course provides an introduction on the industry based DSP processor's architecture and their algorithms. Students will learn about the addressing modes, instruction set and memory allocation of the TMS320C67XX processor.

c) Prerequisite

Discrete Time Signal Processing

d) Related Courses

Signal Processing for Speech Recognition

e) Course Outcome

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic constituents of a digital signal processor.	K2
CO2	Explain the architecture of TMS320C67XX processor.	K2
CO3	Demonstrate the basic DSP algorithms on TMS320C67XX processor.	K3
CO4	Describe the interfacing concepts of external memory, serial and parallel I/O devices.	K2
CO5	Identify the development tools and blocks involved in DSP applications.	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	-	-	-	-	-	-	-	M	-	-
CO2	M	-	-	-	-	-	-	-	L	L	-	L	-	-
CO3	M	L	L	L	H	-	L	L	L	L	-	L	L	H
CO4	L	M	-	-	-	-	-	-	L	L	-	L	-	-
CO5	L	-	-	-	L	-	-	-	L	L	-	L	L	L

g) Course Content

UNIT I ARCHITECTURES FOR PROGRAMMABLE DIGITAL SIGNAL PROCESSORS 9

Introduction: Basic Architectural Features – DSP Computational Building Blocks – Bus Architecture and Memory – Data Addressing Capabilities – Address Generation Unit – Programmability and Program Execution – Features for External Interfacing.

UNIT II PROGRAMMABLE DIGITAL SIGNAL PROCESSORS 9

Introduction, Commercial digital Signal processing Devices, TMS320C67XX Processor: Data Addressing Modes - Memory Space - Program Control - Detail Study of Instructions and Programming - On-Chip peripherals - Interrupts - Pipeline Operation.

UNIT III IMPLEMENTATION OF BASIC DSP ALGORITHM 9

Introduction, the Q-notation, FIR Filters, IIR Filters, Interpolation and Decimation Filters (one example in each case), Implementation of FFT Algorithms: Overflow and Scaling – Bit Reversed Index Generation – Implementation on the TMS320C67XX.

UNIT IV INTERFACING MEMORY, SERIAL AND PARALLEL I/O PERIPHERALS TO DSP DEVICES 9

Introduction, Memory Space Organization, External Bus Interfacing Signals, Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O Direct Memory Access (DMA), Synchronous Serial Interface.

UNIT V DEVELOPMENT TOOLS AND APPLICATIONS OF DSP PROCESSOR 9

DSP Development Tools – The DSP System Design Kit (DSK) – The Assembler and the Assembly Source File – The Linker and Memory Allocation – The Code Composer Studio. Building blocks involved in a DSP Based Bio-telemetry Receiver and Image Processing Algorithms.

Total 45 Hrs

h) Learning Resources

Text Books

1. Avtar Singh and S. Srinivasan, “Digital Signal Processing”, 4^{th} edition, Thomson Publications, 2004
2. Sen M. Kuo, Woon-Seng S. Gan, “Digital Signal Processor-Architectures, implementation, And Applications”, Pearson prentice hall, 2005.

Reference Books

1. Peter Pirsch, “Architectures for Digital Signal Processing”, 2^{nd} edition, John Weily, 2007
2. B. Venkataramani and M. Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications”, 2 Editions, TMH, 2004.
3. Jervis, “Digital Signal Processing- A practical approach”, 4^{th} edition, Pearson Education,2004.
4. J.G.Proakis, “Algorithms for Statistical Signal Processing”, 4^{th} edition, Pearson, 2002.
5. TMS320C50, TMS320C54XX, TMS320C6713 data books.

Online Resource

1. http://www.ti.com/product/TMS320C6713/technicaldocuments
2. http://www.ti.com/tool/tmdsdsk6713

Course Code	Course Title	L	T	P	C
1152EC134	**SIGNAL PROCESSING TECHNIQUES FOR SPEECH RECOGNITION**	**3**	**0**	**0**	**3**

a) Course Category
Program elective

b) Preamble
This course provides concepts, methodology and analysis of speech signals. Speech signal recognition is important for speech-to-text and text-to-speech conversion of signal. This course also covers the basic speech recognition techniques and distortion measures to analyze the speech signal.

c) Prerequisite
Signals and Systems, Digital Signal processing

d) Related Courses
Digital Video Signal Processing

e) Course educational objectives

1. Understand basics of Hidden Markov Models and large vocabulary speech recognition
2. Understand the basic concepts of speech production, speech processing and analysis
3. Study the different speech modeling procedures and their implementation issues
4. Understand basics of Hidden Markov Models and large vocabulary speech recognition

f) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the fundamentals of speech and speech production system	K2
CO2	Compare the speech analysis techniques by considering various distortion measures.	K3
CO3	Explain source coding technique and Discriminative methods for speech recognition.	K2
CO4	Explain Hidden Markov Models for a given application.	K2

CO5	Explain the architecture and basic blocks of large vocabulary speech recognition system	K2

g) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	L	L	-	-	-	-	-	-	-	M	-	-
CO2	H	M	M	M	L	-	-	-	-	L	-	L	-	-
CO3	M	M	L	-	L	-	-	L	L	L	-	L	-	-
CO4	L	M	L	L	L	-	-	-	-	-	-	L	-	-
CO5	L	-	-	-	L	-	-	-	-	-	-	L	-	-

h) Course Content

UNIT I BASIC CONCEPTS 9

Fundamentals of speech recognition, Speech signal-speech production process, representing speech in the Time and Frequency Domains, Speech sounds and features, Automatic Speech Recognition-Acoustic-phonetic, statistical pattern- Recognition, AI, Neural Networks and their applications.

UNIT II SIGNAL PROCESSING ANALYSIS AND DISTORTION MEASURES 10

Spectral analysis model, Filter banks, Linear predictive coding model, vector quantization, speech detection, Distortion measures-Mathematical, Perceptual and spectral–Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Time Alignment and Normalization–Dynamic Time Warping, Multiple Time– Alignment Paths.

UNIT III SPEECH RECOGNITION SYSTEM DESIGN 9

Source coding techniques application- Vector quantization and pattern comparison, Template training- causal, robust, clustering, Performance analysis and recognition, Discriminative methods in recognition- weighting functions, training for minimum recognition error, Speech recognition in adverse environments.

UNIT IV INTRODUCTION TO HIDDEN MARKOV MODELS 9

Hidden Markov Model: Introduction, Discrete Markov Processes, Extension to HMMs, three basic problems for HMM, Types of HMM, Implementation issues.

UNIT V LARGE VOCABULARY SPEECH RECOGNITION 9

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system, language models-statistical, perplexity, context dependent sub-word units.

Total 45 Hrs.

i) Learning Resources

Text Books

1. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", 1st edition, Pearson Education, 2003.

2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", 2nd edition, Pearson Education, 2002.

Reference Books

1. Thomas F Quatieri, "Discrete-Time Speech Signal Processing –Principles and Practice", Pearson Education, 2006
2. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1998

Online Resources

http://nptel.ac.in/syllabus/117104023

Course Code	Course Title	L	T	P	C
1152EC235	**DIGITAL IMAGE PROCESSING**	**1**	**0**	**4**	**3**

a) Course Category

Program elective

b) Preamble

Digital Image Processing provides an introduction to the fundamental concepts and general principles of image processing. It covers the key stages of digital image processing techniques. Students will also get an opportunity to implement the algorithms that are specific to real time image processing systems/applications.

c) Prerequisite

Nil

d) Related Courses

Digital Video Signal Processing

e) Course Outcome

Upon successful completion of the course, the students will be able to

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Perform the basic image processing operations	S2
CO2	Implement the image enhancement, edge detection and noise analysis	S2
CO3	Demonstrate the image compression, morphology and segmentation techniques	S3

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	M	-	-	-	H	-	-	L	L	L
CO2	M	L	L	L	M	L	L	L	H	L	-	M	M	-
CO3	M	L	L	L	M	L	L	L	H	L	-	H	M	-

g) Examination Scheme for practical dominated course

Internal evaluation (40M)							Semester end evaluation (60M)			
Laboratory experiment (15M)				**Model laboratory test (25M)**			**Part-A (20M)**	**Part-B (40M)**		
Performance in Conducting experiment (5)	Result and Analysis (3)	Viva Voce (3)	Record (4)	Performance in conducting experiment (15)	Result and analysis (5)	Viva Voce (5)	Theory questions to evaluate the knowledge and understanding (20)	Performance in conducting experiment (25)	Result and analysis is (10)	Viva-Voce (5)

h) Course Content : Theory 15 Hours

1. Digital image representation – Types of digital image – Basic operations on images – Basic relations between pixels – Image transformations.
2. Image enhancement: Linear filtering – Smoothing and sharpening filters – Fourier transform on images – Edge detection
3. Image degradation model – Noise models – Noise removal filters
4. Fundamentals of image compression: Error free compression: Variable length coding, LZW coding, bit plane coding – discrete cosine transformation.
5. Morphological operations. Image segmentation basics: Local and global processing – Thresholding – background subtraction.

i) List of experiments

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	Digital image conversion from RGB to gray, gray to binary
2.	CO1	Image transformations
3.	CO2	Image enhancement using Histogram Equalization
4.	CO2	Sharpening and smoothing filters

5.	CO2	Fourier transform on images
6.	CO2	Comparison of edge detection techniques
7.	CO2	Noise analysis
8.	CO3	Image compression using Bit plane slicing
9.	CO3	Image compression using DCT
10.	CO3	Morphological operations
11.	CO3	Image Thresholding
12.	CO3	Segmentation using Background subtraction technique

Total: 75hrs

j) Learning Resources

Text Books

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 2nd edition, PHI/Pearson Education, 2002.
2. A.K.Jain, "Fundamentals of Digital Image Processing", 1st edition, Prentice Hall India, 1988.
3. Madhuri. A. Joshi, "Digital Image Processing-an algorithmic approach", 1st edition, PHI, 2006.

List of Major Equipment/ Instrument/Software with Broad Specifications

1. MATLAB 2007a (Licensed version).
2. OpenCV (Free version).
3. Code Composer Studio (Free version).
4. TMS320C6713 (operating at 225 Mhz, Embedded USB JTAG controller with plug and play drivers, USB cable included, TLV320AIC codec, 2M x 32 on board SDRAM, 512K bytes of on board Flash ROM, 3 expansion connectors (Memory Interface, Peripheral Interface, and Host Port Interface).
5. TI - OMAP L-138/6748 LCDK (Audio & Video Development DSP Board) (Integrated floating/fixed-point DSP with up to 456 MHz performance; and ARM9 with up to 456 MHz performance).

List of Software/Learning Websites

1. https://opencv.org
2. https://pythonprogramming.net/

Online resources

1. Prof. P.K. Biswas, Video lecture on Digital Image Processing, Centre for Educational Technology, IIT Kharagpur Sponsored by National Programme on Technology Enhanced Learning (NPTEL).
2. http://nptel.ac.in/syllabus/syllabus.php?subjectId=117105079

Course Code	Course Title	L	T	P	C
1152EC136	**Digital Video Signal Processing**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

Video processing refers to digital manipulation of 2D images that are sequentially ordered in time. This Digital Video Signal Processing course introduces fundamental theory and techniques for efficient representation and processing of video signals. This course also covers Fourier analysis of video signals, properties of the human visual system, motion estimation, and basic video compression techniques.

c) Prerequisite

Digital Signal Processing, Digital Image Processing

d) Related Courses

Signal Processing Techniques for Speech Recognition

e) Course educational objectives

Understand the basic concepts that are widely used in digital video processing

Learn frequency response of the video signal and sampling process
Interpret the performance of different motion estimation methods and video coding.
Familiarize with MATLAB computer vision system Toolbox

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic concepts of human vision, analog and digital video representations	K2
CO2	Discuss the frequency domain characteristics and response of the video signal	K2
CO3	Describe the video sampling mechanism by using lattice theory	K2

CO4	Apply the appropriate motion estimation technique for a given video processing applications	K3
CO5	Explain the advanced motion estimation techniques and appropriate coding system for a given video	K2

g) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	L	L	L	L	L	L	-	L	L	-
CO2	M	L	L	L	L	L	-	-	-	-	-	L	L	-
CO3	M	L	L	-	L	L	-	L	-	-	-	L	-	-
CO4	L	L	L	M	L	L	L	L	M	L	-	M	M	-
CO5	H	L	L	-	L	L	-	L	L	L	-	M	L	-

h) Course Content

UNIT I INTRODUCTION TO DIGITAL IMAGES AND VIDEO 9

Human Visual System and Color: Color Vision and Models, Contrast Sensitivity, Spatio-Temporal Frequency Response, Analog Video: Progressive vs. Interlaced Scanning, Analog-to-Digital Conversion, Digital Video: Spatial Resolution and Frame Rate, Color, Dynamic Range, and Bit-Depth, Image and Video Quality

UNIT II FOURIER ANALYSIS OF VIDEO SIGNALS AND FREQUENCY RESPONSE OF THE HUMAN VISUAL SYSTEM 11

Multidimensional Continuous-Space Signals and Systems, Multidimensional discrete Space Signals and Systems, Frequency Domain Characterization of Video Signals- Spatial and Temporal Frequencies, Temporal Frequencies Caused by Linear Motion, Frequency Response of the Human Visual System- Temporal Frequency Response and Flicker Perception, Spatial Frequency Response, Spatiotemporal Frequency Response, Smooth Pursuit Eye Movement

UNIT III VIDEO SAMPLING 8

Basics of the Lattice Theory, Sampling over Lattices: Sampling Process and Sampled-Space Fourier Transform, The Generalized Nyquist Sampling Theorem, Sampling Efficiency, Implementation of the Prefilter and Reconstruction Filter, Sampling of Video Signals: Required Sampling Rates, Sampling Video in Two Dimensions: Progressive versus Interlaced Scans, Spatial and Temporal Aliasing.

UNIT IV TWO DIMENSIONAL MOTION ESTIMATION METHODS 8

Camera model, object model, 2D motion models, Optical flow, general methodologies, pixel based motion estimation, block based motion estimation, Deformable Block-Matching Algorithms.

UNIT V ADVANCED TWO DIMENSIONAL MOTION ESTIMATION METHODS AND VIDEO CODING 9

Mesh-Based Motion Estimation, Global Motion Estimation, Region Based Motion Estimation, Application of Motion Estimation in Video Coding, Video Coding: Overview of Coding Systems, Basic Notions in Probability and Information Theory, Information Theory for Source Coding, Binary Encoding.

Total 45 Hrs.

i) Learning Resources

Text Books

1. A.Murat Tekalp, “Digital Video Processing”, 2nd edition, Prentice Hall, 2015.
2. Yao Wang, JornOstermann, Ya-Qin Zhang, “Video Processing and Communications”, 1st edition, Prentice Hall, 2002.

Reference Books

1. Alan C. Bovik, “The Essential Guide to Video Processing”, 2nd edition, Elsevier Science, 2009

Online Resources

1. Prof. Sumana Gupta, Video lecture on Digital Video Signal Processing, Centre for Educational Technology, IIT Kanpur Sponsored by National Programme on Technology Enhanced Learning (NPTEL). http://nptel.ac.in/syllabus/117104020/

Course Code	Course Title	L	T	P	C
1152EC152	**ANN AND DEEP LEARNING**	**3**	**0**	**0**	**3**

a) Course Category

Program elective

b) Preamble

This course covers the fundamentals from Artificial Neural Network to the current trending topic of Convolution Neural Network. Deep Learning is one of the most exciting and promising segments of Artificial Intelligence and machine learning technologies. However, with the increased availability of vast amounts of data and computational capability, it has evolved to a field of its own. In the last few years with numerous applications in computer vision, speech analysis, healthcare, agriculture, and understanding climate change etc. Thus this course aims to provide basic knowledge about the deep learning.

c) Prerequisite

Signals and systems

d) Related Courses

Digital Image Processing, Speech Processing

e) Course Objectives

1. To introduce the fundamental techniques and principles of Neural Networks
2. To study the different models in ANN and their applications
3. To familiarize deep learning concepts with Convolutional Neural Network case studies

f) Course Outcomes

On successful completion of the course, the students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic concepts in Neural Networks and applications	K2
CO2	Discuss feed forward networks and their training issues	K2
CO3	Distinguish different types of ANN architectures	K2
CO4	Explain the deep learning concepts using Back Propagation Network	K2

CO5	Discuss Convolutional Neural Network models for Object Detection and Image Retrieval	K2

g) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	L	-	-	-	-	-	-	L	-	-
CO2	L	L	L	L	L	-	-	-	-	-	-	L	L	-
CO3	L	L	L	L	L	-	-	-	-	-	-	L	L	-
CO4	L	L	L	L	L	H	M	-	M	M	-	L	L	-
CO5	L	L	H	H	H	H	M	-	M	M	-	L	L	-

h) Course Content

UNIT I INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS 9

Fundamentals of Neural Networks – Model of Artificial Neuron – Neural Network Architectures – Learning Methods – Taxonomy of Neural Network Architectures – Applications

UNIT II FEED FORWARD NEURAL NETWORKS 9

Perceptron Models: Discrete, Continuous and Multi-Category –Training Algorithms: Discrete and Continuous Perceptron Networks – Limitations of the Perceptron – Model. Credit Assignment Problem – Generalized Delta Rule, Derivation of Back propagation (BP) Training, and Summary of Back propagation Algorithm –Kolmogorov Theorem

UNIT III OTHER ANN ARCHITECTURES 9

Associative Memory – Exponential BAM – Associative Memory For Real Coded Pattern Pairs – Applications Adaptive Resonance Theory – Introduction – ART 1 – ART2 – Applications – Neural Networks Based On Competition – Kohenen Self Organizing Maps – Learning Vector Quantization – Counter Propagation Networks – Industrial Applications.

UNIT IV DEEP LEARNING 9

Deep Feed Forward network, regularizations, training deep models, dropouts, Training Deep Neural Networks using Back Propagation-Setup and initialization issues, vanishing and exploding Gradient problems, Gradient- Descent Strategies

UNIT V CONVOLUTIONAL NEURAL NETWORK 9

Convolutional Neural Network, Basic structure of Convolutional Network, Case studies: Alex net, VGG-Net, GoogLeNet, Applications of CNN– Object Detection, Content based image Retrieval.

Total 45 Hrs.

i) Learning Resources

Text Books

1. CharuC.Aggarwal "Neural Networks and Deep learning" Springer International Publishing, 2018.
2. Satish Kumar, "Neural Networks, A Classroom Approach", Tata McGraw -Hill, 2007.
3. Simon Haykin, "Neural Networks, A Comprehensive Foundation", 2nd Edition, Addison Wesley Longman, 2001.

Reference Books

1. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2006.
2. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000.

Online Resources

1. Michael Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015. http://neuralnetworksanddeeplearning.com/

Course Code	Course Title	L	T	P	C
1152EC153	**FUZZY- NEURAL SYSTEMS**	3	0	0	3

a) Course Category

Program Elective

b) Preamble

This course covers the fundaments of Fuzzy systems and Neural Networks to Applications. Fuzzy logic is form of multi-valued logic to deal with reasoning that is approximate rather than precise. Hence fuzzy logic approach is used to handle ambiguity and uncertainty existing in the complex problem. Neural networks have the ability to learn and can be used to model complex patterns and prediction problems. ANFIS has the ability to combine both into single framework, hence it has the learning capability and incorporates human decision making in solving complex real-world problems.

c) Prerequisite

Nil

d) Related Courses

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the fundamentals of Fuzzy set theory	K2
CO2	Distinguish the different Fuzzy Inference System	K2
CO3	Discuss the basics of Neural Network and supervised learning networks	K2
CO4	Explain various Associative Memory Networks and Unsupervised Learning Networks	K2
CO5	Discuss the Adaptive Neuro-Fuzzy Inference System and applications	K2

f)	Correlation of COs with POs													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	-	-	-	-	L	-	-	L	-	-
CO2	L	M	M	L	L	-	-	-	L	-	-	L	-	-
CO3	L	M	M	L	L	-	-	-	L	-	-	L	-	-
CO4	L	M	M	M	L	-	-	-	L	-	-	L	M	-
CO5	L	M	M	M	L	-	-	-	L	-	-	L	M	-

g) Course Content

UNIT I Fuzzy Sets 9

Introduction – Basic definitions and terminology – Set-theoretic Operations – MF Formulation and Parameterization – MFs of one Dimension - MFs of two Dimension – Derivatives of Parameterized MFs – Fuzzy Complement – Fuzzy Intersection and Union- Parameterized T-norm and T-conorm.

UNIT II Fuzzy Inference System 9

Extension Principle – Fuzzy Relations – Linguistic variables – Fuzzy If-Then Rules – Composite rule of inference – Fuzzy Reasoning – Mamdani Fuzzy Models – Other variants – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models.

UNIT III Neural Network 9

Fundamental Concepts – Models of a Neuron – Learning – Supervised Learning – Unsupervised Learning – Reinforcement Learning - Types of activation function – Network Architectures - Adaptive Networks – Backpropagation for Feed forward Networks – Supervised Learning Neural Networks – Perceptrons – Adaline – Backpropagation Multilayer perceptron – Radial Basis Function Networks

UNIT IV Other Neural Networks 9

Associative Memory Network – Autoassociative Memory Network – Heteroassociative Memory Network – Bidirectional Associative Memory – Hopfield Network - Unsupervised Learning Neural Networks – Competitive learning networks – Kohonen Self-Organizing Networks – Learning Vector Quantization – Adaptive Resonance Theory – Fundamental Architecture.

UNIT V Adaptive Neuro-Fuzzy Inference Systems and Applications 9

Adaptive Neuro-Fuzzy Inference Systems – ANFIS Architecture – Applications - Non-linear system Identification – Channel Equalization – Adaptive Noise cancellation.

Total 45 Hrs

h) Learning Resources

Text Books

1. J.S.R.Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI / Pearson Education 2004.
2. Simon Haykin, “Neural Network, A Comprehensive Foundation”, 2^{nd} Edition Pearson Prentice Hall, 2005.
3. S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.

Reference Books

1. George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic-Theory and Applications”, Prentice Hall, 1995.
2. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson Edn., 2003.
3. Satish Kumar, “Neural Network, A Classroom Approach”, Tata McGraw – Hill, 2007.

Online Resources

1. https://nptel.ac.in/courses/106105173/2
2. https://nptel.ac.in/courses/117105084/

Course Code	Course Title	L	T	P	C
1152EC154	INTRODUCTION TO MACHINE LEARNING	3	0	0	3

a) Course Category

Program Elective

b) Preamble

Machine learning is the technology of designing and implementing algorithms that allow computers to automatically learn from data or past experience and improve their performance without being explicitly programmed. It forms the basis of artificial intelligence. It involves algorithms to design coding by which computers can decipher information. This course covers the fundamental concepts of machine learning and popular machine learning algorithms, core concepts of supervised learning, unsupervised learning along with hands-on problem solving using simple python programming.

c) Prerequisite

Nil

d) Related Courses

ANN and Deep Learning

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain Machine Learning concepts, classifications of Machine Learning and write simple programs using python.	K2
CO2	Describe Supervised Learning concepts.	K2
CO3	Explain Support Vector Machine concepts.	K2
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques.	K2
CO5	Discuss simple Machine Learning applications in a range of real-world applications using Python programming	K2

f)	Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	L	L	-	-	-	L	-	-	L	L	-
CO2	L	L	L	M	-	-	-	-	-	-	-	H	L	-
CO3	L	L	M	M	-	-	-	-	-	-	-	M	M	-
CO4	L	L	H	M	-	-	-	-	-	-	-	H	M	-
CO5	L	L	L	M	M	L	L	L	M	-	L	L	L	-

g) Course Content

UNIT I Basics of Machine Learning and Python 9

Review of Linear Algebra, Definition of learning systems; Designing a learning system, Goals and applications of machine learning; Classification of learning system, Basic concepts in Machine Learning.

Python Basics – string, number, list, tuple, Dictionary, functions, conditional statement, Loop statements, Numpy, Matplotlib, simple programming exercises using python.

UNIT II Supervised Learning 9

Linear regression with one variable, Linear regression with multiple variables, Logistic regression; Linear Methods for Classification; Linear Methods for Regression; Decision trees, overfitting.

UNIT III Support Vector Machines 9

Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, non-linear SVM, Kernels for learning non-linear functions.

UNIT IV Unsupervised Learning 9

Learning from unclassified data, Clustering - Hierarchical Agglomerative Clustering, K-means partitional clustering – Expectation maximization (EM) for soft clustering; Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis

UNIT V Applications of Machine Learning 9

Strategies, guidelines for good design, performance measurement, Reading Data, PreProcessing Data, handwriting recognition, object detection, face detection.

Total 45 Hrs

h) Learning Resources

Reference Books

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010
2. Tom Mitchell, Machine Learning, McGraw-Hill, 1997
3. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
5. Richert & Coelho, Building Machine Learning Systems with Python

Online Resources

1. AndrewNg,“MachineLearning”,StanfordUniversity https://www.coursera.org/learn/machine-learning/home/info
2. Sudeshna Sarkar**, “**Introduction to Machine Learning”, IIT Kharagpur. https://nptel.ac.in/courses/106105152/1
3. Prof. Balaraman Ravindran, **“**Introduction to Machine Learning”, IIT Madras. https://nptel.ac.in/courses/106106139/1

Course Code	Course Title	L	T	P	C
1152EC256	**BASICS OF PYTHON PROGRAMMING**	**2**	**0**	**2**	**3**

a) Course Category

Program Elective

b) Preamble

The Purpose of the course is to provide students with the basic knowledge of python programming. To solve real world problems in an efficient manner, this course also emphasis on algorithm and Programming used in different applications.

c) Prerequisite

Nil

d)Related Courses

Digital Image Processing, Introduction to machine learning, ANN and Deep Learning, Fuzzy-Neural Systems

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Develop and illustrate algorithms to solve simple mathematical problems	K2
CO2	Write programs using various data types, operators, functions, and modules in Python	K2
CO3	a. Distinguish conditional and loop statements in Python b. Identify data handling functions to solve a given problem	K2
CO4	Use appropriate data structures in python to represent compound data	K2

CO5	a. Apply basic operations on data from/to files, modules and packages in Python b. Choose appropriate error and exception handling methods for debugging	K3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	-	M	-	-	-	L	-	-	-	-	-
CO2	M	M	L	-	H	-	-	-	M	-	-	-	-	-
CO3	M	M	L	-	H	-	-	-	M	-	-	-	-	-
CO4	M	L	L	-	H	-	-	-	M	-	-	-	-	-
CO5	M	L	L	-	H	-	-	-	M	-	-	-	-	-

g) Course Content

UNIT I ALGORITHMIC PROBLEM SOLVING 6

Algorithms, building blocks of algorithms, notation, algorithmic problem solving, simple strategies for developing algorithms.

Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA AND EXPRESSIONS 6

Python interpreter and interactive mode; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments.

Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW AND FUNCTIONS 6

Conditionals: Boolean values and operators, conditional, alternative, chained conditional; Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.

Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, binary search, different patterns.

UNIT IV DATA STRUCTURES: LISTS, TUPLES, DICTIONARIES 6

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension;

Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT V FILES, MODULES, PACKAGES 6

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.

Illustrative programs: word count, copy file.

Text Book:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
2. Mark Lutz & David Ascher, "Learning Python", Oreilly Publications, 5thedition, 2013.

References:

1. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

2. John V Guttag, —Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013

3. https://docs.python.org/

LIST OF EXPERIMENTS

S. No	Name of the Experiment	CO	**Skill Level**
1	Introduction to Python language and simple programming using python (3 weeks)	CO2	S3
2	a) Write a program to get the list of even numbers up to a given number b) Write a program to get the ascii distance between two characters c) Write a program to get the number of vowels in the input string (No control flow allowed) d) Write a program to get a list of even numbers from a given list of numbers. (use only comprehensions) (2 weeks)	CO3	S3
3	a) Write a program to get the binary form of a given number b) Write a program to convert base36 to octal c) Write a program to convert a given number into a given base (1 week)	CO2	S3
4	Write a program to check whether a given number has even number of 1's in its binary representation (No control flow, the number can be in any base) (1 week)	CO3	S3
5	a) Write a program to sort given list of strings in the order of their vowel counts b) Write a program to return a list in which the duplicates are removed and the items are sorted from a given input list of strings c) Write a program to test whether given strings are anagrams are not d) Write a program toreturn the top 'n' most frequently occurring chars and their respective counts (3 weeks)	CO3	S3
6	a) Write a program to implement user defined map () function b) Write a program to generate an infinite number of even numbers (Use generator) c) Write a program to implement left binary search d) Write a program to convert the passed in positive integer number into its prime factorization form e) Write a program to convert a given iterable into a list. (Using iterator) (3 weeks)	CO4	S3
7	Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered. (Handle exceptions) (2 week)	CO5	S3

Course Code	Course Title	L	T	P	C
1152EC259	**FUNDAMENTALS OF MACHINE LEARNING**	**2**	**0**	**2**	**3**

a) Course Category

Program Elective

b) Preamble

This course is proposed to meet a growing professional need of individuals skilled in artificial intelligence, data analytics, statistical programming and other software skills. The course will combine theory and practice to enable the student to gain the necessary knowledge to compete in the ever changing work environment. Machine learning is the technology of designing and implementing algorithms that allow computers to automatically learn from data or past experience and improve their performance without being explicitly programmed. It forms the basis of artificial intelligence. It involves algorithms to design coding by which computers can decipher information. This course covers the fundamental concepts of machine learning and popular machine learning algorithms, core concepts of Bayesian decision theory, Linear regression, Logistic regression and Support Vector Machines along with hands-on problem solving using simple python programming.

c) Prerequisite

Nil

d) Related Courses

ANN and Deep Learning

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Outline the Machine Learning (ML) concepts, Classify the learning paradigms and solve simple ML problems by using simulation tools.	K3
CO2	Describe the principle and concepts behind Bayes Decision theory and write simple python programs to implement it in prediction, classification and estimation	K3

CO3	Choose from a wide variety of Linear Regression algorithms and solve by implementation using established tools.	K3
CO4	Comprehend different Logistic Regression algorithms and develop simple programs using software tools.	K3
CO5	Explain Support Vector Machine concepts and make use of algorithms to solve classic ML problems.	K3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	L	M	-	-	-	M	L	-	L	L	-
CO2	L	L	L	M	M	-	-	-	M	L	-	H	L	-
CO3	L	L	M	M	M	-	-	-	M	L	-	M	M	-
CO4	L	L	H	M	M	-	-	-	M	L	-	H	M	-
CO5	L	L	L	M	M	-	-	-	M	L	-	L	L	-

g) Course Content

UNIT I Machine Learning Basics 12

Definition of learning systems; Designing a learning system, Learning paradigms: Supervised (generative/discriminative learning, parametric/nonparametric learning); Unsupervised (clustering, dimensionality reduction, kernel methods); and Reinforcement learning - Learning theory and Performance Metrics - Concepts of Overfitting and Underfitting

UNIT II Bayesian Decision Theory 12

Bayes rule – independence and conditional independence – common discrete and continuous distributions – Bayesian Concept learning - MAP estimation – Bayes Classifier - Bayes estimators for common loss functions -The false positive vs false negative tradeoff – Naïve Bayes model.

UNIT III Linear Regression 12

Simple linear regression –Multiple linear regression–Variable selection– F-tests – Least squares estimation – Collinearity – Residual analysis– Nonlinear regression.

UNIT IV Logistic Regression 12

Logistic Regression Model–Multiple logistic regression –Methods for Logistic Regression: Variable selection Step wise Logistic Regression–Best Subset Logistic Regression –Application of Logistic Regression.

UNIT V Support Vector Machines 12

Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, non-linear SVM, Kernels for learning non-linear functions.

Total : 30(L)+30(P) : 60 Hrs

h) Learning Resources

Reference Books

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, MIT Press 2010
3. Richert & Coelho, Building Machine Learning Systems with Python, 3rd Edition, Packt Publishers, 2018
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Second edition Springer 2007.
5. Weisberg, Sanford, Applied Linear Regression, 4th Edition, John Wiley & Sons, 2014
6. David W. Hosmer Jr., Stanley Lemeshow, Rodney X. Sturdivant, Applied Logistic Regression, 3rd Edition John Wiley & Sons, 2013

Online Resources

1. AndrewNg,“MachineLearning”, StanfordUniversity https://www.coursera.org/learn/machine-learning/home/info
2. Sudeshna Sarkar**,** **“**Introduction to Machine Learning”, IIT Kharagpur. https://nptel.ac.in/courses/106105152/1
3. Prof. Balaraman Ravindran, **“**Introduction to Machine Learning”, IIT Madras. https://nptel.ac.in/courses/106106139/1

LIST OF EXPERIMENTS

Hardware requirement:

- i5 Processor, 8GB RAM, & Internet Connection

Software Environment:

- IDE recommended PYCHARM (Recommended), JUPYTER, VISUAL STUDIO

S.No.	Name of the Experiment	CO	Skill Level
1	Online Retail Case Study	CO1	S3
2	Program to demonstrate Housing Price Prediction	CO2	S3
3	Program to demonstrate on Prediction using Bayes Rule.	CO2	S3
4	Program to demonstrate, classification/estimation using Bayes Rule.	CO2	S3
5	Program to demonstrate Simple Linear Regression	CO3	S3
6	Program to demonstrate Multiple Linear Regression	CO3	S3
7	Program to demonstrate Binary and Multiple Logistic Regression	CO4	S3
8	Program to demonstrate Multinomiaal Logistic Regression	CO4	S3
9	Program to demonstrate SVM based classification	CO5	S3
10	Case study on non-linear SVM classifier	CO5	S3

Course Code	Course Title	L	T	P	C
1152EC261	**PROFESSIONAL PYTHON PROGRAMMING**	**2**	**0**	**2**	**3**

a) Course Category

Program Elective

b) Preamble

The Purpose of the course is to provide students with the basic knowledge of python programming. To solve real world problems in an efficient manner, this course also emphasis on algorithm and Programming used in different applications.

c) Prerequisite

Basics of Python Programming

d)Related Courses

Digital Image Processing, Introduction to machine learning, ANN and Deep Learning, Fuzzy-Neural Systems

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Use object-oriented programming concept in python to solve a given problem	K3
CO2	Apply basic operations on different kinds of files like XML, CSV, and SQL database	K3
CO3	Apply common Python functionality and features for data science	K3
CO4	Compare and plot the data using different kinds of plots	K3
CO5	Apply the python programming for networking applications.	K3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	-	M	-	-	-	L	-	-	-	-	-
CO2	M	M	L	-	H	-	-	-	M	-	-	-	-	-
CO3	M	M	L	-	H	-	-	-	M	-	-	-	-	-
CO4	M	L	L	-	H	-	-	-	M	-	-	-	-	-
CO5	M	L	L	-	H	-	-	-	M	-	-	-	-	-

g) Course Content

UNIT I OBJECT ORIENTED PROGRAMMING WITH PYTHON 12

Class and objects, _init_ method, constructor, class with multiple objects, class attributes vs data attributes, types of variables, types of methods, inner class, encapsulation, inheritance, polymorphism.

UNIT II FILE PROCESSING 12

Processing different kinds of files: interacting with SQLite databases, creating and processing XML files, CSV file reading and writing, basics logging facility for Python, configuration file parser. Communicating with a program's environment: interacting with the operating system, manipulating with dates and time, time access and conversions.

UNIT III PYTHON FOR DATA SCIENCE 12

Introduction to data science, Data science Packages : NumPy with Python – NumPy array creation using array() function and initial placeholder content, Basic arithmetic operations, Mathematical functions, Changing the shape of an array, stacking and splitting of arrays, Pandas – series, data frame.

UNIT IV DATA VISUALIZATION IN PYTHON 12

Introduction to data visualization, Matplotlib, Line Plots, Area Plots, Histograms, Bar Charts, Pie Charts, Box Plots, Scatter Plots, Waffle Charts.

UNIT V PYTHON FOR NETWORKING 12

Introduction-Basics of sockets and methods-working with TCP socket-UDP socket, network analysis-port scanner-banner grabbing, sending Email-GUI programming-Tkinter.

Text Book:

1. Matt Weisfeld, “The Object-Oriented Thought Process”, Bronkella Publishing LLC, 4th Edition, 2013, ISBN: 978-0-321-86127-6.
2. Lillian Pierson, “Data Science Dummies”, John Wiley Publishers, 2nd Edition, 2017, ISBN: 978-1-119-32763-9.

References:

1. Guido van Rossum and Fred L. Drake Jr, “An Introduction to Python”, Revised and updated for Python 3.2, Network Theory Ltd., 2011.
2. John V Guttag, “Introduction to Computation and Programming Using Python‘‘, Revised and expanded Edition, MIT Press , 2013
3. Jeeva Jose &P.SojanLal, “Introduction to Computing and Problem Solving with PYTHON”, Khanna Publishers, New Delhi, 2016.
4. Wesley J. Chun, “Core Python Applications Programming”, 3rd Edition , Pearson Education, 2016.

Websites:

1. https://docs.python.org/
2. https://nptel.ac.in/courses/106/106/106106182/
3. https://online.umich.edu/courses/introduction-to-data-science-in-python/

LIST OF EXPERIMENTS

S.No.	Name of the Experiment	CO	Skill Level
1	Simulation of elliptical orbits in Pygame	CO1	S3
2	Simulation of bouncing ball using Pygame	CO1	S3
3	Demonstrate class variable, instance variable, and self variable for implementing (a) Robot (b) ATM Machine	CO1	S3
4	Develop a Python program to interact with SQLite databases	CO2	S3
5	Demonstrate the processing of XML files in Python	CO2	S3
6	Demonstrate the processing of CSV files in Python	CO2	S3
7	Develop a python program to explore python packages – NumPy and Pandas	CO3	S3
8	Creation of dataframe from ndarrays/lists/list of dictionaries	CO3	S3
9	Demonstration of filtering data in a Pandas dataframe	CO3	S3
10	Demonstrate the use of Matplotlib package and bringing other Python libraries with Matplotlib	CO4	S3
11	Demonstrate the use of line plots and area plots	CO4	S3
12	Demonstrate the use of Bar Charts, Pie Charts	CO4	S3
13	Creation of client server programming using TCP/UDP socket	CO5	S3
14	Develop a python program to send e-mail.	CO5	S3
15	Creation of GUI application using Tkinter module.	CO5	S3

Course Code	Course Title	L	T	P	C
1152EC263	**PYTHON PROGRAMMING**	**2**	**0**	**2**	**3**

a) Course Category

Program Elective

b) Preamble

The Purpose of the course is to provide students with the basic knowledge of python programming. To solve real world problems in an efficient manner, this course also emphasis on algorithm and Programming used in different applications.

c) Prerequisite

Nil

d)Related Courses

Digital Image Processing, Introduction to machine learning, ANN and Deep Learning, Fuzzy-Neural Systems

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Develop and illustrate algorithms to solve simple mathematical problems	K3
CO2	Write programs using various data types, operators, functions, and modules in Python	K3
CO3	Distinguish conditional and loop statements in Python and identify data handling functions to solve a given problem	K3
CO4	Use appropriate data structures in python to represent compound data	K3

CO5	a. Apply basic operations on data from/to files, modules and packages in Python b. Choose appropriate error and exception handling methods for debugging	K3

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	-	M	-	-	-	L	-	-	-	-	-
CO2	M	M	L	-	H	-	-	-	M	-	-	-	-	-
CO3	M	M	L	-	H	-	-	-	M	-	-	-	-	-
CO4	M	L	L	-	H	-	-	-	M	-	-	-	-	-
CO5	M	L	L	-	H	-	-	-	M	-	-	-	-	-

g) Course Content

UNIT I ALGORITHMIC PROBLEM SOLVING 6

Algorithms, building blocks of algorithms, notation, algorithmic problem solving, simple strategies for developing algorithms.

Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA AND EXPRESSIONS 6

Python interpreter and interactive mode; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments.

Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW AND FUNCTIONS 6

Conditionals: Boolean values and operators, conditional, alternative, chained conditional; Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.

Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, binary search, different patterns.

UNIT IV DATA STRUCTURES: LISTS, TUPLES, DICTIONARIES 6

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension;

Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT V FILES, MODULES, PACKAGES 6

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.

Illustrative programs: word count, copy file.

Text Book:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
2. Mark Lutz & David Ascher, "Learning Python", Oreilly Publications, 5th edition, 2013.

References:

1. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
2. John V Guttag, —Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013
3. https://docs.python.org/

LIST OF EXPERIMENTS

S. No	Name of the Experiment	CO	**Skill Level**
1	Introduction to Python language and simple programming using python (3 weeks)	CO2	S3
2	a) Write a program to get the list of even numbers up to a given number b) Write a program to get the ascii distance between two characters c) Write a program to get the number of vowels in the input string (No control flow allowed) d) Write a program to get a list of even numbers from a given list of numbers. (use only comprehensions) (2 weeks)	CO3	S3
3	a) Write a program to get the binary form of a given number b) Write a program to convert base36 to octal c) Write a program to convert a given number into a given base (1 week)	CO2	S3
4	Write a program to check whether a given number has even number of 1's in its binary representation (No control flow, the number can be in any base) (1 week)	CO3	S3
5	a) Write a program to sort given list of strings in the order of their vowel counts b) Write a program to return a list in which the duplicates are removed and the items are sorted from a given input list of strings c) Write a program to test whether given strings are anagrams are not d) Write a program toreturn the top 'n' most frequently occurring chars and their respective counts (3 weeks)	CO3	S3
6	a) Write a program to implement user defined map () function b) Write a program to generate an infinite number of even numbers (Use generator) c) Write a program to implement left binary search d) Write a program to convert the passed in positive integer number into its prime factorization form e) Write a program to convert a given iterable into a list. (Using iterator) (3 weeks)	CO4	S3
7	Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered. (Handle exceptions) (2 week)	CO5	S3

Course Code	Course Title	L	T	P	C
1152EC162	**MEDICAL ELECTRONICS**	**3**	**0**	**0**	**3**

a) Course Category

Program Elective

b) Preamble

This course introduces the medical assist devices, physiological parameters and the methods of recording and transmitting these parameters.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Know the human body electro- physiological parameters and recording of bio-potentials.	K2
CO2	Comprehend the non-electrical physiological parameters and their measurement – body temperature, blood pressure, pulse, blood cell count, blood flow meter etc.	K2
CO3	Interpret the various assist devices used in the hospitals viz. pacemakers, defibrillators, dialyzers and ventilators	K2
CO4	Comprehend physical medicine methods eg. ultrasonic, shortwave, microwave surgical diathermies , and bio-telemetry principles and methods.	K2
CO5	Know about recent trends in medical instrumentation.	K2

f) Correlation of COs with POs (Program Outcomes defined by National Board of Accreditation, India)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	M	-	-	-	-	-	-	-	-	-	-	M	-	-
CO2	M	-	-	-	-	-	-	-	L	L	-	L	-	-
CO3	M	L	L	L	-	-	-	-	L	L	-	L	L	H
CO4	L	M	-	-	-	-	-	-	L	L	-	L	-	-
CO5	L	-	-	-	-	-	-	-	L	L	-	L	L	L

g) Course Content

UNIT I ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING 9

Sources of bio medical signals, Bio-potentials, Biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics.

UNIT II BIO-CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT 9

pH, PO2, PCO2, Colorimeter, Blood flow meter, Cardiac output, respiratory, blood pressure, temperature and pulse measurement, Blood Cell Counters.

UNIT III ASSIST DEVICES 9

Cardiac pacemakers, DC Defibrillator, Dialyser, Ventilators, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems.

UNIT IV PHYSICAL MEDICINE AND BIOTELEMETRY 9

Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Biotelemetry.

UNIT V RECENT TRENDS IN MEDICAL INSTRUMENTATION 9

Telemedicine, Insulin Pumps, Radio pill, Endomicroscopy, Brain machine interface, Lab on a chip.

Total 45 Hrs

h) Learning Resources

Text Books

1. Leslie Cromwell, —Biomedical Instrumentation and Measurement‖, Prentice Hall of India, New Delhi, 2007.

Reference Books

1. Khandpur, R.S., “Handbook of Biomedical Instrumentation”, TATA Mc Graw-Hill, New Delhi, 2003.
2. John G.Webster, “Medical Instrumentation Application and Design”, 3rd Edition, Wiley India Edition, 2007.
3. Joseph J.Carr and John M.Brown, “Introduction to Biomedical Equipment Technology”, John Wiley and Sons, New York, 2004

Course Code	Course Title	L	T	P	C
1153EC101	MICROPROCESSOR AND MICROCONTROLLER	3	0	0	3

a) **Course Category**

Allied Elective

b) **Preamble**

The Purpose of the course is to provide students with the Knowledge of Microprocessors and Microcontroller.To solve real world problems in an efficient manner, this course also emphasis on architecture and Programming.

c) **Prerequisite**

Nil

d) **Related Courses**

Robotics and Embedded System Design

e) **Course Educational Objectives :**

Students undergoing this course are exposed to:

1.The internal organization, addressing modes and instruction sets of 8085, 8086 processor.

2.The various peripheral devices such as 8255, 8279, 8251, 8253 and 8259 the various functional units of 8051 microcontroller.

3.Develop assembly language program by using 8051 Instruction sets and addressing modes.

f) **Course Outcomes**

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the internal organization, addressing modes and instruction sets of 8085 processor.	K2
CO2	Explain the internal organization, addressing modes and instruction sets of 8086 processor.	K2
CO3	Explain the interfacing of various peripherals devices such as 8255, 8279, 8251, 8253 and 8259.	K2
CO4	Explain the architecture and functional block of 8051 microcontroller.	K2

CO5	Develop an embedded C and ALP in 8051 microcontroller using the internal functional blocks for the given specification.	K2

g) Course Content

UNIT I 8085 CPU **9**

8085 Architecture – Pin diagram-Memory interfacing – I/O interfacing- Timing Diagram- Instruction Set- Addressing modes – Assembly language programming

UNIT II 8086 CPU **9**

Intel 8086 microprocessor – Architecture – minimum and maximum mode- Instruction set and assembler directives – Addressing modes – Assembly language programming – Procedures – Macros

UNIT III PERIPHERAL DEVICES **9**

Parallel peripheral Interface (8255) - Timer / Counter (8253) - Keyboard and Display Controller (8279) - USART (8251) - Interrupt Controller (8259).

UNIT IV 8051 ARCHITECTURE **9**

Architecture – memory organization –I/O pins, ports and circuits- Timers - Interrupts –serial communication

UNIT V 8051 PROGRAMMING **9**

Addressing modes -instruction set -Assembly language programming and C Programming– Timer Counter Programming – Serial Communication Programming- Interrupt Programming.

Total 45 Hrs

h) Learning Resources

Reference Books

1. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers
2. Mohamed Rafiquzzaman, Microprocessor and Microcomputer based system design, second edition, CRC press

Text Books

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 6th Edition, Penram International Publishing .(UNIT 1)
2. Yu-cheng Liu, Glenn A. Gibson, “Microcomputer systems: The 8086 / 8088 Family architecture, Programming and Design "second edition, PHI .(UNIT2)

3. A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing “, TMH, (UNIT 3)
4. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D McKinlay, The 8051 microcontroller and embedded systems using assembly and C, second edition Pearson education Asia.(UNIT 4 & 5)

Online Resources

1. https://www.youtube.com/watch?v=liRPtvj7bFU&list=PL0E131A78ABFBFDD0
2. https://www.youtube.com/watch?v=95uGOJ1Ud2c&list=PLJGA4olwzpA-rvcdWULcRuMn2495g0n8j

Course Code	Course Title	L	T	P	C
1153EC202	**EMBEDDED SYSTEMS AND ROBOTICS**	**1**	**0**	**4**	**3**

a) Course Category

Program Elective

b) Preamble

This course introduces the embedded hardware design, programming and introduction of robotics, electronic components, electronic processors and controllers, circuit development with practical knowledge of each modules to give our student the best of robotics training for real-time applications.

c) Prerequisite

Microprocessor and Microcontroller

d) Related Courses

Nil

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Dave's Taxonomy)
CO1	Demonstrate PIC based embedded systems	S4
CO2	Design and develop real time systems using Arduino	S4
CO3	Design robots using arduino for the given specification and demonstrate it	S4

f) Course content

Theory **15 Hours**

PIC-Architecture, pin diagram, ports, on chip peripherals Embedded C programming – General Structure, Data types

Embedded C programming – General Structure, Data types

Arduino-   introduction, IDE, different arduino, Boards & shields

Analog I/O & O/p.Serial and Parallel Communication

Microcontroller ATMEGA 328

Seven Segment and LCD Display

Driving motors

Manual Robots and Autonomous Robots - fundamentals and its applications

Gear assembly and calculations.

Different types of chassis designing

RTOS fundamentals

g) List of experiments.

S. No	**CO Mapping**	**Practical Exercises (60 Hours)**
1.	CO1	LED and seven segment display using PIC- C Programming
2.	CO1	Keypad interface using PIC- C Programming
3.	CO1	Serial communication using PIC-C Programming
4.	CO1	PWM generation using PIC-C Programming
5.	CO1	Motor speed control using PIC
6.	CO2	Interfacing Basic Shield with Arduino
7.	CO2	LED Interfacing using Arduino
8.	CO2	Generating different colors from RGB LED
9.	CO2	LCD Interfacing using Arduino

10.	CO2	LDR Interfacing using Arduino
11.	CO2	IR sensor interfacing using Arduino
12.	CO2	Ultrasound sensor interfacing using Arduino
13.	CO2	Temperature sensor interfacing using Arduino
14.	CO2	Interfacing Motors to Arduino
15.	CO2	Bluetooth Interfacing using Arduino
16.	CO2	WiFi Interfacing using Arduino
17.	CO2	GSM module Interfacing using Arduino
18.	CO3	Color Sensing Robot
19.	CO3	Light Sensing Robot
20.	CO3	Grid Counting Robot
21.	CO3	Range Detecting Robot
22.	CO3	Obstacle Sensing Robot
23.	CO3	Edge Avoiding Robot
24.	CO3	DTMF Controlled Robot
25.	CO3	Bluetooth Controlled Robot
26.	CO3	Wi-Fi Controlled Robot
27.	CO3	GSM Controlled Robot
28.	CO3	Line Follower Robot

Total hrs 75

h) Learning Resources

Reference Books

1. Massimo Banzi, “Getting Started with Arduino” 2 nd edition. O’Reilly, 2011
2. Udayakumar, G.Kulkarni, “ Arduino: A Begineer's Guide” 2017
3. DoganIbrahi, “Advanced PIC Microcontroller Projects in C”, Newnes, 2008
4. MykePredko, “Programming and customizing the PIC”, 3 rd edition
5. Parab, V.G.Shelake and R.K.Kamat-“Exploring C for Microcontrollers: A Hands on Approach”- Springer-2007
6. M. ShohamA Textbook of Robotics 1: Basic Concepts Springer-1984
7. By Kevin M. Lynch, Frank C. Park “Modern Robotics mechanics, planning, controls” Cambridge university press-2017

Online Resources

1. https://www.arduino.cc//
2. https://www.tutorialspoint.com/arduino/index.html
3. http://microcontrollerslab.com/pic-microcontroller-compiler/
4. http://bobblick.com/techref/techref.html
5. http://www.microcontrollerboard.com/pic-microcontroller-books.html
6. http://www.nex-robotics.com/products/microcontroller-development-boards/atmega2560- microcontroller-socket.html
7. http://www.avr-asm-download.de/beginner_en

Course Code	Course Title	L	T	P	C
1153EC103	EMBEDDED SYSTEM DESIGN	3	0	0	3

a) Course Category

Program Elective

b) Preamble

The course gives introduction to embedded system components, design, safety, reliability and optimization performance analysis of an embedded product and gives the brief view on distributed embedded system

c) Prerequisite

Microprocessor & Microcontroller.

d) Related Courses

Real Time Operating System, Embedded Control System

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Review the functional blocks of an embedded system and its software development process.	K2
CO2	Generalize the design and development of sophisticated embedded systems.	K2
CO3	Associate the importance of safety and reliability in contemporary embedded system.	K2
CO4	Explain various techniques for performance optimization.	K2
CO5	Describe the growing area of distributed embedded systems.	K2

f) Course Content

UNIT I FUNDAMENTALS OF EMBEDDED SYSTEM 9

Introduction to embedded system: Processor – Memory – Peripherals – Software – Algorithms – Microcontroller - Microprocessor based – board based.
Compilation Process in Embedded System: Compiling code – preprocessor compilation - linking & loading – Symbols - references and relocation - linker/loader.
Debugging Techniques: High Level language simulation – low level simulation – onboard debugger – task level debugging – symbolic debug - Emulation.

UNIT II HARDWARE - SOFTWARE CO-DESIGN 9

Co-design Process: Overview - Development Life cycles - Specification, Modeling Tools and Languages, Techniques of Hardware Software Codesign: Partitioning - Co-Simulation, Co-Synthesis - Co-Verification

UNIT III SAFETY AND RELIABILITY 9

Safety and Reliability Techniques, Proactive Approach: Software Solutions – Approaches - Hardware Solutions – Approaches, Steps to a Safe Design, Extreme Reliability, Long Life Applications, Critical Components, Dealing with Failure, Specification

UNIT IV OPTIMIZATION AND PERFORMANCE ANALYSIS 9

Introduction, Basic Measures, Real-time Considerations: Hard – Soft – Firm, Time Loading: Simulation – Instrumentation, Response Time, Memory Loading, Performance Evaluation, Performance Optimization, Hardware Accelerators, Hardware Platforms, Microprocessors and FPGAS, Optimizing Power Consumption, Trade-offs.

UNIT V DISTRIBUTED SYSTEMS 9

Introduction to Distributed Systems, Local and Remote Models, Intra and Inter System Communication, Protocols, Error Management: Failure Detection, Reconfiguration, Recovery Idempotent Systems, Pipes, Streams, and Sockets, Remote Services and Procedures, Design Issues, Synchronous and Asynchronous Procedures. **Total 45 Hrs**

g) Learning Resources

Text Books

1. Steve Heath, "Embedded Systems Design", Second Edition, Elsevier.
2. James K.Precol, "Embedded Systems-A Contemporary Design Tool", John Wiley & Sons Inc-2008.
3. Frank Vahid& Tony Givargis, "Embedded System Design-A Unified Hardware/Software Introduction", Third Edition, John Wiley & Sons Inc., Reprint 2010.
4. Michael Barr & Anthony Massa, "Programming Embedded Systems-with C & GNU Development tools", Second Edition, O'REILLY, Reprint-2007
5. Arnold S.Berger, "Embedded Systems Design", CMP Books.

Reference Books

1. David E.Simon, "An Embedded Software primer", Pearson Publication

Online Resources

1. https://www.youtube.com/watch?v=4CPIjYGIYqc
2. https://www.youtube.com/watch?v=y70V0qHAFNQ
3. https://www.youtube.com/watch?v=yAOfqK1kQso

COURSE CODE	COURSE TITLE	L	T	P	C
1153EC104	**REAL TIME OPERATING SYSTEMS**	**3**	**0**	**0**	**3**

Course Category:

Allied Elective

a. Preamble:

This Course deals with fundamentals of Operating Systems, implementation aspects of real time concepts and few applications on RTOS.

b. Prerequisite Courses:

Problem Solving using C
Microprocessor & Microcontroller

c. Related Courses:

Embedded System Design
Embedded Processors

d. Course Educational Objectives :

- To make the student learn fundamentals of Operating Systems,
- Providing the knowledge on the implementation aspects of real time concepts
- Providing the knowledge to build few applications on RTOS.

e. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the fundamentals of interaction of OS with a computer and User computation	K2
CO2	Explain the fundamental concepts of how process are created and controlled with OS	K2
CO3	Describe the programming logic of modeling Process based on range of OS features	K2
CO4	1.Develop the target system by porting RTOS 2.Compare types and Functionalities in commercial OS,	K3 K2
CO5	Application development using RTOS	K3

f. Course Content :

UNIT I: REVIEW OF OPERATING SYSTEMS 9

Basic Principles - Operating System structures – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Introduction to Distributed operating system -Distributed scheduling-Fault & recovery.

UNIT II: OVERVIEW OF RTOS **9**

Multiple Processes in an Application – Multiple Threads in an Application - Task and Task state – Shared data – Interprocess Communication - Semaphores - Message queues– Mail boxes -pipes

UNIT III: REAL TIME MODELS AND LANGUAGES **9**

Event Based – Process Based and Graph based Models – Real Time Languages – RTOS Tasks –RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements.

UNIT IV: REAL TIME KERNEL **9**

Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and Basic study of various RTOS like – VX works – Linux supportive RTOS – C Executive.

UNIT V: APPLICATION DEVELOPMENT USING OS **9**

Basics of Linux supportive RTOS – uCOS-C Executive for development of RTOS Application – introduction to Android Environment -The Stack – Android User Interface – Preferences, the File System, the Options Menu and Intents, with one Application

Total: 45 Periods

g. Learning Resources

i.Text Books :

1. Silberschatz,Galvin,Gagne" Operating System Concepts,6th ed,John Wiley,2003
2. Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill,1997
3. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill,2006.
4. Karim Yaghmour,Building Embedded Linux System",O'reilly Pub,2003

ii.Reference:

1. Marko Gargenta,"Learning Android ",O'reilly 2011.
2. Herma K., "Real Time Systems – Design for distributed Embedded Applications", Kluwer Academic, 1997.
3. C.M. Krishna, Kang, G.Shin, "Real Time Systems", McGraw Hill, 1997.
4. Raymond J.A.Bhur, Donald L.Bailey, "An Introduction to Real Time Systems", PHI,1999
5. Mukesh Sighal and N G Shi "Advanced Concepts in Operating System", McGraw Hill,2000
6. D.M.Dhamdhere," Operating Systems,A Concept-Based Approch,TMH,2008

iii. Online resources:

1. http://etutorials.org/Linux+systems/embedded+linux+systems
2. http://www.freertos.org
3. **rtosonline**.com.au/**rto**-**courses**-units
4. E-books for Android

Course Code	Course Title	L	T	P	C
1153EC105	**ANALOG AND DIGITAL COMMUNICATION**	**3**	**0**	**0**	**3**

Course Category

Allied elective

a) Preamble

This course provides the information about the analog, digital, data and mobile communications, also to determine the error in communication system.

b) Prerequisite

Nil

c) Related Courses

Data Communication Network and Computer Networks

d) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the concept of amplitude and angle modulations	K2
CO2	Compare different types of shift keying techniques.	K2
CO3	Describe various data and pulse transmission schemes	K2
CO4	Study the error in the communication system using error Control coding techniques.	K2
CO5	Describe about multi user communication concepts, radio communication and wireless technology.	K2

e) Course Content

UNIT I ANALOG COMMUNICATION 9

Introduction to Communication Systems: Modulation – Types - Need for Modulation, Theory of Amplitude Modulation - Evolution and Description of SSB Techniques, Theory of Frequency and Phase Modulation, Noise: Source of Noise - External Noise- Internal Noise- Noise Calculation, Comparison of Various Analog Communication System (AM – FM – PM).

UNIT II DIGITAL COMMUNICATION 9

Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Minimum Shift Keying (MSK) Phase Shift Keying (PSK): BPSK – QPSK – 8 PSK, Quadrature Amplitude Modulation (QAM): 8 QAM, Bandwidth Efficiency, Comparison of Various Digital Communication System (ASK – FSK – PSK – QAM).

UNIT III DATA AND PULSE COMMUNICATION 9

Data Communication: History of Data Communication - Data Communication Circuits - Data Communication Codes - Error Detection and Correction Techniques.

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse Code Modulation (PCM), Comparison of Various Pulse Communication Systems (PAM – PTM – PCM).

UNIT IV SOURCE AND ERROR CONTROL CODING 9

Entropy, Source Encoding Theorem - Shannon Fanon Coding - Huffman Coding, Mutual Information - Channel Capacity, Channel Coding Theorem, Error Control Coding - Linear Block Codes - Cyclic Codes - Convolution Codes.

UNIT V MULTI-USER RADIO COMMUNICATION 9

Advanced Mobile Phone System (AMPS), Global System for Mobile Communications (GSM), Code Division Multiple Access (CDMA), Cellular Concept and Frequency Reuse: Channel Assignment and Hand Off, Overview of Multiple Access Schemes

Total 45 Hrs

f) Learning Resources

Text Books

1. Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, Pearson Education, 2009.
2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007.

Reference Books

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. Martin S.Roden, “Analog and Digital Communication System”, 3rd Edition, Prentice Hall of India, 2002.

Online Resources

1. http://nptel.iitm.ac.in/courses/Webcourscontents/IIScBANG/Data%20Communication/Learning%20Material%20-%20DataCommunication.pdf
2. http://www.sp4comm.org/docs/chapter12.pdf

Course Code	Course Title	L	T	P	C
1153EC106	**WIRELESS COMMUNICATION NETWORKS**	**3**	**0**	**0**	**3**

a) Course Category

Allied Elective

b) Preamble

This course addresses the fundamentals of wireless communication and provides an overview of existing and emerging wireless communications networks. It covers radio propagation and fading models, fundamentals of cellular communications, multiple access technologies, and various wireless networks, including past and future generation networks

c) Prerequisite

Nil

d) Related Courses

Network Management, Network Security

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Learn to model radio signal propagation issues and its impact on communication system performance.	K2
CO2	Understand the multiple access schemes based on reservation and random access methods. Explain the concepts of Wi-Fi.	K2
CO3	Describe the fundamentals of cellular communication and its related services as GSM and UMTS.	K2
CO4	Describe the concepts of Packet switching cellular system.	K2
CO5	Understand the concept of mobility management and WPAN	K2

f) Course Content

UNIT I OVERVIEW AND BASIS OF WIRELESS CHANNELS AND COMMUNICATION 9

Review of Digital Communications - Cellular Systems from 1G to 3G - Wireless 4G Systems - Components of a Wireless Transmitter and Receiver – Bandwidth, Duplexing, Licensed and Unlicensed Bands - Power, Rate and SNR - Shannon's Capacity, Bandwidth and Power-Limited Regimes - Radio Propagation and Propagation Path-Loss Model: Free-Space Attenuation, Multipath Channel Characteristics, Signal Fading Statistics, Path-Loss Models.

UNIT II RANDOM ACCESS SYSTEMS AND WIFI 9

Types of Multiplexing: Fixed Assignment vs. Statistical Multiplexing - Aloha, Slotted Aloha - Review of Poisson Process and Analysis of Aloha - CSMA with Collision Avoidance and Collision Detection - WIFI: History and Motivation, Architecture - DCF Mode, RTS-CTS, Hidden and Exposed Terminal Problem - 802.11n Enhancements

UNIT III CIRCUIT-SWITCHED CELLULAR SYSTEMS 9

Cellular Concept and Spatial Reuse - Interference-Limited and Coverage-Limited Systems - Frequency Reuse - Cellular vs. WIFI - GSM: Architecture, Voice Support – UMTS: Basics of CDMA, Architecture and Key Channels.

UNIT IV PACKET-SWITCHED CELLULAR SYSTEMS 9

Packet-Switched vs. Circuit-Switched Communication - HSDPA (High Speed Downlink Packet Access) - HSUPA (High Speed Uplink Packet Access) - Introduction to LTE: History, Architecture - OFDM - Uplink and Downlink Communication in LTE

UNIT V MOBILITY AND WPANS 9

Principles of Handovers: Switching Conditions, Hysteresis, Detection - Mobility in Cellular Systems: The Gateway Concept, Measurement Reports, Mobility Procedures - Mobile IP: Basic Components, Tunneling, Enhancements For Mobile Ipv6 - Wireless Personal Area Networks (PANS): Bluetooth 802 15.1, Zigbee 802.15.4.

Total 45 Hrs

h) Learning Resources

Text Books

1. V. K. Garg, Wireless Communications and Networking, Morgan Kaufmann, 2007, ISBN: 9780123735805.
2. D. P. Agrawal and Q.-A. Zeng, Introduction to Wireless and Mobile Systems, Third Edition, Cengage Learning, 2010, ISBN: 1439062056.
3. W. Stallings, Wireless Communications & Networks, Second Edition, Prentice Hall, 2004, ISBN: 0131918354.
4. T. S. Rappaport, Wireless Communications, Second Edition, Prentice Hall, 2002, ISBN: 0130422320
5. J. Schiller, Mobile Communications, Second Edition, Addison Wesley, 2003, ISBN: 0321123816

Online Resources

1. www.nptelvideos.in/2012/12/wireless-communication.html
2. nptel.ac.in/courses/117105076/pdf/2.2%20Lesson%203%20.pdf
3. https://www.coursera.org/learn/wireless-communication.../5g-mobile-communications
4. https://www.mooc-list.com/.../wireless-communication-emerging-technologies-courser...

Practice Aspects:

NS3 simulator Tool

Course Code	Course Title	L	T	P	C
1153EC107	DISCRETE TIME SIGNAL PROCESSING	2	2	0	3

a) Course Category

Program Core

b) Preamble

Digital Signal Processing provides an introduction to the basic concepts of signal processing methods and to acquire knowledge of analysis of systems using various transformation techniques. It provides students to realize about different filter structure and also to develop algorithm for signal processing.

c) Prerequisite

Transforms and partial Differential Equations, Signals and Systems

d) Related Courses

Advanced Digital Signal Processing, Statistical Signal Processing

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Compute Discrete Fourier Transform for the given signals.	K3
CO2	Design the Digital Infinite Impulse Response Filters (IIR) from given Specifications	K3
CO3	Analyze different windowing and sampling techniques to design FIR filter	K4
CO4	a. Analyze the finite word length effects in filters	K4
	b. Explain the basic signal processing concepts in DSP Processor	K2
CO5	Explain the basics of Multirate Signal Processing & its Applications.	K2

f) Course Contents

UNIT I DISCRETE FOURIER TRANSFORMS 12

Introduction & Properties of DFT – Linear & Circular Convolution Methods, FFT algorithms – Radix-2 FFT algorithms – Decimation in Time – Decimation in Frequency algorithms –Use of FFT algorithms in Linear Filtering and correlation

UNIT II IIR FILTER DESIGN 12

Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by using Approximation of derivatives – Impulse Invariance – Bilinear transformation, (LPF, HPF, BPF, BRF) filter design using frequency translation.

UNIT III FIR FILTER DESIGN 12

Structures of FIR – Linear phase FIR filter - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques, FIR Filter structures.

UNIT IV FINITE WORD LENGTH EFFECTS & DSP PROCESSOR 12

Finite word length effects: Quantization- Truncation and Rounding errors - Quantization noise-coefficient quantization error – Product quantization error - Overflow error – limit cycle oscillations, scaling. **Introduction to DSP architecture** – Harvard architecture - Dedicated MAC unit - Multiple ALUs, Advanced addressing modes, Pipelining, Overview of instruction set C54X.

UNIT V MULTIRATE SIGNAL PROCESSING & APPLICATIONS 12

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Application-Sub band coding, Musical Sound Processing, Digital Audio sampling rate conversion, Oversampling A/D &D/A

Total 60 Hrs

g) Learning Resources

Text Books

1. John G. Proakis& Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, 4th edition, Pearson Education / Prentice Hall, 2007.
2. B. Venkataramani, M. Bhaskar, “Digital Signal Processors: Architecture, Programming and

Applications", 2nd edition, Tata McGraw-Hill Education, 2002.

Reference Books

1. S.Salivahanan, A.Vallavaraj, C Gnanapriya, "Discrete Signal Processing", Tata McGraw-hill Publication, 2002.

2. Emmanuel C..Ifeachor, &Barrie.W.Jervis, "Digital Signal Processing", 2nd edition, Pearson Education / Prentice Hall, 2002.

3. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", Tata Mc Graw Hill, 2007.

4. A.V.Oppenheim, R.W. Schafer and J.R. Buck, "Discrete-Time Signal Processing", 8th Indian Reprint, Pearson, 2004.

Online Resources

1. http://nptel.ac.in/courses/117104070/

2. http://nptel.ac.in/courses/117102060/

3. http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/

4. http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/study-materials/

5. http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/download- resource-materials/

Course Code	Course Title	L	T	P	C
1153EC208	**RECONFIGURABLE COMPUTING WITH FPGA**	**1**	**0**	**4**	**3**

a) Course Category

Allied Elective

b) Preamble

Recent advances in VLSI technology have given upswing to a fresh class of computer architectures which take advantage of application-level parallelism. These reconfigurable computers can be quickly customized at the hardware level to perform exactly the computation required in hardware, overcoming the fixed hardware configurations found in many contemporary microprocessors. In this course, students will understand the state-ofthe-art in reconfigurable computing both from a hardware and software perspective.

c) Prerequisite

VLSI Design

d) Related Courses

System on Chip

e) Course Outcomes

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

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Build reconfigurable system using HDL and FPGAs.	S1
CO2	Perform partial reconfiguration for various applications using peripheral devices.	S2
CO3	Demonstrate an embedded system on FPGA using IP blocks.	S3

f)Examination Scheme for practical dominated course										
Internal evaluation (40M)							**Semester end evaluation (60M)**			
Laboratory experiment (15M)				**Model laboratory test (25M)**			**Part-A (20M)**	**Part-B (40M)**		
Performance in conducting experiment (5)	Result and analysis (3)	Viva Voce (3)	Record (4)	Performance in conducting experiment (15)	Result and analysis (5)	Viva Voce (5)	Theory questions to evaluate the knowledge and understanding (20)	Performance in conducting experiment (25)	Result and analysis (10)	Viva-Voce (5)

g)Course Content

Theory **15 Hours**

Reconfigurable Computing: Reconfigurable Computing Systems, Evolution and Characteristics, Advantages and Issues, Fundamental Concepts and Design Steps, Domain Specific Processors and Application Specific Processors.

Reconfigurable Architectures: Classification of Reconfigurable Architectures, FPGA Technology and Architectures, LUT devices and Mapping, Placement and Partitioning.

Interconnections in Reconfigurable Architectures: Routing and Switching concepts.

Programming Technology: HDL Based Programming and High level Synthesis using C, Partial Reconfiguration.

Intellectual Property Based Design: Soft core, Firm core and Hard Core, Software tools.

h)List of experiments

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	Introduction to Software and Hardware Tools
2.	CO1	Design of VLSI Subsystems using Verilog HDL.
3.	CO1	Implementation of an Arithmetic and Logical Unit on FPGA.
4.	CO1	Design of Finite State Machine using Verilog HDL.
5.	CO2	Implementation and Analysis of VLSI Subsystems in FPGAs.
6.	CO2	Implementation of Filters.
7.	CO2	Interfacing GPIOs and PMODs with FPGA.
8.	CO2	Signal Generation and AD-DA Interfaces.
9.	CO2	Implementation of IP Cores in FPGA.
10.	CO2	Interfacing Sensors and Display Devices with FPGA.
11.	CO3	Study and Implementation of Micro blaze processor.
12.	CO3	Study and Implementation of Zynq Processing system.
13.	CO3	Design and Implementation of an Embedded System in FPGA.

Total 75hrs

i)Learning Resources

Textbooks

1. S. Hauck ,"Reconfigurable Computing: Theory and practice of FPGA based Computation", Morgan Kaufmann, 2008.
2. Simon, "Programming FPGA's : Getting started with Verilog:, McGraw – Hill Education,2016.
3. Wayne Wolf, "FPGA-Based System Design", Pearson Education, 1e, 2005.
4. S. Palnitkar,"Verilog HDL",Pearson Education, 1e, 2003.

List of Major Equipment/ Instrument/Software with Broad Specifications

1. Xilinx VIVADO 2017 (Licensed version)
2. Basys 3
3. Nexys Video
4. ZYBO

List of Software/Learning Websites

1.http://www.verilog.com/ **Online resources**

1. Prof. Ken Eguro, University of Washington, Video lecture on Reconfigurable Computing, Sponsored by Microsoft Research
2. https://www.microsoft.com/en-us/research/video/candidate-talk-reconfigurable-computingarchitectural-and-design-tool-challenges/

Course Code	Course Title	L	T	P	C
1153EC209	**REAL TIME EMBEDDED SYSTEMS**	**2**	**0**	**8**	**6**

a) Course Category

Allied Elective

b) Preamble

In this course, the students will learn about basic building stones in real-time systems, the system parameters required to successfully construct a real-time system, the corner stone of real-time systems, namely the scheduler – and its task in real-time schedules and what kind of real-time guarantees are needed in which systems. Concretely, they will learn (1) What is needed to create a real-time system (2) Where real-time requirements are needed. (3) The task and job structure and the parameters needed to schedule a task. (4) Difference between pre-emptive and non-pre-emptive tasks.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcome

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

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Familiarize and develop programs using the given microcontrollers.	S4
CO2	Design a real time system for the given application.	S4
CO3	Define task set with parameters used in real time embedded systems and implement them using RTOS.	S4

f) Theory Course Content : 30 Hours

Basic Electronics – Passive Elements, Op-Amp, Types of LED and LCD, Logic Gates, Multiplexer, Demultiplexer, Encoder, Decoder, Driver Circuits, ADC, DAC

Sensors – Specifications and Applications of Temperature Sensor, Moisture Sensor, Humidity Sensor, Gas Sensor, IR Sensor, Ultrasonic Sensor, PIR Sensor, Load Cell, LDR

Actuators – Specifications and Applications of Stepper Motor, Servo Motor, DC Motor

Switching Devices – Specifications and Applications of Relays and Switches – Dip Switch, Push Buttons, Touch Switch, Toggle Switch

CPU Architectures – 8 Bit MCU-ATMEGA, 16 Bit MCU-PIC, 32 Bit MCU-ARM 11

Peripheral Interfacing – I/O Port, UART, Timer/Counter

Programming Add-On Modules – LED, LCD, Camera, Bluetooth, Wi-Fi, GSM, Voice IC

High Level Programming – Features of Arduino, MSP430 and Raspberry Pi Boards, Basics of Embedded C And Python Programming, Programming Using IDEs – Arduino, Keil, Energia, Matlab

Real Time Systems – Definition, Classification, Generic Architecture, Applications

RTOS – Need for RTOS, Comparison between General Purpose OS and RTOS, RTOS Fundamentals - Operations, Task/Process, Task States, Functions, Scheduler, Semaphore. Features of Raspbian OS, FreeRTOS, Vxworks, RTX

g) List of Experiments

S. No	CO Mapping	Practical Exercises (30 Hours)
1.	CO1	Arithmetic and Logical Operations using 8/16/32 bit Microcontrollers
2.	CO1	I/O port Read/Write and UART interfacing using 8/16/32 bit Microcontrollers
3.	CO1	LED and Push button interface using 8/16/32 bit Microcontrollers
4.	CO2	Serial Communication and LCD interface using Arduino
5.	CO2	Temperature sensor and LCD interface using MSP430
6.	CO2	Moisture sensor, Gas sensor and LCD interface using Raspberry Pi without Raspbian OS

7.	CO2	PIR sensor, LDR and LCD interface using MSP430
8.	CO2	Ultrasonic sensor and LCD interface using Arduino
9.	CO2	GSM and LCD interface using Raspberry Pi
10.	CO2	Camera and SD Card interface using Raspberry Pi
11.	CO2	Implementing Round Robin Scheduling of Task
12.	CO3	Implementing Task creation and deletion using RTOS
13.	CO3	Implementing Task priority change using RTOS
14.	CO3	Implementing Task synchronization using RTOS
15	CO3	Implementing shared resource access using RTOS

h) List of Projects/Tasks

S. No	CO Mapping	Projects/Tasks (90 Hours)
1.	CO2	Soft RTS Task 1: IR Remote Controlled Systems
2.	CO2	Soft RTS Task 2: Image Acquisition System
3.	CO2	Soft RTS Task 3: Smart Irrigation System
4.	CO2	Firm RTS Task 1: GUI Based Interactive System
5.	CO2	Firm RTS Task 2: Voice Controlled System
6.	CO2	Firm RTS Task 3: Object Counting System
7.	CO3	Hard RTS Task 1: Conveyor Belt System
8.	CO3	Hard RTS Task 2: Industrial Weight Lifting System
9.	CO3	Hard RTS Task 3: Autonomous Robot

i) Learning Resources

Textbooks

a. Real-time systems by Jane W.S Liu Pearson Education Ltd, (2000).

Course Code	Course Title	L	T	P	C
1153EC110	**CONTROL SYSTEMS**	**2**	**2**	**0**	**3**

a Course Category

Program Core- Required

b) Preamble

This course aims to provide a basic knowledge about what is a control system, its significance, transfer function, open and closed loop systems, time domain and frequency domain analysis and its specifications, stability, error constants and designing of compensators viz., lag, lead and lag lead compensators, significance of P, PI and PID controllers and stability & state variable analysis.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course coordinator name

Odd- Dr.G.SASIKALA

Even- Mr.PRABHU KUMAR. S

f) Course Outcomes

On successful completion of this course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Derive the transfer function of electrical, mechanical and Electro mechanical systems Apply the concept of state space for system analysis	K3
CO2	Derive Time response of I order and II order systems Apply the Root locus and Routh - Hurwitz criteria to analyze the stability of the given system	K3

CO3	Determine the system stability by various methods such as Bode plot, Polar plot etc in frequency domain	K3
CO4	Design various controllers and compensators for control systems	K3
CO5	Apply the concept of state space and sampling theorem to digital control system.	K3

g) Course Content

UNIT I CONTROL SYSTEM MODELING & STATE VARIABLE ANALYSIS 12

Basic elements of control system – open loop and closed loop systems: differential equation - transfer function, modeling of electric systems, translational and rotational mechanical systems - block diagram reduction techniques - signal flow graph. State space representation of continuous time systems – physical systems and phase variable model.

UNIT II TIME DOMAIN AND STABILITY ANALYSIS 12

Time response analysis: first order systems - impulse and step response analysis of second order systems. Root locus technique: construction of root locus- stability - dominant poles. Routh - Hurwitz criterion: relative stability.

UNIT III FREQUENCY DOMAIN AND STABILITY ANALYSIS 12

Frequencyresponse - correlation between time and frequency responses - bodeplot, polarplot-frequencydomain specificationsfromthe plots - nyquistplot, nyquist stability criterion.

UNIT IV DESIGN OF COMPENSATORS IN FREQUENCY DOMAIN 12

P, PI,PDand PIDcontrollers: Introduction – transfer function model – characteristics; series, paralleland series- parallelcompensation - Lead and Lag networks– series compensator designfor desired response usingBodediagrams.

UNIT V DIGITAL CONTROL SYSTEMS 12

State space representation for discrete time systems – phase variable model Sampled data control systems – Sampling theorem – Sampler and Hold – open loop and closed loop sampled data systems.

Total 60 Hrs

i) Learning Resources

Text Books

1. M.Gopal, "Control System – Principles and Design", Tata McGraw Hill, 2nd Edition, 2002
2. J.NAGRATH and M.Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007.

Reference Books

1. Ogata, K., "Modern Control Engineering", Prentice Hall of India Ltd., 4th Edition, New Delhi, 2006.

COURSE CODE: 1153EC111	COURSE TITLE: **ELECTRONIC DEVICES AND CIRCUITS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:
Program Core

PREAMBLE :
It is aimed to provide the basics of device operation and the characteristics for various devices along with the basic designing parameters for various circuits.

PREREQUISITE COURSES:
Basic Electrical Engineering

RELATED COURSES:

- Linear and Digital Integrated circuits
- Power Electronics drives
- Digital Electronics

COURSE EDUCATIONAL OBJECTIVES :
The objectives of the course are to make the students,

- An understanding of basic structure and operation of PN Junction devices
- The Knowledge of types of rectifier, filters and regulators
- An understanding the operation and characteristics of Bipolar Junction Transistor
- The capability to analyze the characteristics of Field Effect Transistor and Multi-vibrators

COURSE OUTCOMES :
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
C01	Analyze structure and operation of PN Junction devices	K2
C02	Explain the different types of rectifier, filters and regulators	K2
C03	Illustrate the operation and characteristics of Bipolar Junction Transistor	K3
C04	Analyze the characteristics of Field Effect Transistor	K2
C05	Understand the Condition for oscillations and Mutivibrators	K2

COURSE CONTENT:

UNIT I	PN JUNCTION DEVICES	9

PN junction diode – structure, operation and V-I characteristic-current equation of drift current density and diffusion current density-diffusion and transient capacitance – introduction to SCR, DIAC,TRIAC and UJT- display devices- LED, Laser diodes, Zener breakdown - zener reverse characteristic.

UNIT II	RECTIFIERS, FILTERS AND REGULATORS	9

Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, clipper and clamper circuit and types, Inductor filter, Capacitor filter, LC- filter, Pi-section filter, and comparison of various filter circuits in terms of ripple factors, Simple

circuit of a regulator using zener diode.		
UNIT III	**BIPOLAR JUNCTION TRANSISTORS**	**9**
BJT structure, operation and V-I characteristic- BJT small signal model – biasing – analysis of CE, CB, CC amplifiers- Gain and frequency response. BJT biasing, DC load line, fixed bias, Collector to base bias, self bias techniques for stabilization, comparison of Biasing Techniques		
UNIT IV	**FET CHARACTERISTICS**	**9**
MOSFET – structure, operation and V-I characteristic – types of MOSFET –MOSFET small signal model – biasing – analysis of CS and source follower – gain and frequency response- JFET –structure, operation and V-I characteristic. Introduction of IGBT, comparison of all transistors		
UNIT V	**OSCILLATORS, MULTIVIBRATORS, POWER AND FEED BACK AMPLIFERS**	**9**
Condition for oscillations, phase shift – Wien Bridge, Hartley, Colpitts and Crystal Oscillators - UJT as relaxation oscillator. Multivibrators - Astable, Monostable and Bistable, CLASS A, B, AB, C and D power amplifiers. Feedback amplifiers and its types		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. V.K. Metha, “ Principles of Electronics”
2. David A. Bell, “Electronic devices and circuits”, Oxford University, 5Th Edition,2009.
3. Sedra smith, “Microelectronic circuits “Oxford University Press, 5th Edition 2011.

REFERENCE BOOKS:

1. Floyd, “Electron devices” Pearson Asia 5th Edition, 2011.
2. Donald A Neamen, “Electronic Circuit Analysis and Design” Tata McGraw Hill, 3rd edition 2012

ONLINE RESOURCES:

www.nptel.co.in
www. usstudy.in

COURSE CODE	COURSE TITLE	L	T	P	C
1154EC101	AVIONICS	3	0	0	3

Course Category:

Institutional Elective

Preamble:

This course provides an introduction to the role of electronics in aircraft systems and to acquire Knowledge to analyze the technical data's in various airborne systems.

a. Prerequisite Courses:

Basic Electronics Engineering

b. Related Courses:

Digital Communication Techniques
Digital System Design

Course Educational Objectives:

The students should be made to

- Know the needs for avionics for both Civil and military aircraft
- Understand the various digital electronic principles and working operations of aviation based on digital circuits.
- Be exposed on integration of the digital electronics with cockpit equipments
- Understand the communication and onboard navigation system.

c. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the needs for avionics for both Civil and military aircraft	K2
CO2	Explain the various digital electronic principles and working operations of aviation based digital circuit.	K2
CO3	Describe the integration of the digital electronics with cockpit equipments	K2

CO4	Explain the concept of communication and navigation equipment related to aviation.	K2
CO5	Explain the concept of onboard navigation system.	K2

d. Course Content :

UNITI INTRODUCTION TO AVIONICS 9

Basics of Avionics-Basics of Cockpits-Need for Avionics in civil and military aircraft and space systems – Integrated Avionics Architecture –Military and Civil system – Typical avionics System and Sub systems – Design and Technologies.

UNITII DIGITAL AVIONICS BUSARCHITECTURE 9

Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-AFDX/ARINC-664-MIL STD 1553 B–ARINC 429–ARINC 629- Aircraft system Interface

UNITIII FLIGHT DECK AND COCKPITS 9

Control and display technologies CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) – ARINC 818-Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

UNITIV AVIONICS SYSTEMS 9

Communication Systems-Navigation systems- Flight control systems-Radar electronic Warfare- Utility systems Reliability and maintainability Fundamentals- Certification-Military and civil aircrafts.

UNITV ON BOARD NAVIGATION SYSTEMS

Introduction to GPS -system description -basic principles -position and velocity determination- Over view of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, INS, GPS and GNSS characteristics.

f.Learning Resources

Text Books:

1. R.P.G. Collinson, “Introduction to Avionics”, Chapman & Hall Publications,1996.

Reference:

1. Cary R .Spitzer, “The Avionics Handbook”, CRC Press,2000.
2. Middleton,D.H.“AvionicsSystems”,LongmanScientificandTechnical,LongmanGroupUK Ltd., England, 1989.
3. Spitzer, C.R. “Digital Avionics Systems”, Prentice Hall, Englewood Cliffs, N.J., U.S.A.,1987.
4. Brain Kendal, “Manual of Avionics”, The English Book House, 3rd Edition, New Delhi,1993
5. Jim Curren, “Trend in Advanced Avionics”, IOWA State University,1992.

Online resources

1. http://en.wikipedia.org/wiki/Avionics
2. http://en.wikipedia.org/wiki/Integrated_modular_avionics
3. http://www.airliners.net/aviation-forums/general_aviation/read.main/2329714/
4. http://en.wikipedia.org/wiki/Cockpit
5. http://en.wikipedia.org/wiki/Air_navigation
6. http://virtualskies.arc.nasa.gov/navigation/4.html

COURSE CODE	COURSE TITLE	L	T	P	C
1154EC102	AUTOMOTIVE ELECTRONICS	3	0	0	3

Course Category:

Institutional Elective

Preamble:

This subject serves as the prerequisite for many subjects such as basic electrical & electronics engineering, microprocessor & micro controller. It introduces students to cognitive learning in applied electrical & electronics and develops problem solving skills with both theoretical and engineering oriented problems.

a. Pre-Requisite:

Basic Electronics Engineering

Microprocessor and microcontroller

b. Related Courses:

Embedded system

c. Course Educational Objective:

The student should be made to

- Learn concepts and develop basic skills necessary to diagnose automotive electrical problems
- Understand starting and charging, lighting systems, advanced automotive electrical systems, to include body electrical accessories, and basic computer control.
- Understand the instructions necessary to take the Automotive Service Excellence examination.

d. Course Outcomes:

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy
CO1	Explain the basic automotive and transmission systems.	K2

CO2	Explain the various functions of the sensors and actuators in the field of automotive applications	K2
CO3	Discuss about the various analog and digital control methods.	K2
CO4	Describe the Electronic control unit design.	K2
CO5	Explain the various interfacing techniques and applications of automotive electronics.	K2

e. SYLLABUS:

UNIT 1 Fundamental Of Automotive Electronics 9

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

Unit 2: Sensor technologies in Automotive 9

Interfacing principles: Operation, topologies and limitations of all sensors covered in the above to in-vehicle processing or communications nodes. Interfacing electronics, Operational amplifier circuits, Instrumentation amplifiers, Comparators. Level shifting, Wave-shaping, Filters. Noise mechanisms and reduction. ADCs and DACs. Use of Actuators: Types, Working principle, Characteristics, limitations and use within the automotive context of each type

Unit 3: Automotive Control Systems. 9

Control system approach in Automotive: Analog and Digital control methods, stability Augmentation, control augmentation, Transmission control, System components and Functions. Cruise control, traction control, actuator limiting, wind-up, gain scheduling, Adaptive control. Special Control Schemes: Vehicle braking fundamentals, Antilock Systems, Variable assist steering and steering control, Controls for Lighting, Wipers, Air conditions.

Unit 4: Electronic Control Unit Design. 9

Critical review of microprocessor, microcontroller and digital signal processor Development (overview of development within the automotive context). Architecture of 8/16 bit microcontrollers with emphasis on Ports, Timer/Counters, Interrupts, Watch-dog Timers, PWM, Memory requirement and Usage. High- level language programming.

Unit 5: Automotive Communication Systems 9

Communication interface with ECUs: Interfacing techniques and interfacing with infotainment gadgets. Relevance of internet protocols, such as TCP/IP for automotive applications. Wireless LANs standards, such as Bluetooth, IEEE802.11x. Communication protocols for automotive applications.

Total Periods: 45Hrs

8. Learning Resources:

Text Books

1. Williams. B.Ribbens, Understanding Automotive Electronics_, 6th Edition, 2003, Elsevier Science, Newness Publication.

2. Robert Bosch, Automotive Electronics Handbook_, John Wiley and Sons, 2004.

3. Nitaigour Mahalik, Mechatronics: Principles, Concepts and Applications, TMH, 2003.

4. K.P.Ramchandran, G.K.Vijayraghavan, M.S. Balsundaram, Mechatronics: Integrated Mechanical and Electronic System, Wiley India, 2010.

Reference Books

1. Ronald K Jurgen, Automotive Electronics Handbook 2nd Edition, McGraw-Hill, 1999.

2. James D Halderman, _Automotive Electricity and Electronics, PHI Publication 2005.

3. Terence Rybak, Mark Steffka, _Automotive Electromagnetic Compatibility (EMC)_, Springer, 2004.

4. Allan Bonnick, Automotive Computer Controlled Systems: Diagnostic Tools and Techniques, Elsevier Science, 2001.

5. Uwe Kiencke and Lars Nielsen, Automotive Control Systems: Engine, Driveline and Vehicle, 2nd Edition, Springer Verlag, 2005.

6.BehzadRazavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999.

iii. Online resources:

www.faadooengineers.com.

www.nptelvideos.in

Course Code	Course Title	L	T	P	C
1154EC103	**INDUSTRIAL AUTOMATION**	3	0	0	3

a) Course Category

Institutional Elective

b) Preamble

The purpose of this course is provide the knowledge of automation components, tools, machine to machine communication, internet of things involved in industrial automation

c) Prerequisite

Nil

d) Related Courses

Basics of embedded systems, Building Automation.

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Emphasize the signals from automation components with Computer aided measurement	K2
CO2	Explain the concepts of tools used in industrial Automation.	K2
CO3	Familiarize the concept of various interfaces involved in DCS and applications of DCS	K2
CO4	Explain the need for machine to machine communication in automation	K2
CO5	Familiarize the concepts of internet of things and its application	K2

f) Course Content

UNIT I AUTOMATION COMPONENT AND COMPUTER AIDED MEASUREMENT 9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement, Actuators, process control valves, Role of computers in measurement and control, Elements of computer aided measurement and control – man machine interface – process related interface.

UNIT II PLC and SCADA 9

Evolution of PLC – Sequential and Programmable controllers – Architecture – Programming of PLC – Relay logic and Ladder logic – Functional blocks – Communication Networks for PLC – SCADA introduction – elements of SCADA – Features of SCADA, Communications in SCADA types and components.

UNIT III DCS AND ITS APPLICATION 9

DISTRIBUTED CONTROL SYSTEMS: Evolution – Different architectures – local control unit– Operator Interface – Displays – Engineering Interface

APPLICATION OF DCS: DCS Applications in power plants, Iron and steel plants, Chemical plants, Cement plants, paper and pulp industries

UNIT IV MACHINE TO MACHINE COMMUNICATION 9

Introduction – components of M2M – Features of M2M - Architecture of M2M – Requirements for M2M – Issues in M2M – Standardization effort for M2M – combination of wireless technology: WI-FI, wireless HART, ISA 100 –Industrial network equipment's: Routers, gateways, switches, Applications of M2M

UNIT V INTERNET OF THINGS 9

Introduction – definition and characteristics of IoT – Things of IoT – IoT protocols – IoT functional blocks – IoT communication models – IoT enabling technologies: wireless sensor networks, cloud computing - Indoor air quality monitoring in industries – Difference between IoT and M2M –IoT for Plant automation - case study: Industrial control and smart health.

Total 45 Hrs

h) Learning Resources

Text Books

1. S.K. Singh, "Industrial Instrumentation and control" – The McGraw Hill companies 3rd edition – 2009. [UnitI]
2. Curtis D. Johnson "Prentice Process control Instrumentation Technology" – Hall India, 8th edition, 2006 [Unit II,III]
3. Thomas Hughes, "Programmable Logic Controller", ISA Publication.[UnitII].
4. Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication.[UnitIII]
5. McMillan.G.K, "Process/ Industrial instrument and handbook", McGraw-Hill, New York, 1999 [UNITIV]
6. Machine- to-machine communications edited by vojislab B. misic, Jelenamisic, CRS press Taylor &francis group –2015.
7. Internet of Things: A hands on approach by ArshdeepBahga, Vijay madisetti Published by ArshdeepBahga, Vijay madisetti-2014. [UNITV]

Reference Books

1. Samuel M. Herb, "Understanding Distributed Processor Systems for Control", ISA Publication.
2. Thomas Hughes, "Programmable Logic Controller", ISAPublication.
3. Stuart A. Boyer, "SCADA supervisory control and data acquisition",ISA Publication
4. PoppovikBhatkar, "Distributed Computer Control for Industrial Automation", Dekkar Publication

Online Resources

1. www.nptel.com

Course Code	Course Title	L	T	P	C
1154EC104	**BUILDING AUTOMATION**	**3**	**0**	**0**	**3**

a) Course Category

Institutional Elective

b) Preamble

Security of the building and safety of personal are becoming important aspects nowadays and in near future, it will be in a great demand. Complex infrastructure requires a variety of building automation and control systems. Building Management System (BMS) is computer-based control system installed in building that controls and monitors the total MEP (Mechanical – Electrical – Plumbing) and security structure.

c) Prerequisite

Nil

d) Related Courses

Industrial Automation

e) Course educational objectives

1. Gain knowledge on Building Management System (BMS) and Automation.
2. Be familiarized with various transducers and sensors in BMS.
3. Be exposed on Control panel and Communication.
4. Learn Fire Alarm System (FAS) and security system such as CCTV.
5. Gain knowledge on Energy Management in Building Automation.

f) Course Outcomes

On successful completion of this course, the students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
C01	Understand Building Management system and Automation.	K2
C02	Describe various Sensors and Transducers - Automation components in BMS	K2
C03	Explain control panel and communication such as HVAC and Modbus.	K2
C04	Describe FAS and Security Systems in Building Automation.	K3
C05	Understand the Energy Management systems.	K2

g) Course Content

UNIT I	**INTRODUCTION TO BUILDING MANAGEMENT SYSTEM AND AUTOMATION**	**9**

Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS

UNIT II	**AUTOMATION COMPONENTS IN BMS**	**9**

Temperature Sensors: RTD, Thermistor, Thermocouple, Bimetallic strip - Pressure Sensors: Diaphragm type, piezoelectric sensors – Different types of mounting of pressure sensors in duct, rooms and pipes – Air flow sensor: Anemometer, velocity pressure sensors – Flow sensors: Turbine flow meter, Orifice, Venturi, Pitot tube, ultrasonic flow meter – Different types of mounting for air & water flow meters

UNIT III	**CONTROL PANEL AND COMMUNICATION**	**9**

HVAC Control Panel, MCC Basics, Panel components; Communication Basics, Networks, BACNet, Modbus, LON.

UNIT IV	**FAS AND SECURITY SYSTEMS**	**9**

Fire, Fire modes – Fire Alarm Systems components: Field components, panel components – FAS Architectures – Access Components, Access control system Design - CCTV camera types and operation – camera selection criteria – CCTV Applications.

UNIT V	**ENERGY MANAGEMENT**	**9**

Energy Savings concept & methods, lightning control, Building Efficiency improvement, Green Building (LEED) Concept & Examples.

Total 45 Hrs

h) Learning Resources

Text Books

1. Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life safety, Security, Access Control, Lightning, Building Management Programs) (Hardcover), Reinhold A. Carlson and Robert A. Di Giandomenico.
2. HVAC Systems Design Handbook, Fifth Edition, Roger W. Haines.
3. CCTV (Newnes), VladoDamjanovski (1999).
4. Process control – Instrument Engineers Handbook by Bela G. Liptak, Chilton book co.

Reference Books

1. Building Control Systems, Application Guide (CIBSE Guide), CIBSE, 2000.
2. Smart Buildings by Jim Sinopoli, Butterworth-Heinemann imprint of Elsevier, 2 ed., 2010
3. Design of Special Hazards and Fire Alarm Systems, Robert Gagnon, 2007.

COURSE CODE	COURSE TITLE	L	T	P	C
1154EC105	WIRELESS TECHNOLOGIES	3	0	0	3

Course Category:

Institutional Elective

Preamble:

To provide guidelines to further accelerate research and development in Wireless Technologies. Significant advances in Adhoc sensing and communication technologies like 3G, 4G have led to the development of mobile and satellite communication.

a. Prerequisite Courses:

- Communication Systems
- Data communication and networks

b. Related Courses:

- Wireless Adhoc and Sensor Networks
- Mobile Communication
- Satellite Communication
- Wireless Communication Networks.

c. Course Educational Objectives:

- To learn the different types of MAC protocol
- To be expose the 3G wireless techniques and evaluation
- To understand the need of Adhoc and routing techniques of Wireless Sensor Network for better data processing transmissions.
- To understand the 4G features and Challenges

d. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe the wireless LAN standards and MAC Sub layer	K2
CO2	Illustrate the 3G Network and evaluation	K3

CO3	Explain the concepts of Adhoc protocol and fundamental concepts of Sensor Networks	K2
CO4	Analyze the internetworking between WLANs and 3GWWANs	K4
CO5	Describe the features and challenges of 4G technology	K2

e. Course Content :

UNIT I WIRELESS LOCAL AREA NETWORKS 9

Introduction to wireless LANs - IEEE 802.11 WLANs - Physical Layer- MAC sub layer-MAC Management Sub layer- Wireless ATM - HIPERLAN- HIPERLAN-2, WiMax

UNIT II 3G OVERVIEW & 2.5G EVOLUTION 9

Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture,CDMA2000 overview- Radio and Network components, Network structure, Radio network, TD-CDMA, TDSCDMA.

UNIT III ADHOC & SENSOR NETWORKS 9

Characteristics of MANETs, Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols, Wireless Sensor networks- Classification, MAC and Routing protocols.

UNIT IV INTERNETWORKING BETWEEN WLANS AND 3G WWANS 9

Interworking objectives and requirements, Schemes to connect WLANs and 3G Networks, Session Mobility, Interworking Architectures for WLAN and GPRS, System Description, Local Multipoint Distribution Service, Multichannel Multipoint Distribution system.

UNIT V 4G & BEYOND 9

4G features and challenges, Technology path, IMS Architecture, Convergent Devices,4G technologies, Advanced Broadband Wireless Access and Services, Multimedia, MVNO

Total: 45 Hours

f. Learning Resources

i.Text Books :

1. Kaveth Pahlavan,. K. Prashanth Krishnamuorthy, "Principles of Wireless Networks", Prentice Hall of India, 2006.

2. Vijay. K. Garg, “Wireless Communication and Networking”, Morgan Kaufmann Publishers,http://books.elsevier.com/9780123735805:, 2007.
3. Clint Smith. P.E., and Daniel Collins, “3G Wireless Networks”, 2nd Edition, Tata McGraw Hill, 2007.

iii. Online resources

- www.wirelessnetworksonline.com

Course Code	Course Title	L	T	P	C
1154EC106	**BASICS OF EMBEDDED SYSTEM**	**3**	**0**	**0**	**3**

a) Course Category

Institutional Elective

b) Preamble

The purpose of this course is to acquire knowledge on complete design of an embedded system with functional requirements for hardware and software components including processor, sensors and subsystem interfaces to connect real world applications systems.

c) Prerequisite

Nil

d) Related Courses

Embedded System Design

e) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the general purpose 8-bit and 16-bit microprocessor and instruction set	K2
CO2	Explain the 8-bit microcontroller architecture and its instruction set	K2
CO3	Describe the memory and peripheral interfacing techniques required to design an embedded system for given specifications	K2
CO4	Familiarize various types of sensors and actuators required to design an embedded system for given specifications	K2
CO5	Discuss the various aspects of complete embedded system design through case studies	K2

f) Course Content

UNIT I ARCHITECTURE OF MICROPROCESSORS 9

8085 Architecture, pin diagram, addressing Modes, instruction formats, instruction set, Architecture 8086, Register organization of 8086, Signal descriptions of 8086 chip, Physical Memory organization, Introduction to Maximum and Minimum mode operation.

UNIT II MICROCONTROLLER 9

Overview of the architecture of 8051 microcontroller, Memory organization, special function registers, Addressing Modes, Instruction formats, Instruction set, Interrupt and Interrupt routines, I/O Ports.

UNIT III INTERFACING PERIPHERALS 9

Interfacing with RAMs, ROMs, Introduction to Serial Communication, Interfacing I/O Ports: 8255, 8279, 8259, 8257, Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs).

UNIT IV SENSORS AND ACTUATORS 9

Keyboard Interfacing, Sensors: temperature, pressure, light, ultrasonic. Actuators: LEDs, 7 segment display, LCDs, stepper motor, DC motor, servo motor.

UNIT V EMBEDDED SYSTEMS 9

Embedded system definition, classification of embedded system, Embedded system design process, skills required for an embedded system designer, reset circuit, power up reset, watch dog timer.

Case study: washing machine, Traffic light controller, Microwave oven.

Total 45 Hrs

g) Learning Resources

Reference Books

1. Ramesh Gaonkar, “Microprocessor Architecture, Programming, and applications with the 8085”, Sixth Edition, Penram International Publishing Pvt. LTD, 2013.
2. Ajoy Ray, K Bhurchandi, “Advanced Microprocessors and Peripherals”, Second Edition, McGraw Hill Education – 2006.
3. Mohamed Ali Mazidi, Janice Mazidi, RolinMcKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Second Edition, Pearson education, 2011
4. Raj Kamal, “Embedded Systems: Architecture, Programming and Design”, Second Edition, Tata McGraw-Hill Education, 2011.

COURSE CODE	COURSE TITLE	L	T	P	C
1154EC107	GREEN ELECTRONICS	3	0	0	3

Course Category:

Institutional Elective

Preamble:

This course aims to provide students with knowledge on the theories, eco-design concepts, methods, and relevant hands-on experience for designing a range of sustainable green electronic products. It is expected that students will develop their ability to address relevant issues on environmental impact; product design, operating life, and the 3R concept (reduce, reuse, and recycle).

a. Prerequisite Courses:

Environment engineering

b. Related Courses:

Professional ethics

c. Course Educational Objectives:

The student should be made to

1. To study the introduction of green electronics
2. To study the green electronics materials and products
3. To study the green electronics assembly and recycling
4. To study the flip-chip assembly and bonding for lead-free electronics

d. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)

CO1	Recognise and address the issues relating to the need for a greener world, and environmental electronic design and manufacturing in the local industry	K2
CO2	Recognise the importance of various environmental regulations in indifferent major countries around the world and the need for compliance with these regulations	K2
CO3	Apply the principles and practices of green electronics in selected consumer products	K2
CO4	Describe the process and techniques of assessment of the environmental hazards and suggest ways to reduce them.	K2
CO5	Realize the impact of the environmental regulations on the design, supply chain, manufacturing and recycling of the electronic products.	K2

e. Course Content :

UNIT I INTRODUCTION OF GREEN ELECTRONICS

Environmental concerns of the modern society – Overview of electronics industry and their relevant regulations in China, European Union and other key countries. Restriction of Hazardous substances (RoHs) – Waste Electrical and electronic equipment (WEEE) – Energy using Product (EUP) and Registration Evaluation, Authorization and Restriction of Chemical substances (REACH).

UNIT II GREEN ELECTRONICS MATERIALS AND PRODUCTS

Introduction to green electronic materials and products – Lead (Pb) – free solder pastes, conductive adhesives, halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products. Tin Whiskers Growth in Lead-Free Electronic Assemblies – Factors Influence Whisker Growth – Ways to Mitigate Tin Whisker Risk – Use Finite Element Modeling to Assess Tin Whisker Risk – Evaluation of Tin Whisker Impact on High-Reliability Applications.

UNIT III GREEN ELECTRONICS ASSEMBLY AND RECYCLING

Green electronic Assembly – Soldering Process – Lead-Free Solder Tip and Bumps – Mitigate Deterioration of Lead-Free Tin Solder at Low Temperatures – Fatigue Characterization of Lead-Free Solders – Thermal Fatigue of Solder Joints, Fatigue Design of Lead-Free – Electronics – Fatigue Life Prediction Based on Field Profile, Fatigue Validation of Lead-Free Circuit – Flip-Chip Technology and Assembly process – card Assembly, surface mount technology – Management on e-waste recycle system construction, global collaboration and product disassemble technology.

UNIT IV FLIP-CHIP ASSEMBLY AND BONDING FOR LEAD-FREE ELECTRONICS

Flip-Chip Assembly Process – Placement and Under fill stage-FEM of Die stress – Gold stud Bump Bonding – Materials and Process Variations – Integrating Flip Chip into a Standard SMT Lead-Free Reflow soldering Techniques and Analytical Methods – Electro migration Analysis for Mean-Time-to Failure Calculations – Gold-Tin Solder Integrating Vertical-Cavity Surface Emitting Lasers onto Integrated Circuits – Design and Processing of Flip-Chip Bonding Structures – Opto-Electronic Integration.

UNIT V REAL TIME GREEN ELECTRONIC

Lead-Free Electronic Design – Selection of the Package Type – Substrate or Die Attachment FR4 – Electrical Connections from Die to FR4 – Assess Impact of CTE Mismatch on Stress and Fatigue Life – Design Solder Balls for External Connection to PCB – Thermal Analysis of Flip-Chip Packaging – RLC for Flip-Chip Packages – Drop Test of Flip-Chip Packaging – Wei bull Distribution for Life Testing and Analysis of Test Data.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. John X.Wang ‘Green Electronics Manufacturing’, CRC Press Indian Prentice Hall, 2012

2. Sammy G Shina, ‘Green Electronics Design and Manufacturing’ Mc Graw Hill 2008.

REFERENCE BOOKS:

1.Lee Goldberg, “Green Electronics/Green Bottom Line, Newnes Publications 2000

ONLINE RESOURCES:

www.nptel.com

COURSE CODE	COURSE TITLE	L	T	P	C
1154EC108	**NANO ELECTRONICS**	**3**	**0**	**0**	**3**

a. Course Category:

Institutional Elective

b. Preamble:

The Purpose of the course is to provide students with the basic knowledge in nanoelectronics. This course emphasize on nano materials, types, synthesis, interconnects and fabrication.

c. Prerequisite Courses:

Engineering Physics-II

d. Related Courses:

NIL

e. Course Educational Objectives :

Students undergoing this course are exposed to:

- Know the types of nanotechnology, atomic structure, molecular technology and preparation of nano materials.
- Understand the fundamentals of nano electronics and its properties.
- Know the Silicon MOSFET's, QTD and carbon nano tubes.
- Understand the fundamentals of molecular electronics.

f. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Discuss the types of nanotechnology, molecular technology and the preparation of nano materials.	K2
CO2	Explains the fundamental of the devices such as logic devices, field effect devices, and spintronics.	K2
CO3	Describe the concepts of silicon MOSFET and Quantum Transport Devices.	K2

CO4	Summarize the types, synthesis, interconnects and applications of carbon nano tubes.	K2
CO5	Explain the concepts, functions, fabrications and applications of molecular electronics.	K2

g. Course Content :

UNIT I INTRODUCTION TO NANOTECHNOLOGY L-9

Introduction: Discussion of the International Technology Roadmap characteristics: Need for new concepts in electronics From microelectronics towards biomolecule electronics **Background to nanotechnology:** Types of nanotechnology and nanomachines – periodic table – atomic structure – molecules and phases – energy – molecular and atomic size – surface and dimensional space – top down and bottom up.
Molecular Nanotechnology:
Electron Microscope – Scanning Electron Microscope – Atomic Force Microscope –Scanning Tunneling Microscope.
Nanomaterials:
Preparation –Plasma Arcing – Chemical Vapor Deposition – Sol-Gels – Electrode Position – Ball Milling –Applications Of Nanomaterials.

UNIT II FUNDAMENTALS OF NANOELECTRONICS L-9

Fundamentals of logic devices:- Requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices:- classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons – performance estimation for the human brain. Ultimate computation:- power dissipation limit – dissipation in reversible computation – the ultimate computer.

UNIT III SILICON MOSFETs & QUANTUM TRANSPORT DEVICES L-9

Silicon MOSFETS - Novel materials and alternate concepts:- fundamentals of MOSFET Devices- scaling rules – silicon-dioxide based gate dielectrics – metal gates – junctions & contacts – advanced MOSFET concepts.
Quantum transport devices based on resonant tunneling: Electron tunneling – resonant tunneling diodes – resonant tunneling devices; Single electron devices for logic applications-Single electron devices – applications of single electron devices to logic circuits.

UNIT IV CARBON NANOTUBES L-9

Carbon Nanotube: Fullerenes - types of nanotubes – formation of nanotubes – assemblies –

purification of carbon nanotubes – electronic properties – synthesis of carbon nanotubes – carbon nanotube interconnects – carbon nanotube FETs – Nanotube for memory applications – prospects of all carbon nanotube nanoelectronics.

UNIT V MOLECULAR ELECTRONICS L-9

Electrodes & contacts – functions – molecular electronic devices – first test systems – simulation and circuit design – fabrication; Future applications: MEMS – robots – random access memory – mass storage devices.

Total: 45 Periods

h. Learning Resources

i.Text Books:

1. Michael Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons and Burkhard
2. Raguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall / CRC, 2002.
3. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2003.
4. T. Pradeep, NANO: The Essentials – Understanding Nanoscience and Nanotechnology, TMH, 2007.

ii.Reference:

1. M.Ziese and M.J Thornton(Eds.)"Spin Electronics ", Springer-verlag 2001.
2. M.Dutta and M.A Stroscio Edited by "Quantum Based Electronic Devices and systems", world Scientific, 2000.

iii. Online resources

1. https://www.edx.org/course/fundamentals-nanoelectronics-part-b-purduex-nano521x.

COURSE CODE	COURSE TITLE	L	T	P	C
1154EC109	**MEDICAL ELECTRONICS**	**3**	**0**	**0**	**3**

Course Category:

Program Elective (2)

Preamble:

Medical electronics provides the ideas and the basic knowledge of human anatomy, physiology and the need of electronics principle and applications of equipments used in the medical field as well as introduce the concept of safety aspects for medical instruments.

a. Prerequisite Courses:

- Linear integrated circuits
- Biology for Engineers
- Basic Electronics Engineering
- Measurements &Instrumentation

b. Related Courses:

- Internet of Things (IOT)

c. Course Educational Objectives:

- Understand the basic concepts of human anatomy and physiology.
- Know the classification, application and specification of medical electronic equipments and electrodes like needle, pad and micro electrodes
- Understand the concept of various transducers, sensors and bio electrical machines like pressure transducers, flow sensor etc
- Learn about the patient monitoring systems and measurements like pulse, BP.
- Study about the types of shocks like macro, micro shock and the concept of safety aspects

d. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basic concepts of human anatomy and physiology	K2

CO2	Explain the principles of different medical electronic equipments	K2
CO3	Discuss the concept of various transducers, sensors and bio electrical machines	K2
CO4	Describe about the patient monitoring systems and measurements	K2
CO5	Discuss the importance of safety aspects in medical electronics and their standards.	K2

e. Course Contents:

UNIT I Review of Anatomy and physiology 9

Elementary ideas of cell structure, Heart and circulatory system, Central nervous system, Muscle action, Respiratory system, Body temperature and reproduction system

UNIT II Overview of Medical Electronics Equipments 9

Classification, application and specifications of diagnostic, therapeutic and clinical laboratory equipment, method of operation of these instruments. Electrodes: Bioelectric signals, Bio electrodes, Electrode, Electrode tissue interface, contact impedance, Types of Electrodes, Electrodes used for ECG, EEG, X-Ray & CT-Scan

UNIT III Transducers, Sensors and Bioelectrical Machines 9

Typical signals from physiological parameters, pressure transducer, flow transducer, temperature transducer, pulse sensor, respiration sensor, Bio Medical Recorder Block diagram description and application of following instruments, ECG Machine, EEG Machine, EMG Machine

UNIT IV Applications of Biomedical Instruments 9

Heart rate measurement, Pulse rate measurement, Respiration rate measurement, Blood pressure measurement, Principle of defibrillator and pace mark, Use of Microprocessor in patent monitoring.

UNIT V Safety Aspects of Medical Instruments 9

Radiation safety instrumentation, Radiation monitoring instruments, Physiological Effects due to 50 Hz current passage, Gross current shock, Micro current shock, Special design from safety consideration, Safety standards.

TOTAL: 45 periods

f. Learning Resources

(i) Text Books:

1. Leislie Cromwell, "Biomedical instrumentation and measurement", Prentice Hall ofIndia, NewDelhi, 2007.
2. Khandpur, R.S., "Handbook of Biomedical Instrumentation", TATA McGraw-Hill,New Delhi, 2003.

(ii) References:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment Technology", John Wiley and Sons, New York, 2004.
2. Introduction to Biomedical Electronics by Edward J. Perkstein; Howard Bj, USA.

(iii) Online resources

- http://www.medicalelectronicsdesign.com
- http://electronicsforu.com
- http://engineering.careers360.com

Course Code	Course Title	L	T	P	C
1154EC210	**EMBEDDED SYSTEMS AND ROBOTICS**	**1**	**0**	**4**	**3**

a) Course Category

Program Elective

b) Preamble

This course introduces the embedded hardware design, programming and introduction of robotics, electronic components, electronic processors and controllers, circuit development with practical knowledge of each modules to give our student the best of robotics training for real-time applications.

c) Prerequisite

Microprocessor and Microcontroller

d) Related Courses

Nil

e) Course Outcome

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Demonstrate PIC based embedded systems	S4
CO2	Design and develop real time systems using Arduino	S4
CO3	Design robots using arduino for the given specification and demonstrate it	S4

f) Course Content :

Theory **15 Hours**

PIC-Architecture, pin diagram, ports, on chip peripherals Embedded C programming – General Structure, Data types.

Embedded C programming – General Structure, Data types.

Arduino- introduction, IDE, different arduino, Boards & shields.

Analog I/O & o/p.Serial and Parallel Communication

Microcontroller ATMEGA 328

Seven Segment and LCD Display

Driving motors

Manual Robots and Autonomous Robots - fundamentals and its applications

Gear assembly and calculations

Different types of chassis designing

RTOS fundamentals.

i) List of experiments

S. No	CO Mapping	Practical Exercises (60 Hours)
1.	CO1	LED and seven segment display using PIC- C Programming
2.	CO1	Keypad interface using PIC- C Programming
3.	CO1	Serial communication using PIC-C Programming
4.	CO1	PWM generation using PIC-C Programming
5.	CO1	Motor speed control using PIC
6.	CO2	Interfacing Basic Shield with Arduino
7.	CO2	LED Interfacing using Arduino
8.	CO2	Generating different colors from RGB LED.
9.	CO2	LCD Interfacing using Arduino.
10.	CO2	LDR Interfacing using Arduino.
11.	CO2	IR sensor interfacing using Arduino.
12.	CO2	Ultrasound sensor interfacing using Arduino.
13.	CO2	Temperature sensor interfacing using Arduino.
14.	CO2	Interfacing Motors to Arduino.
15.	CO2	Bluetooth Interfacing using Arduino
16.	CO2	WiFi Interfacing using Arduino
17.	CO2	GSM module Interfacing using Arduino
18.	CO3	Color Sensing Robot.
19.	CO3	Light Sensing Robot.
20.	CO3	Grid Counting Robot.
21.	CO3	Range Detecting Robot.

22.	CO3	Obstacle Sensing Robot.
23.	CO3	Edge Avoiding Robot.
24.	CO3	DTMF Controlled Robot.
25.	CO3	Bluetooth Controlled Robot.
26.	CO3	Wi-Fi Controlled Robot.
27.	CO3	GSM Controlled Robot.
28.	CO3	Line Follower Robot

j) Learning Resources

Textbooks

1. Massimo Banzi, “Getting Started with Arduino” 2 nd edition. O’Reilly, 2011.
2. Udayakumar, G.Kulkarni, “ Arduino: A Begineer's Guide” 2017
3. DoganIbrahi, “Advanced PIC Microcontroller Projects in C”, Newnes, 2008.
4. MykePredko, “Programming and customizing the PIC”, 3 rd edition.
5. Parab, V.G.Shelake and R.K.Kamat-“Exploring C for Microcontrollers: A Hands on Approach”-Springer-2007.
6. M. ShohamA Textbook of Robotics 1: Basic Concepts Springer-1984.
7. By Kevin M. Lynch, Frank C. Park “Modern Robotics mechanics, planning, controls” Cambridge university press-2017.
8. Cameron Hughes, Tracey Hughes “Robot Programming: A Guide to Controlling Autonomous Robots”, 1/e First Edition-2016.
9. John-David Warren, Josh Adams, HaraldMolle, “Arduino Robotics” apress.

Online Resources

1. https://www.arduino.cc//
2. https://www.tutorialspoint.com/arduino/index.html
3. http://microcontrollerslab.com/pic-microcontroller-compiler/
4. http://bobblick.com/techref/techref.html
5. http://www.microcontrollerboard.com/pic-microcontroller-books.html
6. http://www.nex-robotics.com/products/microcontroller-development-boards/atmega2560-microcontroller-socket.html
7. http://www.avr-asm-download.de/beginner_en

Course Code	Course Title	L	T	P	C
1154EC111	**PROCESS CONTROL**	**3**	**0**	**0**	**3**

a) Course Category

Institutional elective

b) Preamble

The purpose of this course is to provide students with the knowledge of various process control elements and controllers to solve real world problems in an efficient manner.

c) Prerequisite

Basic Electronics Engineering

d) Related courses

Control systems

e) Course educational objectives

1. Understand the concepts of various process and its characteristics
2. Study on concepts of various controllers such as P, PI.
3. Gain knowledge in controller tuning and performance evaluation.
4. Expose on final control elements and its characteristics.
5. Learn on various control schemes and its application.

f) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the concepts of various process dynamics and its mathematical model.	K2
CO2	Describe the concepts of various controllers in PID and its operation.	K2
CO3	Illustrate the evaluation criteria and various controller tuning methods such as process reaction curve method.	K2
CO4	Elaborate the various final control elements such as electric actuators, control valves.	K2
CO5	Explain the multivariable control and its application.	K2

g) Course Content

UNIT I PROCESS DYNAMICS 9

Need for process control – Mathematical model of flow, Level, Pressure and Thermal processes – Interacting and non-interacting systems – Degrees of freedom – Continuous and batch processes – Self regulation – Servo and regulatory operations - Inverse response

UNIT II CONTROLLER 9

Characteristics of on-off, proportional, single speed floating, integral and derivative – P+I, P+D and P+I+D control modes – Electronic PID controller - Auto/Manual Transfer – Reset Windup

UNITII CONTROLLER TUNING 9

Need for controller tuning – Evaluation criteria – Quarter Decay Ratio, IAE, ISE and ITAE - Types of controller tuning: Process reaction curve method, Continuous cycling method and Damped oscillation method

UNIT IV FINAL CONTROL ELEMENTS 9

/P converter - Pneumatic and electric actuators – Valve Positioner – Control Valves – Characteristic of Control Valves: - Inherent and Installed characteristics – Modeling of pneumatic control valve – Valve body:- Commercial valve bodies – Control valve sizing – Cavitation and flashing – Selection criteria.

UNIT V MULTILOOP CONTROL 9

Cascade control – feed forward control- ratio control – Interference control – split range control – application in distillation columns, chemical reactors, Heat exchangers and boilers – introduction to adaptive control.

Total 45 Hrs

h) Learning Resources

(i) Text books

1. Bequette, B.W., "Process Control Modeling, Design and Simulation", Prentice Hall of India, 2004

2. Stephanopoulos, G., "Chemical Process Control - An Introduction to Theory and practice", Prentice Hall of India, 2005

(ii) Reference Books

1. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Proces Dynamics and Control”, Wiley John and Sons, 2^{nd} Edition, 2003
2. Coughanowr, D.R., “Process Systems Analysis and Control”, McGraw - Hill International Edition, 2004.

Course Code	Course Title	L	T	P	C
1154EC112	**INTELLIGENT TRANSPORTATION SYSTEMS**	**3**	**0**	**0**	**3**

a) Course Category

Institutional Elective

b) Preamble

Intelligent Transportation Systems (ITS) refers to information and communication technologies, as applied to transportation infrastructure and vehicles, that improve transportation safety, productivity, environment, and travel reliability. It improves the effectiveness and efficiency of surface transportation systems through advanced technologies in information systems, communications, and sensors. This course also includes the basic building blocks and techniques used in the delivery of ITS systems and services. As the field of ITS is developing rapidly, this course is intended to provide solid foundation that enables students to pursue further studies or work in the field of ITS.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the fundamentals of Intelligent Transportation Systems (ITS)	K2
CO2	Describe the use of telecommunication in transportation	K2
CO3	Discuss different functional areas of ITS	K2
CO4	Explain the services offered by ITS	K2
CO5	Summarize the ITS implementation in developing /developed countries.	K2

f) Course Content

UNIT I Introduction to Intelligent Transportation Systems (ITS) 9

Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT II Telecommunications in ITS 9

Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System

UNIT III ITS functional areas 9

Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

UNIT IV ITS User Needs and Services 9

Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management

UNIT V ITS implementation 9

Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries

Total 45 Hrs

g) Learning Resources

Reference Books

1. Jon D. Fricker, Robert K. Whitford, “Fundamentals of Transportation Engineering: A Multimodal Systems Approach”, Prentice Hall, 2004
2. Mashrur A. Chowdhury, Adel W. Sadek, “Fundamentals of Intelligent Transportation Systems Planning”, Artech Print on Demand, 2003

Text Books

1. Kan Paul Chen, John Miles "Recommendations for World Road Association (PIARC)", ITS Hand Book, 2000
2. Joseph M Sussman, "Perspective on Intelligent Transportation Systems", Artech House Publishers, 2005
3. National ITS Architecture Documentation, US Department of Transportation, 2007

Online Resources

1. https://nptel.ac.in/courses/105101008/48
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-221j-transportation-systems-fall-2004/lecture-notes/

Course Code	Course Title	L	T	P	C
1154EC213	**VEHICLE ELECTRONICS**	**2**	**0**	**6**	**5**

a) Course Category

Institutional Elective

b) Preamble

In this course, the students will learn about basic electronic modules used in modern vehicles and the networking architecture used to interconnect these modules. Concretely, they will learn (1) The sensors and actuators used in modern vehicles (2) The design of electronic subsystems in vehicles (3) The interconnection of all the electronic subsystems using vehicle networking.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcome

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

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Interface various automotive sensors and actuators with given Microcontrollers	S4
CO2	Design an automotive electronic system for monitoring engine performance, infotainment and telematics.	S4
CO3	Recognize the appropriate protocols used in vehicle networking.	S2

f) Theory Course Content: 30 Hours

Introduction to basic electronics – Passive elements, Op-Amp, types of LED and LCD, logic gates, Mux, De-mux, driver circuits, ADC, DAC.

Sensors – Specifications and applications of ABS Sensor, wheel speed sensor, crank shaft position sensor, oxygen sensor, air flow sensor, tyre pressure sensor, engine coolant sensor, temperature sensor, brake fluid sensor, accelerometer, light sensor, Infra-Red, ultrasonic sensor.

Actuators – Specifications and applications of tyre inflator, AC unit compressor, windshield wiper, heating coil, lighting systems, airbag system, motors, valve.

Switching Devices – Specifications and applications of relays and switches – dip switch, push buttons, touch switch, toggle switch.

Automotive Electronic Systems – Antilock Braking System, Automatic Emergency Braking System, Engine Control System, Ignition Control and Start-Stop System, Heating and AC System, Vehicle Theft Security System, Seat belt indication system, Camera and Ultrasonic sensor based Parking Assistance System, Vehicle navigation system, Vehicle telematics system.

High Level Programming – Features of Arduino and Raspberry Pi Boards, Basics of Embedded C and Python programming, programming using IDE – Arduino, MATLAB.

Networking – OSI layers, Bus architecture, LAN/WAN, CAN Protocol, FlexRay Protocol, Ethernet Protocol, AUTOSAR architecture.

g) List of Experiments

S. No	CO Mapping	Practical Exercises (30 Hours)
1.	CO1	LED and Push button interface using Arduino
2.	CO1	LCD and Push button interface using Raspberry Pi
3.	CO1	Design of turn light indicator system
4.	CO1	Design of speed indication system
5.	CO2	Design of image acquisition system
6.	CO2	Design of stepper motor, servo motor and DC motor control
7.	CO2	Design of Bluetooth based infotainment system
8.	CO3	Design of GSM based vehicle connectivity system
9.	CO3	Design of GPS based vehicle localization system
10.	CO3	Design of wireless device control system

11.	CO3	Design of Wi-Fi based cloud communication system

h) List of Projects/Tasks

S. No	Theme	CO Mapping	Projects/Tasks (90 Hours)
1.	Vehicle authentication system	CO2	Task 1: Keyless Entry system
2.	Infotainment System	CO2	Task 2: Design of Bluetooth based infotainment system
3.	Engine Performance Monitoring System	CO2	Task 3: Windshield wiper system
4.		CO2	Task 3: Rear view guiding system
5.		CO2	Task 4: Design a Digital Dashboard showing Fuel, Oil and Pressure values.
6.	Vehicle Telematics	CO3	Task 5: Vehicle Tracking System
7.		CO3	Task 6: Vehicle to Vehicle and Vehicle to Infrastructure Communication System
8.		CO3	Task 7: Vehicle telematics system

i) Learning Resources

Textbooks

a. Bosch Automotive Electrics and Automotive Electronics: Systems, Components and Hybrid Drive, Robert Bosch GmbH, Springer Vieweg, (2007).

COURSE CODE	COURSE TITLE	L	T	P	C
1155EC101	**Ethics in Engineering**	**1**	**0**	**0**	**1**

Course Category: Value Education Elective

Course Objective:

To provide guiding principles and tools for the development of the whole person recognizing that the individual is comprised of Physical, Intellectual, Emotional and Spiritual dimensions and to create an awareness on Engineering Ethics and Human Values, to inculcate Moral and Social Values.

Course Outcomes:

Students undergoing this course are able to:

- To promote the importance in value education in society, deepen understanding, motivation and responsibility with regard to making value education.
- To inspire individuals to choose their own personal, social, moral and spiritual.
- To understand the engineering ethics and moral dilemmas.
- To help individuals think about and reflect on different values and to Know the importance of value education towards national and global development.
- To Develop professionals in software industry with idealistic, practical and moral values.

Course content:

VALUE EDUCATION AND ITS ROLE

Importance of Value Education , Criteria And Sources Of Values - Aims And Objectives Of Value Education -Role And Need For Value Education in The Contemporary Society -Role Of Education in Transformation of Values In Society - Role Of Parents, Teachers, Society, Peer Group And Mass Media In Fostering Values -Teaching Approaches And Strategies

ETHICS, HUMAN VALUES AND PERSONAL DEVELOPMENT

Ethics: Morals, Values And Ethics, Work Ethic**,** Environmental Ethics, Computer Ethics- Code Of Conduct

Human Values: Truthfulness, Constructivity, Sacrifice, Sincerity, Self-Control, Altruism, Scientific Vision, Relevancy of Human Values To Good Life- Spirituality-

Personal Development :Character Formation Towards Positive Personality -Modern Challenges Of Adolescent: Emotions And Behavior -Self-Analysis And Introspection: Sensitization Towards Gender Equality, Physically Challenged, Intellectually Challenged, Respect To - Age, Experience, Maturity, Family Members, Neighbors, Co-Workers- Empathy-Self confidence**.**

ENGINEERING ETHICS AND MORAL DILEMMAS

Need of Engineering Ethics- The code of ethics for engineers – Societies for engineers- NSPE Code of Ethics- Ethical and Unethical practices, Personal and Professional Ethics -Engineering As An Ethical Profession- Ethical Issues Faced By Engineers- Moral Dilemmas

VALUE EDUCATION TOWARDS GLOBAL ISSUES

Personal values, Professional Values: Knowledge Thirst, Sincerity in Profession, Regularity, Punctuality, Faith- Constitutional Values, Social Values, Moral Values, Dishonesty - Stealing - Malpractices in Examinations – Plagiarism

CODE ETHICS IN SOFTWARE DEVELOPMENT

Need A Code Of Ethics For Software Development-Ethics, Values And Practices For Software Professionals-Ethics In Computing, From Academia To Industry-Principles Of Software Ethics-Rewriting The Code For Ethics In Software Development-Ethics Of Security-Privacy Ethics – Ethics In A Psychological Perspective- Ethical Issues In Software Industry-Issues In Professional Ethics In Software Project Management-Ethical Issues In Information Technology.

TOTAL: 15

G. Learning Resources

i. Text Books

1. Mike W. Martin And Roland Schinzinger, "Ethics In Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Sharma, S.P. *Moral and Value Education; Principles and Practices*, Kanishka publishers, 2013.
3. Kiruba Charles & V. Arul Selvi. *Value Education*: Neelkamal Publications, New Delhi, 2012.
4. Passi, B.K. and Singh, P. *Value Education*. National Psychological Corporation, Agra. 2004.

ii. Reference Books

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall Of India, New Delhi, 2004.
2. Monica J. Taylor. *Values in Education and Education in Value*. Routledge. 1996.

iii. Digital Resources

- **www.onlineethics.org**
- **www.nspe.org**
- **www.globalethics.org**
- **www.ethics.org**

Course Code	Course Title	L	T	P	C
1155EC102	**HUMAN VALUES FOR ENGINEERS**	**1**	**0**	**0**	**1**

a) Course Category

Value Education

b) Preamble

The purpose of this course is universally adaptable, involving a systematic and rational study of the human being vis-à-vis the rest of existence.

c) Prerequisite

Nil

d) Related Courses

Nil

e) Course Outcomes

On successful completion of this course the student will be able to

- On completion of this course, the students will be able to
- Understand the significance of value inputs in a classroom and start applying them in their life and profession
- Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
- Understand the role of a human being in ensuring harmony in society and nature.
- Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.

f) Course Content

UNIT I Introduction to Value Education 3

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

UNIT II Harmony in the Human Being 3

Human Being is more than just the Body, Harmony of the Self ('I') with the Body.

UNIT III Harmony in the Family and Society and Harmony in the Nature 3

Family as a basic unit of Human Interaction and Values in Relationships, The Basics for Respect and today's Crisis: Affection, Guidance, Reverence, Glory, Gratitude and Love.

UNIT IV Social Values **3**

The Basics for Ethical Human Conduct, Defects in Ethical Human Conduct.

UNIT V Professional Values **3**

Value based Life and Profession, Professional Ethics and Right Understanding.

Total 15 Hrs

g) Learning Resources

Text Books

1. Corliss Lamont, Philosophy of Humanism
2. Gaur. R.R. , Sangal. R, Bagaria. G.P, A Foundation Course in Value Education, Excel Books, 2009
3. Gaur. R.R. , Sangal. R , Bagaria. G.P, Teachers Manual Excel Books, 2009.
4. I.C. Sharma . Ethical Philosophy of India Nagin & co Julundhar
5. Mortimer. J. Adler, – Whatman has made of man
6. William Lilly Introduction to Ethic Allied Publisher

Reference Books

1. A.N Tripathy, New Age International Publishers, 2003.
2. Bajpai. B. L , , New Royal Book Co, Lucknow, Reprinted, 2004
3. Bertrand Russell Human Society in Ethics & Politics
4. A.N Tripathy, New Age International Publishers, 2003.

Value Education Elective (One credit course)

11551EC103 Stress relief for Anxious Mind

Course Description

This course exposes students to a holistic approach to stress management. It treats both cognitive skills and relaxation techniques with the intention of preventing and/or alleviating the physical symptoms of stress.

Objectives of the course:

- Understand the holistic nature (mind-body-spirit) of stress management and comprehend the mind-body connection of the stress.
- Understand the importance of using effective coping skills to resolve stressful perception and gain a sense of wholeness and inner peace by using these skills.
- Learn about and experience several relaxation techniques and learn to integrate these techniques into your daily living habits to help you control stress and tension.

Course Contents:

Stress – Sources of stress – Types of stress – Personality factors and stress – stress and the college student – Stress and Nervous System – Effect of Stress on Immune System – Health Risk Associated with Chronic Stress – Stress and Major Psychiatric Disorders – Effects of stress on behaviour – Recognizing when you are stressed – Mindfulness – Stress Prevention Methods – Nutritional Strategies to ease anxiety – Techniques for avoiding stressful situations.

Video Link: https://nptel.ac.in/courses/121/105/121105009/

References:

1. Misra, G. (Ed.) (1999). Psychological Perspectives on Stress and Health, New Delhi, Concept.
2. Anspaugh Dj, et al. (2011). Coping with and managing stress. In Wellness: Concepts and Applications, 8th ed., pp. 307-340. New York: McGraw-Hill.
3. Freeman L (2009). Relaxation therapy. In Mosby's Complementary and Alternative Medicine: A research-based approach, 3rd ed., pp. 129-157, St. Louis: Mosby Elsevier.