DAYANANDA SAGAR UNIVERSITY

SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT BENGALURU – 560 111, KARNATAKA.

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS FOR BACHELOR OF TECHNOLOGY (B.Tech.) – 2019

ELECTRONICS & COMMUNICATION

ENGINEERING (ECE)

(WITH EFFECT FROM 2019-20)

(III, IV, V & VI SEMESTERS)

SCHEME - B.TECH – 2019 -20 ONWARDS

III **SEM - ELECTRONICS & COMMUNICATION ENGINEERING**

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S / P	C	CIA	END EXAM
1	102	19EN2301	ENGINEERING MATHEMATICS-III	CR	3	1	-	-	4	50	50
2	102	19EC2302	ANALOG CIRCUITS	CR	3	-	2	-	4	50	50
3	102	19EC2303	DIGITAL SYSTEM DESIGN WITH VERILOG	CR	3	-	2	-	4	50	50
4	102	19EC2304	NETWORK ANALYSIS	CR	3	1	-	-	4	50	50
5	102	19EN0001	ENGINEERING ECONOMICS	CR	2	-	-	-	2	50	50
8	102	19EC2373	SPECIAL INITIATIVES -I	CR	-	-	-	4	2	50	50
GRAND TOTAL = 600					**14**	**2**	**4**	**4**	**20**	**300**	**300**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits, CIA – Continuous Internal Assessment

SCHEME - B. TECH – 2019 -20 ONWARDS

IV SEM - ELECTRONICS & COMMUNICATION ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S / P	C	CIA	END EXAM
1	102	19EC2401	SIGNALS AND SYSTEMS	CR	3	1	-	-	4	50	50
2	102	19EC2402	COMPUTER SYSTEM ARCHITECTURE	CR	3	1	-	-	4	50	50
3	102	19EC2403	MICROCONTROLLERS	CR	3	-	2	-	4	50	50
4	102	19EC2404	ELECTROMAGNETIC WAVES	CR	3	-	2	-	4	50	50
5	102	19EN0002	LAW FOR ENGINEERS	CR	2	-	-	-	2	50	50
6	102	19EC2473	SPECIAL INITIATIVES -II	CR	-	-	-	4	2	50	50
GRAND TOTAL = 600					**14**	**2**	**4**	**4**	**20**	**300**	**300**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits, CIA – Continuous Internal Assessment

SCHEME - B.TECH – 2019 -20 ONWARDS

V SEM - ELECTRONICS & COMMUNICATION ENGINEERING

Sl. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{AU}{CR}$	Scheme of Teaching					Scheme of Evaluation	
					L	T	P	S/ P	C	CIA	End Exam
1	102	19EC3501	Analog and Digital Communication	CR	03		02		04	50	50
2	102	19EC3502	Probability Theory and Stochastic Processes	CR	03	01	--		04	50	50
3	102	19EC3503	CMOS VLSI Design	CR	03	--	02		04	50	50
4	102	19EC3504	Digital Signal Processing	CR	03		02		04	50	50
5	102	19EC35XX	Program Elective – 1	CR	03		--		03	50	50
6	102	19OEXXXX	OE-1	CR	03	--	--		03	50	50
7	102	19EC3505	Special Initiatives -III	CR	--	--		04	02	50	50
Grand Total 900					**18**	**01**	**06**	**04**	**24**	**350**	**350**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits, CIA – Continuous Internal Assessment

Program Elective –1

Sr. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE
1	102	19EC3506	Information Theory and Coding
2	102	19EC3507	MEMS*
3	102	19EC3508	C Programming for Embedded Systems
4	102	19EC3509	PLC and SCADA

SCHEME - B.TECH – 2019 -20 ONWARDS

VI SEM - ELECTRONICS & COMMUNICATION ENGINEERING

Sl. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{AU}{CR}$	Scheme of Teaching					Scheme of Evaluation	
					L	T	P	S/ P	C	CIA	End Exam
1	102	19EC3601	RF and Microwave Communication	CR	03	--	02		04	50	50
2	102	19EC3602	Networking and Communication	CR	03	--	02		04	50	50
3	102	19EC3603	Power Electronics		03	--	02		04	50	50
4	102	19EC36XX	Program Elective -2	CR	03	--	--		03	50	50
5	102	19EC36XX	Program Elective – 3	CR	03	--	--		03	50	50
6	102	19OEXXXX	Open Elective-2	CR	03	--	--		03	50	50
Grand Total 600					**18**	**01**	**04**	**04**	**21**	**300**	**300**

Program Elective –2

Sr. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE
1	102	19EC3604	Analog VLSI Design
2	102	19EC3605	Wireless Mobile Communication
3	102	19EC3606	Embedded System Design/Architecture

Program Elective –3

Sr. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE
1	102	19EC3607	Digital IC Design
2	102	19EC3608	Digital Image Processing
3	102	19EC3609	Real Time Embedded system
4	102	19EC3610	Industry IOT

SCHEME - B.TECH – 2019 -20 ONWARDS

VII SEM - ELECTRONICS & COMMUNICATION ENGINEERING

Sl. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{AU}{CR}$	Scheme of Teaching					Scheme of Evaluation	
					L	T	P	S/ P	C	CIA	End Exam
1	102	19EC4701	ROBOTICS AND CONTROL SYSTEMS	CR	03	01	--		04	60	40
2	102	19EC4702	ANTENNAS AND WAVE PROPAGATION	CR	03	01	02		04	60	40
3	102	19EC3603	PROGRAM ELECTIVE – IV		03	--			03	60	40
4	102	19EC36XX	PROGRAM ELECTIVE – V	CR	03	--	--		03	60	40
5	102	19EC36XX	OPEN ELECTIVE – III	CR	03	--	--		03	60	40
6	102	19OEXXXX	PROJECT STAGE-I	CR		--	--	04	02	60	40
Grand Total 600					**18**	**01**	**04**	**04**	**19**	**300**	**300**

Program Elective –IV

Sr. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE
1	102	19EC4704	OPTICAL COMMUNICATIONS AND NETWORKING
2	102	19EC4705	ANALOG MIXED SIGNAL VLSI DESIGN
3	102	19EC4706	EMBEDDED LINUX
4	102	19EC4707	VLSI TESTING AND TESTABILITY
5	102	19EC4708	SENSOR AND SIGNAL CONDITIONING

Program Elective –V

Sr. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE
1	102	19EC4709	SENSOR NETWORK AND PROTOCOLS
2	102	19EC4710	LOW POWER VLSI
3	102	19EC4711	LINUX DEVICE DRIVERS
4	102	19EC4712	NETWORK SECURITY
5	102	19EC4713	VLSI PROCESS TECHNOLOGY
6	102	19EC4714	EMBEDDED SYSTEMS AND AUTOMATION

SCHEME - B.TECH – 2019 -20 ONWARDS

VII SEM - ELECTRONICS & COMMUNICATION ENGINEERING

Sl. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{AU}{CR}$	Scheme of Teaching					Scheme of Evaluation	
					L	T	P	S/ P	C	CIA	End Exam
1	102	19EC48XX	PROGRAM ELECTIVE – VI	CR	03	--	02		03	50	50
2	102	19EC4801	PROJECT STAGE – II	CR		--		20	10	50	50
Grand Total 600					**03**	**--**	**02**	**20**	**13**	**100**	**100**

Program Elective –VI

Sr. No.	PROGRAM CODE	COURSE CODE	COURSE TITLE
1	102	19EC4802	WIRELESS SENSOR NETWORKS
2	102	19EC4803	HARDWARE ARCHITECTURE FOR AI
3	102	19EC4804	ADVANCED EMBEDDED SYSTEMS
4	102	19EC4805	SATELLITE COMMUNICATION
5	102	19EC4806	VLSI - DIGITAL SIGNAL PROCESSING
6	102	19EC4807	SIGNAL CONDITIONING AND DATA ACQUISITION

EMESTER	**III**					
YEAR	**II**					
COURSE CODE	**19EC2301**					
TITLE OF THE COURSE	**ENGINEERING MATHEMATICS – III**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- Understanding basic concepts of Complex variables and Complex integration to illustrate its importance through applications to science and Engineering.
- Understanding basic concepts of ODE to illustrate its power and utility through applications to science and Engineering.
- Understanding basic concepts of Probability and Random variables.
- Apply the concepts of Probability distribution in engineering.
- The course is discussed with theoratic as well as geometric perspectives.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	the basic notion of Complex variables and complex integration	**L3- Apply**
CO2	the abstract concepts of Probability	**L3-Apply**
CO3	to solve differential equations in the field of Circuit analysis and signal processing.	**L4-Analyze**
CO4	apply the concept of probability and complex variables in communication.	**L3- Apply**

COURSE CONTENT:	
MODULE 1: COMPLEX VARIABLES	**08Hrs**
Complex function, Limits, Continuity, differentiability, Analytic Functions, CR Equations, Properties of Analytic functions. **Self Learning Component** : Complex number and its properties	
MODULE 2 INTEGRATION IN THE COMPLEX PLANE	**12Hrs**
Complex Integrals, Cauchy -Goursat Theorem, Independence of Path, Cauchy's Integral Formulas and Their Consequences, Cauchy's Two Integral Formulas, Some Consequences of the Integral Formulas, Applications. **Self Learning Component :** Integration and some basic formulae	
MODULE 3 DIFFERENTIAL EQUATIONS	**12Hrs**
Second and higher order linear ODE with constant coefficients, General solution to the homogeneous equations, Method of variation of parameters, Method of undetermined coefficients, Cauchy-Euler and Legendre's linear equations, Power series solution for second order linear ODE. **Self Learning Component:** First order ODE and its solving techniques	
MODULE 4 PROBABILITY DISTRIBUTIONS	**08Hrs**
Basic Probability- Probability introduced through sets and relative frequency- conditional probability- independence-Random Variable-Discrete and continuous random variables-Independent random variables-Mixed random variable **Self Learning Component** : Events, Sample space	
MODULE 5 PROBABILITY DISTRIBUTIONS	**12Hrs**
Distribution and density function-Properties-Binomial Distribution-Poisson Distribution-Uniform Distribution-Gaussian Distribution-Exponential Distribution-Rayleigh Distribution-Conditional Distribution- Multinomial Distribution Density Function-Properties **Self-Learning Component:** Distribution of discrete and continuous random variable	

TEXT BOOKS:

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1. A First course in complex analysis with applications, Dennis Zill and Patrick Shanahan, Jones and Bartlett publishers.
2. A First Course in Probability, S. Ross, Pearson International Edition, 9th Edition
3. Fundamentals of Mathematical Statistics, S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons, 11th Edition
4. Thomas's Calculus, G.B.Thomas, M.Weir, J. Hass, Pearson , 12th edition

REFERENCE TEXT BOOKS

.

1. Complex Variables and applications, Brown and Churchill, Mc Graw Hill Education, Eighth Edition.
2. Probability, Statistics and Statistics with Reliability, Queuing, and Computer Science Applications, Kishore Trivedi, Prentice Hall, 2nd Edition
3. Probability and Random Processes, S. Miller and Childers, Elsevier Inc., Second Edition
4. Advanced Engineering Mathematics, E. Kreyzsig, Wiley, 10th Edition

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SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**19EC2302**					
TITLE OF THE COURSE	**ANALOG CIRCUITS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

- To study frequency response behavior of BJT and hybrid parameters
- To study biasing circuits of BJT and MOSFETs for amplification, feedback concepts
- To study the basic principles, configurations, stability and frequency response, linear and nonlinear applications, signal processing and signal generation circuits.

COURSE OUTCOMES:

	Outcomes	**Blooms Taxonomy Level**
CO1	**Demonstrate** the applications of Diode, BJT and FET	**2 - Understand**
CO2	**Analyze** Frequency response behaviour of amplifiers and oscillators without feedback	**4-Analysing**
CO3	**Design** rectifiers, Clippers, clampers, regulators, amplifiers and oscillators for given specifications	**6-Creating**
CO4	**Analyze** stability, frequency response and infer required compensation techniques	**4 - Analyzing**
CO5	**Analyze** the performance of OpAmp in linear, nonlinear circuits and data convertors	**4 - Analyzing**
CO6	**Analyze** the working of active filters, oscillators and multivibrators using OpAmp	**4 – Analyzing**

COURSE CONTENT:	
MODULE 1: Diode Applications:	**08Hrs**
Review – PN Junction and Zener Diode, Types of Diodes – Construction and working of Schottky, Tunnel, Photo Diode. Performance Analysis and comparison of Half wave rectifier, Full wave Centre tap and Bridge rectifier. RC and LC power supply filters, Series Clipping Circuits, Shunt Clipping Circuits, Clamping Circuits.	

MODULE 2: Transistors Biasing	**8Hrs**
Review-BJT Concept, DC load Line and Bias point, BJT Biasing- Voltage Divider Bias, h-parameters and small signal analysis of CE configuration , Concept of Feedback, RC Tank Circuit, Introduction to Power Amplifiers **Field Effect Transistors:** MOSFETs –Structure and types- Enhancement, Depletion, MOSFET Biasing. Application – Single Stage CS Amplifier	
MODULE 3: Operational Amplifiers	**8Hrs**
IC Operational Amplifier, Voltage Follower Circuit, Non-Inverting and Inverting Amplifier, Op-Amp as DC Amplifiers – Direct coupled - voltage follower, Inverting Amplifier, Non-Inverting Amplifier, Op-Amp as AC Amplifiers – Capacitor coupled voltage follower – Inverting and Non-Inverting, High Impedance Capacitor coupled Voltage follower - non-Inverting. OP-Amp Frequency Response and Compensation: Op-Amp circuit stability, Op-Amps and Linear Integrated Circuits, Internally Compensated Op-Amps- frequency and phase response	
MODULE 4: Op-Amp Switching Circuits-	**8Hrs**
Zero Crossing Detector, Inverting Schmitt trigger, Signal Processing Circuits- Limiting Circuits and Clamping Circuits, Peak Detectors, Sample and Hold circuit, Sinusoidal oscillators: Wien Bridge and phase shift oscillators, Signal Generators-: Multivibrators, Triangular waveform generator, 555 timers monostable	
MODULE 5: Instrumentation Amplifier	**7Hrs**
Active Filters: First order and second order active Low-pass and high pass filters, Bandpass Filter, Band stop Filter. DAC and ADC convertor: DAC using R-2R, ADC-Successive approximation. Phase locked loop: Basic Principles, Phase detector/comparator, VCO.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.Interpretation of data sheets- Diode, transistor, Op-Amps
2. Performance Analysis of Half wave and Full wave Rectifiers, Bridge Rectifier – Discrete Components.
3.Testing of Diode clipping (Single/Double ended) circuits for peak clipping, peak detection- Discrete and Simulation
4.Testing of Clamping circuits: positive clamping /negative clamping.
5.RC coupled Single stage BJT amplifier - Determination of the gain-frequency response, input and output impedances.

6.MOSFET V-I Characteristics
7.Testing for the performance of BJT – Hartley & Colpitts Oscillators for given frequency
8.Design of Summing Amplifier, Integrator, Differentiator, Voltage Follower
9.Design of Comparators, Zero crossing detector, Schmitt Trigger, triangular waveform generator.
10.IC 555 timer as Monostable and Astable Multivibrator - Discrete and Simulation
11.Design of D/A converter- Weighted resistor, R-2R type, staircase waveform generator.
12.Design of Active Filters - BPF, LPF, HPF for given frequency range
13.Design of Precision Rectifier [Half and Full wave] circuit.

TEXT BOOKS:

1. David A.,Bell "Electronic Devices and Circuits", Oxford Higher Education Press, 5th Edition, 2010.
2. David A. Bell "Operational Amplifiers and Linear ICs", 3rd edition, PHI/Pearson, 2004.

REFERENCES:

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1. Millman.J. and Halkias C.C, "Electronic Devices and Circuits", Mc Graw Hill, 2007.
2. Donald .A. Neamen, Electronic Circuit Analysis and Design –2nd Edition, Tata Mc Graw Hill, 2009.
3. Robert L.Boylestad and Louis Nashelesky,"Electronic Devices and Circuit Theory", 10 th Edition, Pearson Education/PHI, 2008
4. Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4nd edition, Reprint 2006.
5. Ramakant A Gayakwad, "Op-Amps and Linear Integrated Circuits," Pearson, 4th Ed, 2015

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**19EC2303**					
TITLE OF THE COURSE	**DIGITAL SYSTEM DESIGN WITH VERILOG**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To translate the elements of digital system abstractions using digital logic to Boolean algebra.
- To illustrate simplification of Boolean expressions using Karnaugh Maps and Quine-McClusky TechniquesUnderstanding basic concepts of Probability and Random variables.
- To model combinational logic circuits for arithmetic operations and logical operations.
- To characterise, analyse and model bi-stable elements such as latches and flip-flops.
- To outline the concept of Mealy Model, Moore Model and apply FSM for digital design.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	**Discuss** the various elements of digital logic	**2 - Understand**
CO2	**Simplify** Boolean Expressions in digital design	**3 - Applying**
CO3	**Design** Combinational and Sequential logic circuits	**4 - Design**
CO4	**Analyse** the hardware model of a digital system at different levels of abstraction in Verilog	**4 - Analyze**
CO5	**Verify** the functionality of digital design	**4 - Evaluating**
CO6	**Design** architectures for arithmetic and logic units, registers and counters.	**6 - Creating**

COURSE CONTENT:	
MODULE 1: Introduction to Logic Circuits	**08Hrs**
Boolean Algebra, Logic Gates, Canonical Notation - SOP & POS forms, Introduction to Verilog, Switching Expression from truth tables, Minimization of K-maps (3,4,5) variables, Strategy for Minimization, Minimization of SOP and POS forms, Incompletely specified functions (Don't care terms), Quine-McCluskey minimization technique, Quine-McCluskey using don't care terms, Reduced prime implicant table, problems.	
MODULE 2: Number Representation and Arithmetic Circuits	**08Hrs**
Positional Number Representation, addition of unsigned numbers, half adder, full adder, Ripple carry adder, signed numbers, adder and subtractor unit, fast adders-CLA, Design of arithmetic circuits using CAD tools, model hierarchy in Verilog, Number representation in Verilog, BCD Representation, comparator- 2 bit.	
MODULE: Combinational Circuit Building Blocks	**08Hrs**
Multiplexers, decoders, demultiplexers, encoders, code converters, Design of ALU-4 bit, Verilog for combinational circuits, if else, case-casex, casez, for loop, Verilog operators, generate, task, function, design examples	
MODULE 4: Flip Flops, Registers and Counters	**08Hrs**
Basic Latch, Gated latches, Flip Flops SR, D, JK, T, master-slave flip-flops, flip flops with preset & clear capability, Characteristic equations, registers, binary counters – asynchronous and synchronous, mod-n counter using clocked T flip flop, BCD counter, ring counter, Johnson counter, Verilog constructs for storage elements, registers, counters, blocking and non-blocking, timing analysis.	
MODULE 5: Synchronous Sequential Circuits	**07Hrs**
Mealy Model, Moore Model, Finite State diagram- design steps for speed regulation of an automatically controlled vehicle, Verilog code for FSM specifying state assignments in Verilog code, Example of Serial Adder using FSM, Coin Operated Vending Machine, mod-n counter.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Component -1 Experiments- Combinational and Sequential Circuit Design using Kits
1. Realize 4 variable Boolean expressions
2. Realize and design the following combinational circuits **a.** Adders and Subtractors **b.** Binary to Gray Conversion and vice versa- 4 Bit **c.** Applications of MUX and DEMUX as function generator
3. Flip Flop: SR FF, D FF, T FF, JK FF
4. Synchronous Sequential Circuits – Binary, BCD counters, Johnson Counter and Ring Counter
5. A4-bit register with shift left and shift right Modes of operation and test its operation.

Component -2 Experiments-Sequential and combinational Circuit Design using Verilog HDL
Model, Verify and Synthesize the following
6. Combinational designs - I **a.** Multiplexer: 4:1, 8:1 MUX. **b.** De Multiplexer: 1:4, 1:8 DEMUX. **c.** Encoder with and without Priority: 8:3 and 4:2. **d.** Decoder: 3:8 and 2:4.
7. Adder – HA,FA, RCA using different modelling styles.
8. Realize and Model an ALU (4 bit)
9. Flip Flop: SR FF, D FF, T FF, JK FF and MS JK FF
10. Counters: 4 bit Binary and BCD Up/Down Counter with Synchronous reset and Asynchronous reset
11. Serial Adder, Mod –n counter using Mealy/Moore Model
12. Speed Regulation of an automatically controlled Vehicle
13. Coin operated Vending machine

TEXT BOOKS:

. 1. Stephen Brown, Zvonko Vranesic (2014), "Fundamentals of Digital Logic with Verilog design", McGraw Hill.

REFERENCES:

1. John M Yarbrough (2014), "Digital Logic Applications and Design", Thomson Learning.
2. M. Morris Mano Michael D. Ciletti (2014), "Digital Design with an Introduction to the Verilog HDL", Pearson Education.
3. Charles Roth, Lizy K. John, Byeong Kil Lee (2016), "Digital Systems Design Using Verilog", Cengage Learning.
4. Nazein M. Botros (2006), HDL programming (VHDL and Verilog), Dreamtech Press.
5. Donald D. Givone (2015), "Digital Principles and Design", McGraw Hill.
6. Samir Palnitkar (2016), "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education.

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SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**19EC2304**					
TITLE OF THE COURSE	**NETWORK ANALYSIS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To apply the knowledge of various fundamental circuital laws and simplify complex network using reduction techniques
- Analyse the circuits using network theorems and determine current, voltage and other associated electrical parameters.
- Examine and infer steady state and transient response network functions
- Evaluate two port network parameters and analyse their interdependencies
- Apply filter concepts to design various types of filters that allow particular range of frequency and attenuates the remaining based on the requirement.
- To predict the impedances in cases like high voltage electrical and low voltage transistor applications using two port network configurations

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Apply the knowledge to simplify complex networks using circuital laws and reduction techniques	**3- Apply**
CO2	Analyse networks using circuit theorems and determine electrical parameters	**4 - Analyse**
CO3	Evaluate steady state and transient response of network functions	**5- Evaluate**
CO4	Evaluate two port network parameters and analyse interdependencies	**5-Evaluate** **4- Analyze**
CO5	Solve for two port network parameters	**2-Understand** **3-Apply**
CO6	Use fundamentals of network filter terminologies for designing advanced filters	**1-Remember** **3-Apply**

COURSE CONTENT:	
MODULE 1: Basics & Network Topology	**12Hrs**
Passive and active components, Series and parallel circuits, source transformation, Star – Delta transformation, Delta-Star Transformations, Kirchhoff's Laws, Mesh Analysis with and without dependent source, Super mesh, Nodal Analysis with and without dependent source, Super nodes. Graph of a network, Tree, Co-tree, Sub graph, Connected graph and loop, Incidence matrix, Tie- set matrix and Cut-set matrix. Principle of duality	
MODULE: Network Theorems	**10Hrs**
Superposition, Thevenin's, Norton's, Maximum power transfer, Reciprocity, Tellegen's, Millman's, Compensation theorem, Substitution theorem	
MODULE 3: Sinusoidal Steady State and Transient Analysis	**12Hrs**
Steady state analysis: Phasor, RLC circuits, complex power Transient Analysis: Time constant, RL circuits with and without source, RC circuits with and without source, AC transients, Series RLC circuits, Laplace Transform Applications	
MODULE 4: Network Parameters	**10Hrs**
Z parameters, Y parameters, H parameters, ABCD parameters, Symmetry and reciprocity, Bartlett bisection theorem, Relation between two port parameters, Interconnection of two port networks	
MODULE 5: Network Filters	**08Hrs**
Filter fundamentals, Pass and stop bands, Characteristic impedance, Constant K- low pass filter, Constant K-high pass filter, Band pass filter, All pass filter	

TEXT BOOKS:

. 1. Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd.,2008.
2. Roy Choudhury, ―Networks and systems , 2nd edition, New Age International Publications, 2006

REFERENCES:

1. Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition., 2007
2. Network Analysis & Synthesis By Franklin S. KUO, Wiley Publication, 2006
3. Boylestad, Robert L. Introductory circuit analysis. Pearson Education India, 2003.

SEMESTER	**III**
YEAR	**II**
COURSE CODE	**19EN0001**

TITLE OF THE COURSE	ENGINEERING ECONOMICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

Study of this subject provides an understanding of:-

- The scope of an entrepreneurship development, key areas of business development, sources of finance, project preparation, methods of taxation and tax benefits
- Significance of economic growth, application of engineering skills in entrepreneurial activities.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.	**3- Apply**
CO2	To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.	**2-Understanding**

COURSE CONTENT:	
MODULE 1: Introduction	**05Hrs**
Micro and Macro Economics, Relationship in Science, Engineering, Technology and Economic Development. Production Possibility Curve, Nature of Economic Laws	
MODULE 2: Time Value of Money	**06Hrs**
Concepts and application. Capital budgeting; Traditional and modern methods, Payback period method, Return on Investment Internal Rate of Return, Equity value analysis, Net Present Value (with the help of case studies)	
MODULE 3: Costing	**06Hrs**
Meaning of Production and factors of production, Law of variable proportions and returns to scale. Internal and external economies and diseconomies of scale. Concepts of cost of production, different types of costs; accounting cost, sunk cost, marginal cost, and	

Opportunity cost. Break even analysis, Make or Buy decision (case study). Relevance of Depreciation towards industry.	
MODULE 4: Market and supply	**04Hrs**
Meaning of market, types of market, perfect competition, Monopoly, Monopolistic, Oligopoly. (Main features). Supply and law of supply, Role of demand and supply in price determination.	
MODULE: Indian Economy	**05Hrs**
Indian Economy, nature and characteristics. Basic concepts; fiscal and monetary policy, Liberalization Privatization Globalization, Inflation, Sensex, General Agreement on Tariffs and Trade, World trade organization and International Money Fund. Difference between Central bank and Commercial banks.	

TEXT BOOKS:

. 1. Jain T.R., Economics for Engineers, VK Publication.
2. Singh Seema, Economics for Engineers, IK International.

REFERENCES:

. 1. Chopra P. N., Principle of Economics, Kalyani .
2. Dewett K. K., Modern economic theory, S. Chand
3. H. L. Ahuja., Modern economic theory, S. Chand.
4. Dutt Rudar & Sundhram K. P. M., Indian Economy
5. Mishra S. K., Modern Micro Economics, Pragati Publications.
6. Pandey I.M., Financial Management; Vikas Publishing House.

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SEMESTER	**III**
YEAR	**II**
COURSE CODE	**19EC2305**
TITLE OF THE COURSE	**SPECIAL INITIATIVES – I**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			-	**4**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- Understand the problem and identify the modules.
- Simulate the identified modules and check for the feasibility.
- Outline the specifications as per the design.
- Build and test the modules and integrate the modules.
- Demonstrate the project work, enhance the communication skills, and report writing.
- Learn the simulation software TINA/PSpice.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Formulate the project problem and identify the feasible modules.	2- **Understanding** 3- **Applying**
CO2	Simulate the modules and test for functionality.	**3-Applying** **4-Analyzing** **5-Evaluating**
CO3	Choose the design specifications and interpret the data sheet by selecting the required components.	**5-Evaluating**
CO4	Develop the prototype of the simulated modules.	**6-Creating**
CO5	Demonstrate and explain the developed project.	**5-Evaluationg**
CO6	Organize the design, specifications with results of the project work in the form of document.	**3-Applying**

COURSE CONTENT:	
List of Minor Projects to be carried out using discrete components and TINA/Pspice	**26Hrs**
1. Capture moister, temperature, fire and earth quake related information using sensors and send alerts using IoT technology.	

2. Real time identification of crops, weeds, diseases and pest damage and nutrient deficiency symptoms.
3. Waste Management.
4. Monitoring of electricity at household level.
5. Developing a Prototype for Smart Traffic Management and Street Light Control System.
6. Developing Self-Powered IOT based Patient Health Monitoring System.
7. Design of ultra-low power circuits for IOT application.
8. Air and Water Quality Care System.
9. Tracking parking designated for employee in an organization.
10. Smart domestic electric energy management system.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19EC2401**					
TITLE OF THE COURSE	**SIGNALS AND SYSTEMS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/II	19EN1101&19EN1201	Engineering Mathematics I and II
2			

COURSE OBJECTIVES:

- Understanding of signals, their classification and signal transformations
- Develop input output relationship for linear shift invariant system and understand the c
- onvolution and correlation operator for continuous and discrete time system
- Knowledge of Fourier Series as an important tool to analyze periodic signals for continuous and discrete time signals
- Knowledge of Fourier Transform and Z -Transform for the frequency domain description of continuous and discrete time signals and systems
- Basics of sampling for discretization of continuous time signal
- Build foundation for advanced courses such as signal processing, control system and communication

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	**Define** and model the continues and discrete time signals	**2 - Understanding**
CO2	**Illustrate** signals in coordinate systems.	**2 - Understanding**
CO3	**Model** the LTI system and study the response to various input signal	**4 - Analysing**
CO4	**Explain** the concept of convolution and correlation.	**2 - Understanding**
CO5	**Apply** the Fourier transform and Z- transform to continuous-time and discrete-time signals for stability analysis	**3 -Applying**
CO6	**Explain** the process of sampling to convert an analog signal into discrete signal and methods of signal reconstruction.	**3-Applying**

COURSE CONTENT:	
MODULE 1: Introduction to signal	**12Hrs**
Continuous and discrete time signals: Classification of Signals – Periodic aperiodic even – odd – energy and power signals – Deterministic and random signals – complex exponential and sinusoidal signals – periodicity – unit impulse – unit step – Transformation of	

independent variable of signals: time scaling, time shifting. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions.
MODULE 2: Introduction to Systems and Behavior of LTI systems **10Hrs**
System properties: linearity: Additivity and Homogeneity, Shift-invariance, Causality, Stability, Realizability. Impulse response and step response, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.
Module 3: Convolution and Correlation Of Signals **08Hrs**
Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Convolution property. Concept of correlation, Cross correlation and Auto correlation of functions, properties of correlation functions, Energy density spectrum, Power density spectrum, Relation between auto correlation function and energy/power spectral density function. Relation between convolution and correlation.
MODULE 4: Fourier and z- Transforms **12Hrs**
Representation of Fourier series for Continuous time periodic signals , Dirichlet's conditions, properties of Fourier series, Exponential Fourier series, Relationship between Exponential Fourier series and trigonometric Fourier series, Complex Fourier spectrum. Fourier transformation of continuous and discrete time signals and their properties.. Parseval's theorem. Basic principles of z-transform - z-transform definition –, Relationship between z-transform and Fourier transform, region of convergence – properties of ROC – Properties of z-transform – Poles and Zeros – inverse z-transform.
MODULE 5: Sampling and Reconstruction **10Hrs**
The Sampling Theorem and its implications. Types of sampling Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Sampling of band pass signals.

TEXT BOOKS:

1. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, ―Signals and Systems Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
2. Simon Haykins and Barry Van Veen, ―Signals and Systems, 2nd Edition,2004

REFERENCES:

. 1. Michael Roberts, ―Fundamentals of Signals & Systems, 2nd edition,Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
2. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, ―Signals and Systems Pearson Education Asia PHI, 2nd edition, 1997. India Reprint 2002.
3. H. P Hsu, R. Ranjan, ―Signals and Systems‖, Scham's outlines, TMH
4. B. P. Lathi, ―Linear Systems and Signals‖, Oxford University Press, 2005.
5. Ganesh Rao and Satish Tunga, ―Signals and Systems, Pearson/SanguineTechnical Publishers, 2004.

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SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19EC2402**					
TITLE OF THE COURSE	**COMPUTER SYSTEM ARCHITECTURE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To make students know about the Parallelism concepts in Programming
- To give the students an elaborate idea about the memory hierarchy.
- To introduce the advanced processor architectures to the students.
- To make the students know about the importance of multiprocessor and multicomputers.
- To study about data flow computer architectures

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Explain** the concept of evolution of computer systems, classification of computers on their ability to perform multiprocessing	**L2-Understanding**
CO2	**Explain** the study of parallel computer architecture various trends towards parallel processing	**L2-Understanding**
CO3	**Analyze** the advanced processor technologies **Categorize** memory organization and explain the function of each element of a memory hierarchy	**L3- Applying** **L4- Analyze**
CO4	**Explain and compare** the architectures of multiprocessors, and multicomputers, and their interconnecting mechanisms	**L4-Analyze**
CO5	**AnAnalyse** different message passing mechanisms Explain how pipelining is implemented in various computer architecture	**L4-Analyze**
CO6	**ExExplain** the advance concepts of improving the performance of multiprocessor by using different techniques	**L2-Understanding** **L3 - Applying**

COURSE CONTENT:	
MODULE 1: Parallel computer models	**10Hrs**
Parallel computer models – Evolution of Computer Architecture, System Attributes to performance, Amdahl's law for a fixed workload. Multiprocessors and Multicomputers, Multivector and SIMD computers, Architectural development tracks, Conditions of parallelism.	

MODULE 2: Processors and memory hierarchy	**12Hrs**
Processors and memory hierarchy – Advanced processor technology- Design Space of processors, Instruction Set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar and vector processors, Memory hierarchy technology	
MODULE 3: Multiprocessors System Interconnects	**12Hrs**
Hierarchical bus systems, Cross bar switch and multiport memory, Multistage and combining networks. Cache Coherence and Synchronization Mechanisms, Cache Coherence Problem, Snoopy Bus Protocol, Directory Based Protocol, Hardware Synchronization Problem	
MODULE 4: Message Passing Mechanisms	**10Hrs**
Message Routing schemes, Flow control Strategies, Multicast Routing Algorithms. Pipelining and Superscalar techniques – Linear Pipeline Processors and Nonlinear pipeline processors	
MODULE 5:	**08Hrs**
Instruction pipeline design, Arithmetic pipeline deign - Super Scalar Pipeline Design Multithreaded and data flow architectures - Latency hiding Techniques, Principles of multithreading – Multithreading Issues and Solutions	

TEXT BOOKS:

. **1.1** K. Hwang and Naresh Jotwani, Advanced Computer Architecture, Parallelism, Scalability, Programmability, TMH, 2010.

REFERENCES:

. 1. H P Hayes, Computer Architecture and Organization, McGraw Hill, 1978.
2. K. Hwang & Briggs , Computer Architecture and Parallel Processing, McGraw Hill International, 1986
3. M J Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House, 2012.
4. M Sasikumar, D Shikkare and P Raviprakash, Introduction to Parallel Processing, PHI, 2014.
5. P M Kogge, The Architecture of Pipelined Computer, McGraw Hill, 1981.
6. P V S Rao , Computer System Architecture, PHI, 2009.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19EC2403**					
TITLE OF THE COURSE	**MICROCONTROLLERS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/II	19EN1103	Computer Programming and Problem Solving
2			

COURSE OBJECTIVES:

- To understand the architecture of microcontroller and the basics of assembly language programming.
- To explore the Programming model, Instruction set and Addressing modes supported by microcontroller.
- To understand Memory Structure related to Program and Data memory.
- To gain knowledge on Parallel and serial data transfer methods.
- To discuss various interrupt handlers and their implementations.
- To understand programming microcontrollers using Embedded C and interfacing logic with various peripherals.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Outline** the architectural details of Microcontrollers and ARM Processor.	**2 - Understanding**
CO2	**Classify** the instruction sets and various addressing modes.	**4 -Analyzing**
CO3	**Understand** the Memory Organization of the PIC Microcontroller	**5 - Evaluating**
CO4	**Interpret** and configure interrupt control logic.	**2 -Understanding**
CO5	**Analyze** the timing diagram for communication Protocol	**4- Analyzing**
CO6	**Demonstrate** interfacing logic for various Sensors and Actuators	**3 -Demonstrate**

COURSE CONTENT:	
MODULE 1: Introduction to Microcontroller	**08Hrs**
Microprocessor and Microcontroller Characterization, Components of a Microcontroller, Microcontroller Architecture. **Main Characteristics of PIC Microcontrollers** - Arithmetic and Logic Unit (ALU), Working Register in PIC Microcontrollers, Machine Cycles and Execution of Instructions,	

Pipelining for Instruction Execution, Oscillators, Configuration Bits, Reset Options, Low-Power Consumption Mode, Watchdog Timer, Program Counter,RISC, Compare Harvard architecture with von Neumann architecture.	
MODULE 2: Memory in Microcontrollers	**08Hrs**
Memory Organization, RAM, Data Memory, EEPROM, Flash Memory. **Instruction Set and Assembler Language Programming** - Arithmetic Instructions, Logic and Compare instructions, Rotate Instruction and Data Serialization, Branch Instructions and Looping, Call Instructions and Stack	
MODULE 3: Programming In C	**08Hrs**
Data Types and Time Delays, bit-addressable I/O, Logic Operations, Data Serialization, ROM & RAM Allocation	
MODULE 4: Timers and Interrupts	**08Hrs**
Instruction Pipeline, Timers, The CCP Module, Interrupt, Examples of Timer and Interrupt Applications. **Parallel and Serial Communication** – Parallel IO, Serial IO, advantages of serial communication over parallel, Streaming Parallel Port, USART, SPI, I2C	
MODULE 5: Sensors and Actuators	**07Hrs**
Interfacing LED, LCD, Keypad, ADC, DAC, Buzzer, Sensor, Relays, Stepper & DC Motor	

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Check Register and Memory with MPLAB IDE
2. Develop and Execute Programs on Arithmetic, Logic & Compare instructions
3. Develop and Execute Programs on Rotate instructions and Data Serialization
4. Develop and Execute Programs on BCD and ASCII code conversion.
5. Develop and Execute Programs on branching instructions and Looping.
6. Develop and Execute Programs on Call instructions and Time Delay.
7. Develop and execute programs on Timers and Counters
8. Develop and execute programs on Different Interrupt handling
9. Develop and execute program on I/O Port programming, Serial & Parallel Communication.
10. Interface ADC & DAC
11. Interfacing Sensors & Actuators

12. Interfacing Motors and speed control using PWM

TEXT BOOKS:

. 1. Fernando E. Valdes-Perez, Ramon Pallas-Areny, "Microcontrollers - Fundamentals and Applications with PIC", CRC Press, 1st Edition, 2009.
2. Mazidi M. A., McKinlay R. D., Causey D., "PIC Microcontroller And Embedded Systems.", Pearson Education International, 2008

REFERENCES:

. 1. Myke Predko, "Programming and Customizing the PIC Microcontroller", Mc Graw Hill Education, 3rd Edition, 2008.
2. John B. Peatman, "Design with PIC Microcontrollers", Prentice Hall, 1997.
3. Verle Milan, "PIC Microcontrollers – Programming in C", Mikroelektronika, 1 st Edition, 2009

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SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19EC2404**					
TITLE OF THE COURSE	**ELECTRO-MAGNETIC FIELD THEORY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields.
- To introduce and analyse the concepts of electrostatics, electric potential, energy density and their applications.
- To understand and apply the concepts of magnetostatics, magnetic flux density, scalar and vector potential to the engineering applications.
- To apply the knowledge of electrostatics and magnetostatics for time varying fields.
- To study uniform plane waves and its characteristic parameters

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Explain** the concept of vector calculus for different co-ordinate systems.	**L3- Applying**
CO2	**Apply** Coulomb's Law and Gauss Law for the **evaluation** of electric fields produced by different charge configurations.	**L4 – Analyze** **L5- Evaluate**
CO3	**Calculate** the energy and potential due to a system of charges. **Discuss** the behavior of electric field across a boundary condition. **Explain** the Poisson's, Laplace equations with applications	**L4- Analyze**
CO4	**Explain and apply** various laws involved in magneto statics	**L3- Applying**
CO5	**SoSolve** Maxwell's equations for time varying electric and magnetic fields	**L3- Applying**
CO6	**ExExplain and analyse** EM wave propagation and its properties.	**L3 - Applying** **L4 – Analyze** **L5- Evaluate**

COURSE CONTENT:	
MODULE 1: Electrostatics -1	**08Hrs**
Introduction: Vector analysis, 3 Coordinate systems; Coulomb's Law and Electric Field Intensity, Electric Field due to line charge, volume Charge and Sheet Charge, Related Problems. Gauss' Law: Electric flux, Electric Flux Density, Gauss' Law, Applications of Gauss' Law , Maxwell's first equation, Introduction to 'del' operator and Divergence Theorem, Related Problems	
MODULE 2: Electrostatics - 2	**08Hrs**
Energy and Potential: Energy and potential in a moving point charge in an Electric Field, Line Integral, Definition of Potential Difference , Potential field of a moving charge , Potential Gradient, conductor properties and boundary conditions, boundary conditions for perfect dielectric materials.	

Poisson's and Laplace's Equations: Poisson's and Laplace's Equations, Uniqueness Theorem, Applications of Laplace's and Poisson's Equations, Related Problems
MODULE 3: The Steady Magnetic Field **08Hrs**
Biot-Savart Law, Applications of Biot-Savart's law, Ampere's Circuital Law, Curl, Stokes' Theorem, Magnetic Flux and Flux Density, Scalar and Vector Magnetic Potentials, Magnetic Boundary Conditions, Energy in Magnetic Field Related Problems
MODULE 4: Time Varying Magnetic Field **08Hrs**
Faraday's Law of e.m.f, Inconsistency of Ampere's law, Displacement Current, Maxwell's Equation in Point and Integral Form of different media, The retarded potential, Boundary Conditions: Dielectric –Dielectric boundary. Related Problems
MODULE 5: Uniform Plane Waves **07Hrs**
Wave propagation in free space and dielectrics, Propagation in Conductors: Skin Effect, The Poynting Vector and Power Considerations, Power loss in plane conductor, Wave Polarization, Reflection of uniform plane waves at normal Incidence, for perfect conductor-dielectric boundary & dielectric-dielectric boundary, Standing Wave Ratio, Introduction to transmission lines and waveguide

List of Laboratory/Practical Experiments activities to be conducted (if any) :
Part-A:Software MATLAB /MATHEMATICA/SONNET/MAGICAD/HFSS
1. Vector addition in 3 dimensional coordinate system:To understand the meaning of vectors, plotting vectors in 2 D and 3 D and rotating them in space.
2. Gradient of scalar field: With positive and negative charges.
3. Divergence of vector:To understand vector with positive and negative divergence.
4. Curl of a vector: To understand curl and rotational field.
5. To study the wave propagation in conductor and dielectrics using HFSS tool.
6. To verify Maxwell's equations
7. Introduction to magnetometer/Gaussmeter

TEXT BOOKS:

. 1. Engineering Electromagnetics-William H. Hayt Jr. and John A. Buck, Tata McGraw Hill, 6th Edition, 2001
2. Electromagnetic Waves and Radiating systems – E. C. Jordan and K.G. Balman, PHI, 2nd Edition.

REFERENCES:

. 1. Field theory –S.P.Basavaraju, Edition 2011

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SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19EN0002**					
TITLE OF THE COURSE	**LAW FOR ENGINEERS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- Apply the knowledge of the constitutional literacy to become aware of the fundamental rights and duties in their role as Engineers
- Understanding of ethical and legal aspects of advertising, consumer problems and their redressal mechanism related to product and service standards.
- Demonstrate an advanced and integrated understanding of the nature and extent of the corporate entity principle and to understand how this principle applies to corporate groups
- Critically evaluate the extent and application of the Corporate Law.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand process of ethical and moral analysis in decision making scenarios and inculcate ethical behavior as a trait for professional development.	**L2-Understanding** **L4- Analyze**
CO2	Apply the knowledge to solve practical problems with regard to personal issues & business enterprises	**L4- Analyze**
CO3	Identify the conflict management in legal perspective and judicial systems pertaining to professional environment; strengthen the ability to contribute to the resolution of human rights & Ragging issues and problems through investigative and analytical skills	**L3- Applying** **L4- Analyze**

COURSE CONTENT:	
MODULE 1: Introduction	**05Hrs**
Introduction to Indian legal system, Review of Constitution of India, Sources of Law and Judicial system. Contracts and its Elements: Employment contracts, Contract Interpretation, service contract, Contract of Indemnity, Law of Agency, Employment Agreement	
MODULE 2: Legal documentation	**06Hrs**

Legal documentation: Drafting of legal documents including Non-Disclosure Agreements (NDA), Request for proposal (RFP), Collaboration Agreement, Joint Venture Agreements, Tendering and sub-contracting.	
MODULE 3: Property Rules, Trademarks & Copy Rights	**06Hrs**
Intellectual Property Rules (IPR) Overview, Trademarks, Copy Rights, Patents with special emphasis in Biotechnology Inventions, Software Circuits and Design, Protection in Foreign Countries	
MODULE 4: Introduction to Labour and Environmental Laws	**04Hrs**
Labour Laws: Provident Fund, ESIC, Gratuity, Bonus, Perquisites, Contract labour, Health, Safety and welfare of construction workers,Introduction to Environmental Law, Concept of Law & Policy , Environment and Governance ,Sustainable Development and Environment , Understanding Climate Change and its processes – CDP, CDMs and Carbon Off Setting, Overview of International Environmental Laws, Introduction to Environment and IPR	
MODULE 5: Cyber Laws & Taxation	**05Hrs**
Cyber Laws, E-Commerce and E-Governance, Taxation: Income Tax, Service Tax, VAT, Excise Duty, RTI Act.	

TEXT BOOKS:

. 1. V.S. Datey, Indirect Taxes: Law and Practice, Taxmann Publications (P) Ltd, Latest Edition Publications (P) Ltd, latest Edition.
2. S.C. Srivastava, Industrial Relations and Labour Laws, Vikas Publishing House Pvt. Ltd.
3. Joseph Minatiur, Indian Legal System, Indian Law Institute, New Delhi.

REFERENCES:

. 1. Kamith Seth, Computer Internet and New Technology Laws, LexisNexis, First Edition 2013.
2. Prafulla C Pant, The Arbitration and Conciliations Act, 1996, ButterworthsIndia, New Delhi.
3. J. Beatson, Anson's Law of Contract, Oxford University Press.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19EC2405**					
TITLE OF THE COURSE	**SPECIAL INITIATIVES – II**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**4**	**26**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- Understand the problem and identify the modules.
- Simulate the identified modules and check for the feasibility.
- Outline the specifications as per the design.
- Build and test the modules and integrate the modules.
- Demonstrate the project work, enhance the communication skills, and report writing.
- Learn the simulation software TINA/PSpice

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Formulate the project problem and identify the feasible modules.	**2-Understanding** **3-Applying**
CO2	Simulate the modules and test for functionality.	**3-Applying** **4-Analyzing** **5-Evaluating**
CO3	Choose the design specifications and interpret the data sheet by selecting the required components.	**5-Evaluating**
CO4	Develop the prototype of the simulated modules.	**6-Creating**
CO5	Demonstrate and explain the developed project.	**5-Evaluationg**
CO6	Organize the design, specifications with results of the project work in the form of document.	**3-Applying**

COURSE CONTENT:	
List of Minor Projects to be carried out using discrete components and TINA/Pspice	**26Hrs**
1. Capture moister, temperature, fire and earth quake related information using sensors and send alerts using IoT technology. 2. Real time identification of crops, weeds, diseases and pest damage and nutrient deficiency symptoms. 3. Waste Management. 4. Monitoring of electricity at household level.	

5. Developing a Prototype for Smart Traffic Management and Street Light Control System.
6. Developing Self-Powered IOT based Patient Health Monitoring System.
7. Design of ultra-low power circuits for IOT application.
8. Air and Water Quality Care System.
9. Tracking parking designated for employee in an organization.
10. Smart domestic electric energy management system.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19EC3501**					
TITLE OF THE COURSE	**ANALOG AND DIGITAL COMMUNICATION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV	19EC2404	ELECTROMAGNATIC WAVES
2			

COURSE OBJECTIVES:

- To study the basic concepts of Analog and Digital communication systems.
- To compare the various modulation and demodulation techniques.
- To understand the trans receiver design and the effect of noise in communication system.
- To understand the process of digitization through Sampling and Quantization.
- To determine the performance of line codes and methods to reduce inter symbol interference.
- To interpret the detection process using analytical methods.
- To compute the probability of error of digital communication systems.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	**Explain** the basic elements of a communication system.	**2 - Explain**
CO2	**Analyse** baseband signals in time domain and frequency domain.	**4 - Analyse**
CO3	**Interpret** the various modulation and demodulation techniques.	**2 - Interpret**
CO4	**Analyse** the behavior of a communication system in presence of noise.	**4 - Analyse**
CO5	**Estimate** the performance of a communication system using analytical methods.	**5 - Estimate**
CO6	**Determine** the probability of error analysis for different modulation techniques.	**5 - Determine**

COURSE CONTENT:	
MODULE 1: Introduction to Communication System	**08Hrs**
INTRODUCTION and AMPLITUDE MODULATION - Elements of Communication System, Need of Modulation, Applications, Time and Frequency Domain Representation of AM, Modulation Index and Transmission Power Calculation, DSB-SC, SSB, VSB. Generation of AM waves-square law Modulator, Principle of Detection of AM Wave-envelope detector. Generation of DSBSC Waves, Balanced Modulators, Coherent detection of DSB-SC Modulated waves. Phase discrimination method for generating AM SSB Modulated waves. Demodulation of SSB Waves using Coherent detection, Frequency Division Multiplexing.	
MODULE 2: Angle Modulation and Noise	**08Hrs**
ANGLE MODULATION - Time and Frequency Domain Representation, FM, NBFM, WBFM and PM, Modulation Index of FM and PM, Transmission bandwidth of FM waves, Relation between FM and PM. Generation of FM waves: Indirect FM, Direct FM. Demodulation of FM waves: Balanced frequency discriminator, Zero-crossing detector. TRANSMITTER, RECEIVER AND NOISE –AM Transmitter, FM Transmitter, Tuned radio frequency receiver, Superheterodyne receiver, Comparison of FM receiver with AM Receiver, Source of noise, Noise in AM using envelop detector, Noise in FM, Pre-emphasis & de-emphasis in FM.	
MODULE 3: SAMPLING AND QUANTIZATION	**08Hrs**
SAMPLING PROCESS - Block diagram of Digital communication system, Sampling process, Sampling theorem, quadrature sampling of bandpass signals, multirate sampling, sampling rate conversion, Signal distortion in sampling, Practical aspects of sampling and signal recovery. QUANTIZATION - Quantization & Coding, Quantization error, Companding in PCM systems, Differential PCM system, Delta modulation (DM) and its drawbacks, adaptive delta modulation.	
MODULE 4: Baseband data transmission	**08Hrs**
BASEBAND SHAPING FOR DATA TRANSMISSION - Line Coding, Characteristics of Line coding, Discrete PAM signals, Power spectra of discrete PAM signals, Inter symbol Interference, Nyquist criterion for distortion less baseband binary transmission, Correlative coding, Eye pattern. DETECTION OF SIGNALS - Orthogonal signals, Geometric interpretation of signals, Correlation receiver, Matched filter, Properties of matched filter, ML detector.	
MODULE 5: Pass Band Modulation Techniques	**07Hrs**
PASS BAND MODULATION AND DEMODULATION -Coherent modulation techniques-ASK, FSK, PSK, QPSK, signal representation, Generation and detection, deriving probability of error for coherent ASK, FSK, PSK, QPSK, Non coherent binary modulation techniques.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
PART-A List of Experiments using MATLAB
1. Design and testing of AM modulator and demodulator circuit and analysis spectrum using spectrum analyser
2. Design and testing FM modulator and demodulator circuit and analysis spectrum using spectrum analyser
3. Design and testing DSBSC modulator and demodulator circuit.
4. Spectrum analysis of modulated signal using spectrum analyse
5. To study and observe the effect on input signal using pre-emphasis and de-emphasis circuit.
6. Verification of sampling theorem, demonstrate over sampling and under sampling.
7. To study the Pulse Amplitude Modulation & demodulation.
8. To study Pulse width modulation, Pulse Position modulation and demodulation.
9. To study Phase lock loop(PLL) and calculate its capture range, lock range and free running VCO.
10. To analyse a ASK & FSK modulation systems and interpret the modulated & demodulated waveform
11. Using Linear block codes-the error received through a noisy channel can be removed/minimized by error detection and correction code.
12. To study Cyclic encoding & decoding of BCD bit sequence and error detection & correction of bits' sequence.
13. To employ one of the convolution codes and observe its error correcting performance and decode-ability.
14. Verify the Encoding and Decoding process of Delta Modulator
15. To implement of μ-law companding and A-law companding for compression and expanding of a signal.

TEXT BOOKS:

. 1. Simon Haykin, Michael Moher " Introduction to analog and Digital communication 4th edition, John and Wiley & Sons

REFERENCES:

1. Principles of Communication Systems–Taub & Schilling, Gautam Sahe, TMH, 3rdEd
2. Communication Systems Second Edition – R.P. Singh, SP Sapre, TMH, 2007.
3. Modern Analog and Digital Communication Systems, 3rd Edition, Oxford University – B.P. Lathi,
4. Electronics & Communication System – George Kennedy and Bernard Davis, TMH

SEMESTER	V

YEAR	**III**					
COURSE CODE	**19EC3502**					
TITLE OF THE COURSE	**PROBABILITY THEORY AND STOCHASTIC PROCESSES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**		**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

- Understand probability, random variable and random process concepts and their importance in Electronics and Communication Engineering.
- Calculate statistics related to Random variables and operation such as mean, variance etc.
- Evaluate standard distribution functions highlighting the application scenarios.
- Discuss inequality bounds considering the importance of moment generating function.
- Extend the various operations to multiple random variables and apply them to analyse practical problems.
- Explain the concept of random process and its classifications.

COURSE OUTCOMES:

	Outcomes	**Blooms Taxonomy Level**
CO1	Understand basics of probability through set theory, the axiom formulation and the need of random variables for the analysis of random phenomena.	**2 - Understand**
CO2	Characterize the standard distributions and demonstrate various operations performed on the random variable.	**2–Demonstrate**
CO3	Compare the various inequality bounds and probabilistic limits.	**2–Compare**
CO4	Evaluate and Apply moments & characteristic functions for single and multiples random variables.	**3–Apply**
CO5	Outline the importance of Central limit theorem and the concepts of random processes.	**2- Outline**
CO6	Simplify the complex operations by approximating to standard distributions and theorems for estimating the probable value.	**5 - Estimate**

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COURSE CONTENT:

MODULE 1: Probability Theory and Density Functions	**10Hrs**
Probability introduced through Sets and Relative Frequency: Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability Definitions and Axioms, Mathematical Model of Experiments, Probability as a Relative Frequency, Joint Probability, Conditional Probability, Total Probability, Bayes' Theorem and Independent Events, Engineering application- probability of error in optical communication system.	
MODULE 2: Random Variables	**10Hrs**
Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete and Continuous random variables, Mixed Random Variable, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, distributions, Conditional Distribution and density functions, properties. Engineering application- study of system reliability and failure rates.	
MODULE 3: Operations on Single Random Variable	**10Hrs**
Functions of a Random Variable, Expected Value of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Markov Inequality, Chebychev's Inequality, Chernoff Inequality, Characteristic Function, Moment Generating Function. Engineering application- scalar quantization, Entropy and source coding.	
MODULE 4: Multiple Random Variables	**12Hrs**
Introduction, Vector Random variables, Joint Distribution and its properties, Marginal Distribution Functions, Joint density and its properties, Conditional Distribution and Density, Statistical independence, Sum of Two Random Variables, Sum of Several Random Variables Central limit theorem, Operations on multiple random variables-Expected Value of a Function of Random Variables: Joint Moments about the Origin, Joint Central Moments. Engineering application- concept of mutual information, channel capacity and channel coding in a digital communication system.	
MODULE 5: Random Processes	**10Hrs**
Random process concepts, Classification of Random process, Deterministic and Nondeterministic Processes, concept of Stationary and Statistical Independence. First-Order Stationary Processes, Second- Order Wide-Sense Stationary, (N-Order) and Strict-Sense Stationary, AutoCorrelation, Cross correlation and Covariance Functions, Gaussian Random process, Time Averages and Ergodicity, Random signal response of linear systems, noise in an amplitude modulation communication system, noise in a simple control system.	

TEXT BOOKS:

1. Probability, Random Variables & Random Signal Principles - Peyton Z. Peebles, TMH, 4th Edition, 2001.
2. Probability and Random Processes- Scott Miller and Donald Childers, AP, 2nd Edition, 2012.

REFERENCES:

. 1. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S. Unni krishna Pillai, PHI, 4th Edition, 2002.
2. Probability and Random Processes with Application to Signal Processing – Henry Stark and John W. Woods, Pearson Education, 3rd Edition.
3. Probability Methods of Signal and System Analysis. George R. Cooper, Clave D. MC Gillem, Oxford, 3rd Edition, 1999.
4. Statistical Theory of Communication - S.P. Eugene Xavier, New Age Publications.

SEMESTER	**V**
YEAR	**III**

COURSE CODE	19EC3503					
TITLE OF THE COURSE	CMOS VLSI DESIGN					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		2	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	III	19EC2302	ANALOG CIRCUITS
2			

COURSE OBJECTIVES:

- Study the IC Fabrication process and to define the rules governing the process
- Analyze MOS device properties and short channel effects.
- Illustrate stick diagrams, layouts for various CMOS circuits and other MOS logic structures.
- Analyse Sequential MOS logic structures.
- Study advanced VLSI Circuits.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Understand** the basic Physics and Modelling of MOSFETs.	**2 - Understand**
CO2	Learn the basics of Fabrication and Layout of CMOS Integrated Circuits	**2 - Understand**
CO3	**Illustrate** stick diagrams, layouts for various CMOS circuits and other MOS logic structures.	**2 - Understand**
CO4	**Analyse** Sequential MOS logic structures	**4 - Analyze**
CO5	**Demonstration** of DC, AC and transient responses of the CMOS logic gates.	**4 - Analyze**

COURSE CONTENT:	
MODULE 1: CMOS Technologies	**08Hrs**
Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO2), Isolation, Gate Oxide, Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Metrology MOS layers, Stick diagrams- NMOS and CMOS Design Rules and Layout, Fabrication-NWELL, PWELL, Twin-Tub, BiCMOS. Scaling Of MOS Circuits: Scaling models and factors.	

MODULE 2: MOS Transistor	**08Hrs**
Introduction, Ideal I-V characteristics, C-V Characteristics, Simple MOS Capacitance Models, MOS Device Parameters, Detailed MOS Gate Capacitance Model, Non-ideal I-V Effects, Mobility Degradation and Velocity Saturation, Channel Length Modulation, Threshold Voltage Effects, Junction Leakage, Body effect, Tunneling, CMOS Inverter, DC Characteristics, Transient Response, Beta Ratio Effect, Noise Margin. NAND NOR DC characteristics, Inverter Switching Characteristics	
MODULE 3: Combinational Circuit Design	**08Hrs**
Introduction: CMOS Logic, Inverter, NAND Gate, NOR Gate, Combinational Logic, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers. Circuit Families, Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Complementary Pass-Transistor Logic Circuits, BICMOS Circuits	
MODULE 4: Sequential Circuit Design	**08Hrs**
Behavior of Bistable Elements, SR Latch Circuit, Clocked Latch Flip-Flop Circuits, CMOS D-latch and Edge Triggered Flipflop, Semiconductor Memories,DRAM Cells -1T, 2T, 3T, 4T, 6T, SRAM-Resistive Load, Depletion Load	
MODULE 5: Advances in VLSI Design	**07Hrs**
Introduction to FINFET, Memristors	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
Schematic Entry, Simulation, DC, AC, Transient Analysis, Layout Design, DRC, LVS and QRC extraction, and verification using post layout simulation of
a. All Basic logic gates using various circuit families
b. Flip flops using MOS
c. Simple memory design.

TEXT BOOKS:

. 1. CMOS VLSI Design, Neil H.E. Weste, David Harris, Ayan Banerjee, 3rd Edition, 2006, Pearson Education, ISBN: 0321149017.
2. CMOS Digital Integrated Circuits, Sung MO Kang, Yousf Leblebici, 3rd Edition, Tata McGrawHill, ISBN: 0-7923-7246-8.

REFERENCES:

SEMESTER	**V**
YEAR	**III**
COURSE CODE	**19EC3504**

TITLE OF THE COURSE	DIGITAL SIGNAL PROCESSING					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV	19EC2401	SIGNAL AND SYSTEM
2			

COURSE OBJECTIVES:

- Familiarize with the behavior of a system in terms of both its time domain and frequency domain representations.
- Understand the importance of FFT algorithms.
- Identify the correct type of filter required for a given problem and be able to demonstrate the design and implementation of such a digital filter.
- Explain the concept of aliasing and its effect on the design and use of practical systems.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Apply** transform methods to analyze the analog and digital linear time-invariant systems.	**3-Applying**
CO2	Convert between time and frequency domain representations of signals and systems.	**3-Applying**
CO3	**Infer** the practical aspects of sampling, reconstruction and select a suitable sampling rate for a given signal processing problem.	**2- Understanding**
CO4	**Analyze** and design analog and digital filters for a given Specification.	**4- Analyzing**
CO5	Interpret and demonstrate the applications of the discrete Fourier transform and implement the digital filters.	**2- Understanding 5-Evaluating**

COURSE CONTENT:	
MODULE 1: Discrete Fourier Transforms (Dft)	**08Hrs**
Frequency domain sampling and reconstruction of discrete time signals. DFT as a linear transformation, its relationship with other transforms. Properties of DFT, multiplication of two DFTs- the circular convolution, additional DFT properties.	
MODULE: FFT Algorithms	**08Hrs**
Use of DFT in linear filtering, overlap-save and overlap-add method. Direct computation of	

DFT, need for efficient computation of the DFT (FFT algorithms) Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and decimation-in-frequency algorithms. Goertzel algorithm, and chirp-z transform.
MODULE 3: IIR Filter Design **08Hrs**
Characteristics of commonly used analog filters –Butterworth and Chebysheve filters, analog to analog frequency transformations. Design of digital IIR filters from analog filters (Butterworth and Chebyshev) - impulse invariance method. Mapping of transfer functions: Approximation of derivative (backward difference and bilinear transformation) method, Matched z transforms
MODULE 4: FIR Filter Design **08Hrs**
Introduction to FIR filters, design of FIR filters using - Rectangular, Hamming, Bartlet and Kaiser Windows, FIR filter design using frequency sampling technique.
MODULE 5: Digital Signal Processor **07Hrs**
Elementary idea about the architecture and important instruction sets of TMS320C 6XXX processor, writing of small programs in Assembly Language.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
PART-A List of Experiments using MATLAB
16. MATLAB program for Linear Convolution of two right sided and two sided sequences.[(i) standard equation (ii) DFT & IDFT]
17. MATLAB program for Verification of sampling theorem for Sine & Cosine at different frequencies.
18. MATLAB program for Impulse response of a given system.
19. MATLAB program for Computation of N-point DFT of a given sequence and to get magnitude & phase spectrum.
20. MATLAB program for Circular Convolution of two given sequences using (i) standard equation (ii) DFT & IDFT
21. MATLAB program for DFT computation using FFT function for sine and cosine sequence.
22. MATLAB program to solve a given difference equation with and without initial condition.
23. MATLAB program for verification of Autocorrelation and Cross-correlation of a given sequence.
24. MATLAB program to design FIR low pass, high pass, band pass and band stop filter using Rectangular and Hamming window.

25. MATLAB program to design Butterworth IIR low pass, high pass, band pass and band stop filter.
PART-B List of Experiments using DSP Processor
26. Linear and circular convolution of two given sequences.
27. Computation of N-point DFT of a given sequence.
28. Realization of an FIR filters to meet given specification.
29. Impulse response of first order and second order system.
30. Audio application such as to plot a time and frequency display of a Microphone plus a cosine using DSP.

TEXT BOOKS:

. 1. Digital signal processing – Principles Algorithms &Applications, Proakis & Monalakis, Pearson education, 4th Edition, New Delhi, 2007.
2. Digital Signal processing – A Computer Based Approach, S. K. Mitra, TMH Publishing Co.
3. Digital Signal Processing Signals using MATLAB, Vinay K. Ingle, III edition, Cengage Learning

REFERENCES:

4. Digital Signal Processing, P. Rameshbabu, Scitech Publications (India).
5. Digital Signal Processing, S.Salivahanan, A.Vallabraj & C. Gnanapriya, TMH Publishing Co.
6. Digital Signal Processing; A Hands on Approach, C. Schuler & M.Chugani, TMH Publishing Co.
7. Texas Instruments DSP Processor user manuals and application notes

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19 EC3506**					
TITLE OF THE COURSE	**INFORMATION THEORY & ERROR CONTROL CODING**					
	Lecture	Tutorial	Practical	Seminar/Projects	Total	Credits

SCHEME OF Instruction	Hours	Hours	Hours	Hours	Hours	
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- Understand the performance characteristics of an ideal and noisy communication system.
- Interpret the encoding and decoding concepts
- Analyze the performance of discrete communication channels and measure the rate of information transmission and channel capacity of discrete channel.
- Apply suitable coding /decoding schemefor digital communication applications.
- Understand the concept of error control coding.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Examine** information sources and channels based on their statistical properties.	**4- Analyze**
CO2	**Apply** Shannon's theorems in information transmission systems	**3-Apply**
CO3	**Demonstrate** applications of source coding and error coding techniques in selected fields of information and communication technology (ICT).	**2-Demonstrate**
CO4	**Design** source coding and error coding techniques to suit prescribed requirements.	**6- Creating**
CO5	Evaluate the performance of various coding techniques over noisy communication channels.	**5-Evaluate**

COURSE CONTENT:	
MODULE 1: Information Theory	**08Hrs**
Introduction, Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Mark-off statistical model for information source, Entropy and information rate	

of mark-off source.	
MODULE 2: Source Coding	**08Hrs**
Encoding of the source output, properties of codes, Kraft inequality, construction of instantaneous codes, code efficiency and redundancy, Shannon's encoding algorithm, Shannon-Fano Coding, Huffman minimum redundancy code, Extended Huffman coding, Arithmetic Coding.	
MODULE 3: Information Channels	**08Hrs**
Communication Channels: Channel Models, Channel Matrix, Joint probability Matrix, System Entropies, Mutual Information, Properties of Mutual information, Channel Capacity, Special Channels, Channel Capacity of: Binary Symmetric Channel, Binary Erasure Channel, Muroga,s Theorem, Continuous Channels: Maximization of entropy Mutual information of continuous noisy channels, Shannon-Hartley law and its implications Joint and Conditional Entropies, Shannon Limit.	
	08Hrs
Introduction, Examples of error control coding, Methods of controlling errors, types of codes, types of errors, Linear block codes matrix description of, minimum distance consideration Error detection and correction capabilities, single error correcting Block codes, single error correcting Hamming codes Table lookup for decoding using Standard array.	
Module: Types of coding	**07Hrs**
Binary cyclic codes Algebraic structure of cyclic codes Encoding using (n-k) bit shift register Syndrome calculation, Error detection and correction Convolution Codes, Time domain approach. Transform domain approach, State Diagram, tree diagram, Trellis diagram. Encoders and Decoders using Viterbi's algorithm for (n,k,l) convolutional codes	

TEXT BOOKS:	
.	1. Digital and analog communication systems, K.SamShanmugam, JohnWiley India Pvt. Ltd,20011 2. Digital Communication, Simon Haykin, John Wiley India Pvt. Ltd,2012. 3. Information Theory and Coding, Muralidhar Kulkarni, K.S. Shivaprakasha, Wiley India Pvt. Ltd, 2015, ISBN:978-81-265-5305-1.

REFERENCES:

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1. ITC and Cryptography, Ranjan Bose, TMH, 2 ndedition,2012
2. Digital Communications - Glover and Grant; Pearson Ed. 2nd edition2010.
3. Digital Communications: Fundamentals & Applications, 2nd edition, Sklar, Pearson Education India.
4. Error Control Coding-Fundamentals & Applications, Shulin, Daniel J. Costello, 2ndEdition, Prentice Hall Inc. Eagle wood Cliffs.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19EC3507**					
TITLE OF THE COURSE	**MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To introduce the fundamental concept of MEMS & Microsystem and their relevance to current industry/scientific needs
- To introduce and demonstrate processes which are used in MEMS fabrication
- To apply basic sensing principles of chemical/biological systems to develop novel sensors
- To discuss the limitations and challenges in the design and fabrication of micro sensors, sensing modalities to build the desired microsystem
- To introduce students to apply general micromachining principles to build novel devices.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to know about the basics of MEMS	**4-Analyze** 1-**Remembering**
CO2	Explain about various materials and technology of MEMS	**1-Remembering** 2- **Understand**
CO3	Study about micromachining processing and fabrication techniques	**2-Understand** **3-Apply**
CO4	Explore about MEMS sensors and MEMS novel devices	**1-Remembering** **2-Understand**
CO5	Identify problems and suggest suitable MEMS material/ Devices/Process to get the Requisite Solution for a given application.	**3-Apply** **4-Analyze**
CO6	Apply advanced MEMS techniques to solve future engineering problems	**5-Evaluate** **6-Create**

COURSE CONTENT:	
MODULE 1: Definition	**08Hrs**
Development- fundamentals of MEMS, Micro fluidics, microelectronics, micro systems- design and fabrication, working principles and applications. Integrated circuit processes, potential of MEMS in industry.	
MODULE 2:	**07Hrs**
Materials substrates and wafers, silicon substrate- properties of silicon, silicon compounds, silicon piezo resistors. Galium Arsenide, quartz, polymer for MEMS, conductive polymer. Shape memory alloys	

MODULE 3:	08Hrs
Photolithography, photo resist applications, light sources, X-ray lithography, electron beam lithography, ion implantation, thin film deposition, diffusion process, Chemical and physical vapour deposition, bulk and surface machining, LIGA, DRIE, RIE, laser ablation process, Micro sterio lithography for 3D fabrication and nanolithography.	
MODULE 4:	**08Hrs**
Micro sensors, classification of physical sensors, integrated, intelligent or smart sensors, sensors principle, thermal sensors, electrical sensors, mechanical sensors, chemical and biosensors.	
MODULE 5:	**08Hrs**
Electromagnetic and thermal micro actuation, mechanical design of micro actuators, micro actuator, micro valves, micro pumps, micro motors. Micro actuator systems: Ink jet printers, micro-mirror TV projectors. Micro-opto-electromechanical systems, metal oxide semiconductor field effect transistor, multi-disciplinary applications.	

TEXT BOOKS:

. 1. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata McGraw Hill, New Delhi, 2002.
2. Nitaigour Premchand Mahalik, Micro Electro Mechanical Systems, Tata McGraw Hill, New Delhi, 2007.
3. Mohamed Gad-El-Hak, The Micro Electro Mechanical SystemsHandbook, CRC Press, New York, 2002.

REFERENCES:

. 1. Kalpakjian, Manufacturing Engineering and Technology, 4'edition, Addison Wesley Congmen Pvt. Ltd., Singapore, 2009.
2. Mark Madou, Fundamentald of Microfabrication, CRC Press, New York, 1997. Maluf.N, An Introduction to Microelectro mechanical Sytems Engineering, Artech House, Boston, 2000.
3. Rai Choudhury, Micro Electro Mechanical Systems and _ Micro-opto-electromechanical systems Technology and Applications, PHI Learning, 2009.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19EC3508**					
TITLE OF THE COURSE	**C PROGRAMMING FOR EMBEDDED SYSTEMS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- Setting the required background in embedded system concepts
- Understanding the C Programming Language in the context of embedded systems
- Familiarizing the students in advanced topics in 'C' such as Memory management, Pointers, Data structures which are of high relevance in embedded software is considered in depth.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To understand the technologies and development platforms behind the embedded systems.	**Understand - 2**
CO2	To define and manage Data structures, Functions and Operators based on problem subject domain.	**Remember - 1**
CO3	To apply the method of writing program using Interrupts	**Apply - 3**
CO4	To construct the program logic using the Arrays, Strings, Pointers and Structures.	**Apply -3**
CO5	To understand various debugging techniques required during embedded software development	**Evaluate - 4**
CO6	To understand the technologies and development platforms behind the embedded systems.	**Understand - 2**

COURSE CONTENT:	
MODULE 1: Introduction	**08Hrs**
Introduction to the embedded target for the course, various constraints in an embedded device. Your First Embedded Program , The role of Infinite Loop, Build Process : Scatter File(loader/linker script), Scatter File to ElF mapping, make file, using standard and external libraries.	
MODULE 2: Embedded C basics	**08Hrs**
Type Qualifiers: Volatile, Static(how it is compiled??), little endian and big endian, Macros, bitwise operations: set, clear, creating masks, Structure padding, packing & bit fields, Union, size of structures and unions, stack(main stack, ISR stack, thread stack), malloc/memory management using memory pools, thread management: creation, priority, watchdog and idle thread, Pointer to pointer, function pointers, dynamic memory allocation, memory leakage.	
Module 3: Interrupts	**08Hrs**

Interrupts: Interrupt Vector Table, FIQ, IRQ, Exceptions, watchdog, Reset Interrupt handling, Nesting of Interrupts, context switching(thread to thread, thread to interrupt, interrupt to interrupt: (IRQ to FIQ, IRQ-IRQ), interrupt to exception.	
MODULE 4: Optimization and Pre-Processor directives in C	**08Hrs**
Optimization: Increasing Code Efficiency, Decreasing Code Size, Reducing Memory Usage, Compiler Optimization and Flags. Pre-Processor directives: File Inclusion, Conditional Compilation, #error & #pragma directive.	
MODULE 5: Debugging Techniques	**07Hrs**
During development GDB, Runtime debugging: register dumps, persistent data, stack dump, types of error: stack corruption (magic words on stack boundaries, check stack on thread switching)	

TEXT BOOKS:

1. Programming Embedded Systems in C and C++, Micheal Barr

REFERENCES:

. 1. Programming With STM32 Getting Started with the Nucleo Board and CC++, Donald Norris.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19EC3509**					
TITLE OF THE COURSE	**PLC and SCADA**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To understand basic concept of PLC and to describe the hardware components, program scan sequence, the communication of information to the PLC using different languages, internal relay instruction, writing and entering the ladder logic programs.
- To impart knowledge about the working of timers, counters, sequencers, describe the function of selectable timed interrupt, define the functions of Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits and Latching Relays and fault routine files and use of temporary end instruction and the about PLC program flow instructions.
- To Understand the basic concepts and overview of applications of PLC, SCADA and DCS Systems and their interfacing. To understand the basic concept of Industry 4.0
- To develop an Industrial Automation applications using PLC and understand how Internet of Things plays major role in various process in industrial Setup.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Understand** the basic concepts of PLC's and SCADA techniques.	**2-Understand**
CO2	**Apply** the programming concepts to interface peripheral and to **Analyze** and evaluate the automation techniques for industrial applications	**3-Apply** **4-Analyze**
CO3	Describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.	**2-Understand** **6-Create**
CO4	Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module.	**2-Understand**
CO5	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals.	**2-Understand**

COURSE CONTENT:	
MODULE 1: Introduction	**08Hrs**
Definition of Automation, Types &Application of Automation to Industry processors, Basic Concepts of PLC, PLC in industry, Components, I/O Configuration, Introduction to PLC operation, Binary Data Representation, The input and output status files, Sixteen point I/O modules. PLC Hardware:	

Input modules: Discrete input modules, Discrete AC and DC input & Output Modules: Discrete & solid-state output module switching, relay output modules. PLC memory.	
MODULE 2: Basics of PLC Programming	**08Hrs**
Processor memory organization, The Program Scan, PLC Programming languages, Bit or Relay Instruction, OSR Instruction, Output latching instructions, Negated output Instruction, Internal Bit type Instruction, Modes of PLC operation interfacing start/stop Push button switch and Motor to PLC. Special programming Instructions: Timer and Counter Instructions: On delay and off delay and retentive timer instructions, PLC Counter up and down instructions, combining counters and timers.	
MODULE 3: Special programming Instructions	**08Hrs**
Timer and Counter Instructions: On delay and Off delay and retentive timer instructions, PLC Counter up and down instructions, combining counters and timers. Program Control &Data manipulation Instructions: Data handling instructions, Sequencer instructions, Programming sequence output instructions.	
MODULE 4: Case Studies	**08Hrs**
Temperature control, Valve Sequencing, Conveyor Belt control, Control of a Process, Material Sorting, and Elevator System Problems **SCADA & DCS**: Introduction to Supervisory Control and Data Acquisition (SCADA), SCADA Hardware and Software, Introduction to Distributed control system (DCS), DCS Software.	
MODULE 5: Introduction: Fundamentals of IIOT	**07Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	

TEXT BOOKS:

. 1. Garry Dunning, "Introduction to Programmable Logic Controllers", CENGAGE Learning, 3rd edition, 2006. ISBN- 9-781-4018-8426-0
2. Bolton W., "Industrial Control and Instrumentation", Universities Press, 4th Edition, 2006. ISBN9-780-7506-8112-4.

REFERENCES:

. 1. Krishna Kant, "Computer Based Industrial control", PHI Publishers, 2nd Edition, 2006. ISBN-9-788-1203-3994-1
2. John W. Webb. Ronald A Reis "Programmable logic controllers" PHI Publishers,5ndEdition,2007, ISBN 9-788-1203-2308-7
3. Industry 4.0 the industrial Internet of Things , Alasdair Gilchrist, 1stedition, Apress Publisher,2017,ISBN-13: 978-1-4842-2046-7

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SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3601**					
TITLE OF THE COURSE	**RF AND MICROWAVE COMMUNICATION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1	IV	19EC2404	ELECTROMAGNATIC WAVES
2			

COURSE OBJECTIVES:

- To familiarize students with the importance of Microwaves in the present scenario.
- To use the concept of Electromagnetic field theory and network analysis to analyze the microwave transmission line and waveguides.
- To make the students learn about microwave passive and active devices, SWR and Impedance Matching
- To design an impedance matching circuit at microwave frequency using transmission lines.
- Make the students to know S-matrix and S-parameters
- To familiarize students with the various network parameters and analyze microwave networks

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Explain** different types of waveguides and their respective modes of propagation.	**2-Understanding**
CO2	**Analyze** typical microwave networks using impedance, admittance, transmission and scattering matrix representations.	**4-Analayze**
CO3	**Design** microwave matching networks using L section, single and double stub and quarter wave transformer.	**6-Create**
CO4	**Explain** working of microwave passive circuits such as isolator, circulator, Directional couplers, attenuators etc.	**2-Understanding**
CO5	Describe and **explain** working of microwave tubes and solid-state devices.	**2-Understanding**
CO6	Perform measurements on microwave devices and networks using power meter and VNA	**6-Create**
CO7	Explain the basics of RF and RF mixers.	**2-Understanding**

COURSE CONTENT:	
MODULE 1: Introduction to Rf And Transmission Line Theory	**08Hrs**
Microwave frequencies, Microwave devices and Microwave Systems, Transmission Line Equations and Solutions, Reflection Co-efficient and Transmission Co-efficient, standing wave and standing-wave ratio, Line Impedance and Admittance, Smith Chart and Impedance Matching	
MODULE 2: Planar Transmission Lines	**07Hrs**

Planer transmission lines such as strip line, micro-strip line, slot line and coplanar waveguides. Characteristics of planar transmission lines. Losses in Micro-strip Lines- Quality Factor Q of Micro-strip Lines: - Properties of materials (Substrate, Conductor, Dielectric and Resistive). Introduction to MIC's:-Technology of hybrid MICs, monolithic MICs, comparison of both MICs.	
MODULE 3: Microwave Network Characterization And Passive Devices	**08Hrs**
The scattering Matrix – Reciprocity Theorem- Lossless networks and unitary conditions- ABCD parameters- Cascaded networks-Relations between S- Y and ABCD parameters. Properties and s-matrices for typical network such as section of uniform transmission line, 3-port networks (reciprocal and nonreciprocal), T-junctions directional coupler, magic tee, ferrite devices, isolator, circulators.	
MODULE 4: Microwave Devices	**08Hrs**
Klystron, Multicavity Klystron, Reflex klystron, velocity modulation, transit time, density modulation, beam spreading/ debunching, power output and efficiency, Travelling Wave Tube, Magnetron. Gunn diode and its applications, PIN diode, schottky barrier diodes. (For all the devices: only constructions, operation, definition with explanation and end equations are included. Derivations are excluded).	
MODULE 5: Rf/Microwave Circuits And Measurements	**08Hrs**
A brief overview of microwave circuits like LNAs, RF mixers. Introduction, tunable detector, Slotted line carriage, VSWR meter, Spectrum Analyzer, Power Measurements, Insertion loss and attenuation measurements, VSWR Measurements, Return loss measurements by reflectometer, Impedance measurement, frequency measurements.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Study of Reflex Klystron Oscillator Mode Characteristics / Gunn diode characteristics.
2. Study of Circulator/Isolator. Extraction of S-Parameters. (Waveguide/stripline component)
3. Study of E-plane, H-plane & Magic Tee. Extraction of S-Parameters. (Waveguide Tees)
4. Study of E-plane, H-plane & Magic Tee. Extraction of S-Parameters. (Waveguide Tees)
5. Measurement of Frequency and wavelength measurement using slotted Line Assembly.
6. Plot Radiation Pattern of an Antenna. (Horn/Parabolic)
7. Measurement of Reflection coefficient using Smith chart (Magnitude and phase)
8. Measurement of input impedance of the line using smith chart.

TEXT BOOKS:

. 1. Samuel Y.Liao, “Microwave Devices and Circuits” ,PHI/Pearson Education, Third Edition, 2003.
2. Annapurna Das and Sisir K Das, “Microwave Engineering”, Tata McGraw Hill, Second Edition, 2009.
3. Ali A Behagi, “RF and Microwave Circuit Design: A Design Approach using (ADS)”, ISBN-13: 978-0996446617

REFERENCES:

. 1. David M Pozar, “Microwave Engineering”, John Wiley & Sons, Inc., Fourth Edition, 2011.
2. John D Ryder, “Networks, Lines and Fields”, PHI, Second Edition, 2002

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SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3602**					
TITLE OF THE COURSE	**NETWORKING AND COMMUNICATION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1	V	19EC3501	ANALOG AND DIGITAL COMMUNICATION
2			

COURSE OBJECTIVES :

- To understand the protocol layering and physical level communication.
- To analyze the performance of a network.
- To understand the various components required to build different networks.
- To learn the functions of network layer and the various routing protocols.
- To familiarize the functions and protocols of the Transport layer.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Independently **understand** basic computer network technology.	**2-Understanding**
CO2	Understand and **explain** Data Communications System and its components.	**2-Understanding**
CO3	**Identify** the different types of network topologies and protocols.	**3-Apply**
CO4	Enumerate the layers of the OSI model and TCP/IP. Explain the functions of each layer.	**2-Understanding**
CO5	Understand and building the skills of subnetting and routing mechanisms.	**3-Apply** **6-Create**
CO6	Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.	**1-Remember** **6-Create**

COURSE CONTENT:	
MODULE 1: Introduction	**08Hrs**
Data communications (Components, Data Representation, and Dataflow), Networks (Distributed Processing, Network Criteria, Physical Structures, Network Models, and Categories of Networks), Reference Models: OSI, TCP/IP Physical Layer: Transmission media: Magnetic Media, Twisted pair, Base band Coaxial Cable, Fiber optics, Wireless Transmission: Electromagnetic Spectrum, Radio Transmission, Microwave Transmission	
MODULE 2: Data Link Layer	**07Hrs**
Data link layer: Design issues: framing, error detection and correction, Elementary Data link Protocols: Stop and wait, Sliding Window protocols: Go-back-N, Selective Repeat, **Medium Access sub layer:** Channel allocation methods, Multiple Access protocols:	

ALOHA, CSMA, Ethernet and Wireless LAN.	
MODULE 3: Network Layer	**08Hrs**
Network Layer design issues, Virtual circuit and Datagram subnets, Routing algorithms: Shortest path routing, Flooding, Distance vector routing, Hierarchical routing, Broad cast and Multi cast routing, Congestion Control: Congestion prevention policies. The Network layer in the internet: The IP Protocol, IP Addresses, and Internet Control Protocols, IPv6.	
MODULE 4: Transport Layer	**08Hrs**
Transport Services, Elements of Transport Protocols: Addressing, Connection establishment, Connection Release, Flow control and Buffering, Internet Transport Protocols: UDP and TCP. Session layer: Dialog Control and Synchronization.	
MODULE 5: Application Layer	**08Hrs**
Presentation Layer: Translation, Encryption and Compression Domain Name System, Electronic Mail, World Wide Web, Hyper Text Transfer Protocol, **Network Security:** Cryptography, Symmetric key algorithms, Public key algorithms, Digital signatures	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
Part-A:Software MATLAB /MATHEMATICA/SONNET/MAGICAD/HFSS
1. Simulate three nodes point-to-point networks with duplex links between them. Set the queue size and vary the bandwidth and find the number of packets dropped.
2. Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
3. Implement an Ethernet LAN using n nodes and set multiple traffic nodes and plot congestion window for different source / destination.
4. Write a program for error detecting code using CRC-CCITT (16- bits).
5. Write a program to find the shortest path between vertices using Dijkstra algorithm.
6. Write a program for a HDLC frame to perform the following. Bit Stuffing Character Stuffing
7. Implementation of Stop and Wait protocol, Sliding Window Protocol.
8. Write a program for simple RSA algorithm to encrypt and decrypt the data.
9. Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if

present. Implement the above program using as message queues or FIFOs as IPC channels.
10. Implement and study the performance of CDMA.

TEXT BOOKS:

. 1. Data Communications and Networking – Behrouz A. Forouzan, Fourth Edition TMH, 2006.
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, Pearson Education.

REFERENCES:

. 1. Understanding communications and Networks, 3rd Edition, W.A. Shay, Thomson

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3603**					
TITLE OF THE COURSE	**POWER ELECTRONICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**2**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

1			
2			

COURSE OBJECTIVES:

- Study the semiconductors devices as switches suitable for power circuits.
- Select and design the converters for various forms of power conversions.
- Understand the operations of various motor drives
- Design and implement the control circuits for various power electronics Applications
- Understanding power electronic circuits for EV applications

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Compare** the different semiconductors devices as switches suitable for power circuits.	**2-Understanding 4-Analyze 5-Evaluate**
CO2	Selection and design of suitable converters for various forms of power conversions.	**1-Remember 4-Analyze**
CO3	**Analyse** various drive circuits suitable for different motors.	**4-Analyze**
CO4	**Design** and implementation of control circuits for EV applications	**6-Create**

COURSE CONTENT:	
MODULE 1: Introduction to Power Electronics	**08Hrs**
INTRODUCTION: Need for power electronics, power semiconductor devices, Types of power electronic circuits. Power BJTs, switching characteristics, Power MOSFET Switching characteristics, Power IGBTs, switching characteristics, gate and base drives.	
MODULE 2: Thyristors	**08Hrs**
Introduction, VI characteristics, two transistor models, switching characteristics, di/dt and dv/dt protection, thyristor types, series and parallel operation of thyristors, thyristor firing circuits. COMMUTATION TECHNIQUES: Natural commutation, Forced commutation: self-commutation, impulse commutation, resonant pulse commutation and complementary commutation.	
MODULE 3: Controlled Rectifiers And Controllers	**08Hrs**
Introduction, Principle of phase controlled converter, Operation of single-phase semi converters, full converters and dual converters with parameter analysis. Principle of Three phase half wave converter. AC VOLTAGE CONTROLLERS: Introduction, principle of ON-OFF and phase control, Operation of single phase, Bi-directional controllers with resistive and inductive loads. Single phase Cyclo converters.	

MODULE 4: DC Choppers	**07Hrs**
Introduction, principle of step-down operation, step-down chopper with RL loads, Principle of step-up operation, step-up chopper with Resistive load, performance parameters, Chopper classification (Class A to Class E).	
MODULE 5: DC Drives and Inverters	**08Hrs**
DC DRIVES: Introduction, Basic Characteristics of DC Motors, Operating modes, Single phase Drives. Stepper motor characteristics, Permanent Magnet stepper motors (bipolar and unipolar motor drive sequence), Stepper Motor Drives INVERTERS: Introduction, principle of operation, performance parameters, single phase bridge inverters, three phase inverters, voltage control of single phase inverters, current source inverter, variable DC link inverter, Introduction to Hybrid Electric Vehicles, Basics of Conventional Vehicles. Hybrid Electric Drive-trains and Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies.	

TEXT BOOKS:

. 1. Power Electronics - M. H. Rashid, Prentice Hall of India Pvt. Ltd., (Pearson (Singapore–Asia)) New Delhi, 2002.
2. Modern Power Electronics – P.C. Sen, 2nd Edition S.Chand, 2000.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press , 2004

REFERENCES:

. 1. Power Electronics- M. D. Sing and Khanchandani K. B., Tata McGraw Hill Publishing Company Limited, Reprint 2001.
2. Power Electronics - Cyril W.Lander, 3rd Edition, McGraw Hill, 1993.
3. Power Electronics, Converters, Applications and Design – Ned Mohan, Undeland, Riobbins
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2011
5. Power Electronics Lab Manual, SOE DSU , 2018

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3604**					
TITLE OF THE COURSE	**Analog VLSI Design**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	V	19EC3503	CMOS VLSI DESIGN
2			

COURSE OBJECTIVES:

- Analyse small signal and large signal model of MOSFETS
- Analyse characteristics of single-stage amplifiers and differential amplifiers.
- Understand and Analyse Op-Amp parameters.
- Study Analog Comparators.
- Infer VCO and PLL Characteristics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Acquire knowledge about physics involved in modelling of semiconductor device.	**3-Apply**
CO2	To study key analog circuits for signal processing, conditioning and detection in system.	1. Understand
CO3	Apply knowledge of mathematics, science, and engineering to design and analysis of analog integrated circuits.	**3-Apply**
CO4	Identify, formulates, and solves engineering problems in the area of analog integrated circuits.	**3-Apply** **4-Analyze**
CO5	Use the techniques, skills, and modern programming tools, necessary for engineering practice.	**3-Apply**

COURSE CONTENT:	
MODULE 1: CMOS Device Modelling	**10Hrs**
CMOS Device Modelling: MOS large Signal Model, Small Signal Model. Analog CMOS Subcircuits: MOS Switch, MOS Diode, Current Sinks and Sources, Current Mirrors, Basic Current Mirror, Cascode Current Mirror.	
MODULE 2: Single Stage Amplifiers:	**10Hrs**
Common Source with Resistive load, Diode connected Load, Current Source load, Triode Load, Source degradation, Source follower, Common Gate	
MODULE 3: Differential Amplifiers and Operational Amplifiers	**10Hrs**
Differential Amplifiers and Operational Amplifiers: Single Ended Differential operation,	

Basic differential Pair, Common Mode Response, Differential Pair with MOS Load. **OP- AMPS:** General Consideration and Performance Parameters, One/Single Stage OP-AMP, Two stage Op-amp, Gain Boosting, Slew Rate and Power Supply Rejection Ratio	
MODULE 4: Other Analog Circuits:	**09Hrs**
Comparators, Characterization of a Comparator, Two Stage Open Loop Comparator, Voltage Controlled Oscillator, Basic PLL Topology	

TEXT BOOKS:

. 1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, 3rd Edition, 2002, Tata McGrawHill

REFERENCES:

. 1. CMOS Analog Circuit Design, Phillip E Allen, Douglas R Holberg, 2rd Edition, 2006, Oxford University Press.
2. Analysis and Design of Analog Integrated Circuits, Gray, Hurst, Lewis, and Meyer, John Wiley & Sons, 5th edition, 2009
3. Analog Integrated Circuit Design, Carusone, Johns, and Martin, 2nd edition, John Wiley, 2012.
4. Analog Design for CMOS VLSI Systems, Franco Maloberti, Kluwer Academic Publishers, 2001

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SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3605**					
TITLE OF THE COURSE	**Wireless and Mobile Communication**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	V	19EC3501	ANALOG AND DIGITAL COMMUNICATION
2			

COURSE OBJECTIVES:

- To understand the concepts and techniques of mobile radio communication
- fundamentals like reflection, diffraction, scattering and fading.
- The course provides the basic foundation of mobile communication. This course covers aspects like working principles, types, modulation methods, channeling and applications.
- To understand equalization techniques and the analysis of same to improve the signal strength
- To analyze the modulation and multiple access techniques to increase the channel efficiency
- To understand cellular design concepts and apply them in wireless communication
- To understand the short distance communication and the concept of 5G wireless communication and analyses the pros and cons of technology.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the concepts and techniques of mobile radio communication fundamentals like reflection, diffraction, scattering and fading	**2-Understand**
CO2	Understand working principles, types, modulation methods, channeling and applications.	**1-Remember** **2 Understand**
CO3	Understand equalization techniques and the analysis of the same to improve the signal strength	**2-Understand** **4- Analyze**
CO4	Analyse the modulation and multiple access techniques to increase the channel efficiency	**4- Analyze** **5 -Evaluate**
CO5	Understand cellular design concepts and apply them in wireless communication	**2 Understand** **3- Apply**
CO6	Understand the short distance communication and the concept of 5G wireless communication and analyses the pros and cons of technology	**2 – Understand** **4 - Analyze**

COURSE CONTENT:	
MODULE 1:	**08Hrs**
Evolution of mobile radio communication fundamentals, General Model of Wireless Communication Link, Types of Signals, Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems, Channel Assignment, Frequency reuse, Channel Assignment strategies, Handoff Strategies Cellular Interferences, Sectorization; Wireless Channel and Radio Communication, Free Space Propagation Model, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing.	
MODULE 2:	**08Hrs**
Theory of Vocoders, Types of Vocoders; Spread Spectrum Modulation, Pseudo-Noise Codes	

with Properties and Code Generation Mechanisms, DSSS and FHSS Systems, Time Hopping and Hybrid Spread Systems; Multicarrier Modulation Techniques, Zero Inter Symbol Interference Communication Techniques, Detection Strategies, Diversity Combining Techniques: Selection Combining, Threshold Combining, Equal Gain Combining, Maximum Ratio Combining; Spatial Diversity and Multiplexing in MIMO Systems, Channel Estimation.	
MODULE 3:	**08Hrs**
Equalization Techniques: Transversal Filters, Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, and related algorithms; Multiplexing and Multiple Access: FDMA, TDMA, CDMA, OFDMA, SC-FDMA, IDMA Schemes and Hybrid Method of Multiple Access Schemes, RAKE Receiver; Multiple Access for Radio Packet Systems: Pure ALOHA, Slotted ALOHA, CSMA and their versions; Packet and Pooling Reservation Based Multiple Access Schemes.	
MODULE 4:	**08Hrs**
GSM system for mobile Telecommunication, General Packet Radio Service, Edge Technology; CDMA Based Standards: IS 95 to CDMA 2000, Wireless Local Loop, IMT 2000 and UMTS, Long Term Evolution (LTE), Mobile Satellite Communication.	
MODULE 5:	**07Hrs**
Introduction to Mobile Adhoc Networks, Bluetooth, Wi-Fi Standards, WiMax Standards, Li-Fi Communication, Ultra-Wideband Communication, Mobile data networks, Wireless Standards IMT 2000, Introduction to 5G concept	

TEXT BOOKS:

. 1. T.S. Rappaport, "Wireless Communication-Principles and practice", Pearson Publications, Second Edition.
2. Upena Dalal, "Wireless Communication and Networks", Oxford Press Publications.

REFERENCES:

. 1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press.
2. S. Haykin & M. Moher, "Modern wireless communication", Pearson, 2005.
3. T L Singal, "Wireless Communications", McGraw Hill Publications

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3606**					
TITLE OF THE COURSE	**EMBEDDED SYSTEMS DESIGN**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV	19EC2403	MICROCONTROLLERS
2			

COURSE OBJECTIVES:

- To introduce the fundamentals of embedded processor modeling.
- To understand the hardware components involved in embedded system design.
- To discuss on the software aspects required in developing an embedded system.
- To involve in Discussions/ Practices/Exercises onto revising & familiarizing the concepts acquired with applications for improved employability skills.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To identify various functional and structural modules within an embedded processor.	**Identify -1**
CO2	Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.	**Describe - 2**
CO3	To demonstrate automated process with improved design strategies.	**Demonstrate - 2**
CO4	To Understand the implementation of operating systems for Embedded applications.	**Understand -2**
CO5	Analyze various examples of embedded systems.	**Analyze - 4**

COURSE CONTENT:	
MODULE 1: Introduction To Embedded Systems	**08Hrs**
Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock- Software Development tools-IDE, assembler, compiler, linker, simulator, debugger, In circuit emulator, Target Hardware Debugging, need for Hardware-Software Partitioning, Co-Design.	
MODULE 2: Embedded Hardware and System Components	**08Hrs**
Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES. Core of an Embedded System including all types of processor/controllers, Memory, Sensors, Actuators, LED, Opto-coupler, Relay, Piezo buzzer, Push button switch, Communication Interface, Embedded firmware.	
MODULE 3: Embedded Software	**08Hrs**
Embedded Systems programming in C – Binding & Running Embedded C program in IDE, Dissecting the program, Building the hardware, Basic techniques for reading & writing from I/O port pins, Examples fo r switches, LED Interfacing using Embedded C. Firmware : Firmware and Bootloader, Example: Sandstone	
MODULE 4: Embedded Operating Systems (Seos)	**07Hrs**

Basic OS Concepts: Process Management, Memory Management, I/O and File Management. Basics of sEOS, Timer Design consideration using sEOS, Multi-state system design.	
MODULE 5: Embedded Systems Applications	**08Hrs**
Case study – Intruder alarm system. HyperTerminal based control-packet based control for LED interfacing, Discussions on Design, Development & Product Manufacturing Processes' of embedded Products like Digital Camera /Adaptive Cruise control in a Car /Mobile Phone / Automated Robonoid Implementation of Traffic light sequencing using on chip UART for RS-232 communication- memory requirements.	

TEXT BOOKS:

.

1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009.
2. Andrew N. Sloss, Dominic Symes,Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier, 2004

REFERENCES:

1. Tammy Noergaard, "Embedded system architecture", Elsevier.
2. Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", The publisher, Paul Temme.
3. Peckol, "Embedded system Design", JohnWiley &Sons.
4. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson.
5. Jonathan W.Valvano,"Embedded Microcomputer Systems, Real Time Interfacing", Cengage Learning.
6. Jivan S. Parab, Vinod G. Shelake, Rajanish K.Kamot, and Gourish M.Naik, "Exploring C for Microcontrollers- A Hands on Approach", Springer, 2007.
7. Michael J. Pont, "Embedded C", Addison Wesley.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3607**					
TITLE OF THE COURSE	**Digital IC Design**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	V	19EC2302	Analog Circuits
2			

COURSE OBJECTIVES:

- Analyse small signal and large signal model of MOSFETS
- Analyse characteristics of single-stage amplifiers and differential amplifiers.
- Understand and Analyse Op-Amp parameters.
- Study Analog Comparators.
- Infer VCO and PLL Characteristics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To impart the knowledge about various VLSI digital design flow	**2-Understand**
CO2	Acquire knowledge about timing issues in digital circuits.	**3-Apply**
CO3	Acquire knowledge about RAM, ROM and High-Performance Subsystem Memories	**3-Apply**
CO4	Solve engineering problems for feasible and optimal solutions in the core area of CMOS Digital ICs.	**3-Apply**
CO5	Apply the CMOS Digital IC concepts for usage of modern CAD tools and their Limitations.	**3-Apply**

COURSE CONTENT:	
MODULE: Implementation Strategies For Digital Ics	**08Hrs**
Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design, Methodology Standard Cell, Compiled Cells, Macrocells, Megacells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Pre-wired Arrays.	
MODULE 2: Timing Issues In Digital Circuits	**08Hrs**
Introduction, Timing Classification of Digital Systems, Synchronous Interconnect, Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect, Synchronous Design — An In-depth Perspective, Synchronous Timing Basics Sources of Skew and Jitter, Clock-Distribution Techniques, Latch-Based Clocking, Self-Timed Circuit Design, Self-Timed Logic - An Asynchronous Technique , Completion-Signal Generation, Self-Timed Signaling, Practical Examples of Self-Timed Logic, Synchronizers and Arbiters, Synchronizers—Concept and Implementation, Arbiters, Metastability	
MODULE 3: Designing Arithmetic Building Blocks	**08Hrs**
Introduction, Datapaths in Digital Processor Architectures, The Adder, The Binary Adder: Definitions, The Full Adder: Circuit Design Considerations, The Binary Adder: Logic Design Considerations, The Multiplier: Definitions, Partial-Product Generation, Partial Product Accumulation, Final Addition, Multiplier Summary, The Shifter Barrel Shifter, Logarithmic Shifter.	

MODULE 4: Designing Memory and Array Structures	**07Hrs**
Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read-Only Memories, Nonvolatile, Read-Write Memories, Read-Write Memories (RAM), Contents-Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References Drivers/Buffers, Timing and Control, Memory Reliability and Yield, Signal-To-Noise Ratio, Memory yield.	

TEXT BOOKS:

. 1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, 3rd Edition, 2002, Tata McGrawHill

REFERENCES:

. 1. CMOS Analog Circuit Design, Phillip E Allen, Douglas R Holberg, 2rd Edition, 2006, Oxford University Press.
2. Analysis and Design of Analog Integrated Circuits, Gray, Hurst, Lewis, and Meyer, John Wiley & Sons, 5th edition, 2009
3. Analog Integrated Circuit Design, Carusone, Johns, and Martin, 2nd edition, John Wiley, 2012
4. Analog Design for CMOS VLSI Systems, Franco Maloberti, Kluwer Academic Publishers, 2001

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3608**					
TITLE OF THE COURSE	**DIGITAL IMAGE PROCESSING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	V	19EC3504	DGITAL SIGNAL PROCESSING
2			

COURSE OBJECTIVES:

- To understand the basics of Image Processing and color image processing.
- To appreciate the usage of image transforms in image processing
- To learn various image processing techniques like image enhancement, restoration.
- To know segmentation, image compression and basics of watermarking.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Analyze basics of image and full color image processing techniques.	**4-Analyze**
CO2	Appreciate image manipulations and different digital image processing techniques in various fields and apply the various image transforms used in image processing.	**3-Apply**
CO3	Perform basic operations like – Enhancement, Image transform and restoration techniques on image.	**6-Create**
CO4	Make use of image segmentation, compression for various applications.	**3-Apply**

COURSE CONTENT:	
MODULE 1: Digital Image Fundamentals	**08Hrs**
What is Digital Image Processing? Fundamental Steps in Digital Image Processing, Components of an Image processing system, elements of Visual Perception, Image sensing and acquisition, Image sampling and quantization, basic relationships between pixels. An introduction to mathematical tools in digital image processing. Color Fundamentals: Color Models, Pseudo color Image Processing, basics of full color image processing, color transformations.	
MODULE 2: Image Transforms	**08Hrs**
Two-dimensional orthogonal & unitary transforms, properties of unitary transforms, two dimensional discrete Fourier transform, Discrete cosine transform, sine transform, Hadamard transform, Haar transform, Problems.	
MODULE 3: Image Enhancement	**08Hrs**
Image Enhancement in Spatial domain, Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering. Image enhancement in the Frequency Domain filters, Smoothing Frequency Domain filters, Sharpening Frequency Domain filters, homomorphic filtering.	
MODULE 4: Image Restoration	**07Hrs**
A Model of the Image Degradation/Restoration Process, Noise models, Restoration in the presence of noise, Linear Position-Invariant Degradations, Inverse filtering, Minimum Mean	

Square Error (Wiener) Filter, Constrained Least squares filtering.	
MODULE 5: Image Segmentation And Compression	**08Hrs**
Fundamentals, point, Line and Edge detection, Thresholding, Region based Segmentation. Fundamentals, Image Compression Models, Error Free Compression, Lossy and lossless Compression, Image compression using DCT and DWT. Application of image processing technique using opencv/Python/Matlab/Scilab.	

TEXT BOOKS:

1. Digital Image Processing" Rafel C.Gonzalez and Richard E.Woods, Pearson Education, 3rd edition 2011.
2. Fundamentals of Digital Image Processing", Anil K. Jain, 2003, Pearson Education

REFERENCES:

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1. "Digital Image Processing" S.Jayaraman S.Esakirajan T.Veerakaumar Mc Graw Hill publishers, 2009
2. "Digital Image Processing", S.Sridharoxford publishers, 2011
3. "Digital Image Processing and Analysis" Chanda & Majumdar, 2003, PHI
4. "Digital Image Processing" Vipula Singh, , Elsevier Publications

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SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3609**					
TITLE OF THE COURSE	**REAL TIME EMBEDDED SYSTEMS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV	19EC2403	MICROCONTROLLERS
2			

COURSE OBJECTIVES:

- To acquire knowledge about concepts related to OS such as Scheduling techniques, threads, inter-thread communications, memory management.
- To understand the architecture and programming model of STM 32 microcontroller.
- To gain knowledge on UML and resource modelling
- To study about Free RTOS and incorporate in projects

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Describe the fundamental concepts of RTOS	**4-Analyze**
CO2	Describe STM 32 processor architecture and Programming model	**1-Remembering 2-Analyze**
CO3	Analyze different scheduling and multitasking approaches	**4-Analyze**
CO4	Develop programs for real time services, firmware and RTOS.	**1-Remembering 2-Analyze**

COURSE CONTENT:	
MODULE 1: Introduction To Real Time Systems	**08Hrs**
Introduction to Embedded Systems, Real time Embedded Systems, characteristics, Hard and Soft Real-Time Embedded Systems, Examples, Cross platform development process, Hardware architecture, Software development, build target images, Memory mapping, integrated testing on target, system production.	
MODULE 2: ARM for Real Time Systems	**07Hrs**
ARM STM32, Architecture, Memory organization, Process instructions, General Purpose Input Output pin hardware, Interrupts, External & Software Interrupts, Timers, Case Study	
MODULE 3: Software Architecture for Real Time Embedded Systems	**08Hrs**
Real time tasks, Periodic and Aperiodic tasks, Task specification, Clock driven scheduling, Round Robin Architecture, Priority driven scheduling algorithms, Round Robin Architecture with interrupts, Queue based architecture, Case study.	
MODULE 4: Real Time Operating Systems	**08Hrs**
Operating system basics, Tasks, Process, Threads, Process Management, Memory Management, Multitasking, Real time scheduling, non-Pre-emptive Scheduling, Pre-emptive scheduling, Inter-task Communication, Resource sharing, Introduction to OSEK standards OS, Architecture of OSEK OS.	
MODULE 5: Embedded System Design with Freertos	**08Hrs**
Fundamental of UML, Structural modelling: UML, class diagram & class modelling, object	

diagram, Real time UML, General resource modelling, Resource modelling, concurrency modelling, Getting started with Free RTOS – Task Management, Queue Management, Interrupt & Resource Management. Incorporating Free RTOS in projects.

TEXT BOOKS:

. 1. Jiacun Wang, Real Time Embedded Systems, Wiley Publications, 2017.
2. Xiaocong Fan, Real Time Embedded Systems: Design Principles & Engineering Practices, Elsevier, 2014.
3. Shibu K V, Introduction to Embedded Systems, McGraw Hill Education(India) Private Limited, 2017.
4. Lemieux Joseph. Programming in the OSEK/VDX Environment, R & D.(2001)

REFERENCES:

1. Jim Cooling, Real Time Operating Systems: Book 2 - The practice -Using STM Cube, FreeRTOS and the STM32F4 Discovery boards, Lindentree Associates Publications 2017.
2. Donald Norris, Programming with STM32: Getting started with Nucleo board and C/C++, McGraw Hill Education Publications, 2018.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC3610**					
TITLE OF THE COURSE	**Industrial Internet of things (IIoT)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV/III	19ECxxx	**PLC and SCADA**
2			

COURSE OBJECTIVES:

- To introduce the fundamental concept Industry 4.0 and IoT
- 2. To introduce and demonstrate role of sensors and actuators in industries
- 3. To apply basic knowledge of data analytics to analyses data obtained from machines
- 4. To understand Role of AR and VR
- 5. To introduce students to what role IIoT will play in healthcare, power plant industries as case study

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will able know the basic of 4th industrial Revolution	**1-Remembering**
CO2	Explain about Sensors and Actuators	**1-Remembering** **2-Understanding**
CO3	Explore Various Technologies used in Industrial IoT	**2-Understanding** **3-Applying**
CO4	Analyzing the data obtained from the machines and host them in cloud	**1-Remembering** **2-Understanding**
CO5	IIoT links the automation system with enterprise, planning and product lifecycle.	**3-Applying** **4-Analyzing**
CO6	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits	**5-Evaluate** **6-Create**

COURSE CONTENT:	
MODULE 1: Introduction	**08Hrs**
Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories	
MODULE 2: IIoT Technologies	**08Hrs**
Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems. Industrial Sensing & Actuation.	
MODULE 3: IIoT Communication	**08Hrs**
IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II. Industrial IoT-Layers: IIoT Sensing, IIoT Processing. Communication-Part I. Industrial IoT- Layers: IIoT Communication, IIoT Networking-Part I, Part II, Part III.	
MODULE 4: IIoT Analytics	**08Hrs**
Introduction, Machine Learning and Data Science in Industrial IoT: Big Data Analytics and	

Software Defined Networks: IIoT Machine Learning and Data Science - R and Julia Programming, Data Management with Hadoop Data Center Networks, Industrial IoT Security and Fog Computing - Fog Computing in IIoT, Industrial IoT- Application Domains.
MODULE 5: Application Domains **07Hrs**
Healthcare, Power Plants Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies

TEXT BOOKS:

. 1. Introduction to industrial internet of things and industry 4.0 by Sudip Misra, Chandan Roy, Anandarup Mukarjee, 1st edition , CRC Press publisher,2021, ISBN 9781003020905

REFERENCES:

1. Industry 4.0 the industrial Internet of Things , Alasdair Gilchrist, 1st edition, Apress Publisher,2017, ISBN-13: 978-1-4842-2046-7
2. Industry 4.0: Managing The Digital Transformation, Alp Ustundag, EmreCevikcan, 1st edition, Springer, 2018, ISBN 978-3-319-57869-9.
3. Designing the Industry - Internet of things connecting the physical, digital and virtual worlds, OvidiuVermesan and Peer Friess,1st edition, Rivers Publishers, 2016, ISBN 978-87-93379-81-7

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**19EC4701**					
TITLE OF THE COURSE	**ROBOTICS AND CONTROL SYSTEMS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV/II	19ECxxx	**Signals & Systems**
2			

COURSE OBJECTIVES:

- To familiarise the functional elements of Robotics
- To disseminate fundamental knowledge on the direct and inverse kinematics
- To introduce the terminologies governing the manipulator differential motion and control
- To introduce various path planning techniques
- To familiarise with the fundamental skills underlying the dynamics, mechanism and control of manipulators.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will Master the basic concept of robotics.	**3-Applying**
CO2	Students will be able to examine the Instrumentation characteristics, and their applications to various robotic systems	**3-Applying** **4-Analyzing**
CO3	Apply differential motion add statics in robotics	**2-Understanding** **3-Applying**
CO4	Analyzing the data obtained from the machines and host them in cloud	**3-Applying** **4-Analyzing**
CO5	Configure and apply various path planning techniques.	**3-Applying** **4-Analyzing**
CO6	Maneuver dynamics and control mechanisms for applying in robotics industries.	**4-Analyzing** **5-Evaluate**

COURSE CONTENT:	
MODULE 1: BASIC CONCEPTS IN ROBOTICS	**10Hrs**
Evolution of Robots and Robotics-Laws of Robotics-Progressive Advancements in Robotics-Types of Robot–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.	
MODULE 2: DIRECT AND INVERSE KINEMATICS	**10Hrs**
Mechanical structures and notations-Description of links and joints- Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution..	
MODULE 3: MANIPULATOR DIFFERENTIAL MOTION AND STATICS	**10Hrs**

Linear and angular velocities-Relationship between transformation matrix and angular velocity-Mapping velocity vector-Manipulator Jacobian-Prismatic and rotary joints– Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.
MODULE 4: PATH PLANNING **10Hrs**
Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.
MODULE 5: DYNAMICS AND CONTROL **12Hrs**
Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Open loop and closed loop control-Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator-Basics of robotic sensors and vision

TEXT BOOKS:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009

REFERENCES:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. R.D.Klafter, T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
3. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.

SEMESTER	**VII SEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4702**					
TITLE OF THE COURSE	**ANTENNAS AND WAVE PROPAGATION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

- Understand the basic antenna parameters and radiation mechanism from an antenna
- Understand the array concepts in antennas, and their applications.
- Understand the concepts of Reflector Antennas and their applications.
- Study the properties of different types of antennas, and special antennas.
- Understand the methods of measuring various antenna parameters.
- Study the wave propagation concepts in ground, sky and troposphere regions.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain Antenna radiation mechanism and fundamentals concepts along with antenna measurement techniques.	**2-Understand**
CO2	Analyze wire antenna and its radiation characteristics.	**4-Analyse**
CO3	Evaluate antenna array performances	**4- Analyze** **5 -Evaluate**
CO4	Interpret design consideration for Aperture antennas	**3- Apply**
CO5	Design low profile antennas for specific applications	**6-Create**
CO6	Identify characteristics of wave propagation	**2-Understand** **3-Apply**

COURSE CONTENT:	
MODULE 1: ANTENNA FUNDAMENTALS	**10 Hrs**
Introduction, Radiation Mechanism. Antenna Parameters- Radiation Patterns, Main Lobe and Side Lobes, Beam-width, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency, Polarization, Antenna regions, Reciprocity theorem, Friis Transmission equation -Path loss.	
Assignment on Numerical Problems	
MODULE 2: WIRE ANTENNAS	**10 Hrs**
Single Wire, Two Wire, Dipoles, Current Distribution on a Thin Wire Antenna Radiation from Small Electric Dipole, Quarter wave Monopole and Half wave Dipole – Current Distributions, Evaluation of Field Components-only equations , Power Radiated, Radiation Resistance.Introduction to Loop Antennas.	
Numerical Problems **Design of dipole antenna**	
MODULE 3: Antenna Arrays	**12 Hrs**
Two element Arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, End-fire Arrays, EFA with Increased Directivity; Binomial Arrays, Effects of Uniform and Non-uniform Amplitude Distributions, Related Problems, Yagi - Uda Arrays, Folded Dipoles and their characteristics. Flat Sheet and Corner Reflectors.Paraboloidal Reflectors – Geometry, characteristics, types of feeds, F/D Ratio, Spill Over, Back Lobes, Aperture Blocking	
Numerical Problems **Presentation on effect of array factor**	
MODULE 4: SPECIAL ANTENNAS & ANTENNA MEASUREMENTS	**10 Hrs**
Helical Antennas – Significance, Geometry, basic properties; Design considerations for monofilar helical antennas in Axial Mode and Normal Modes (Qualitative Treatment), Microstrip patch antenna- Rectangular patch antenna, Horn Antennas – Types, Optimum Horns, Design Characteristics of Pyramidal Horns Antenna measurment :Measurment of antenna ranges, directivity measurement, Anaechoic chamber, CATR	
Presentation on smart antenna, antenna beamforming and MIMO **Design of Microstrip patch antenna, fractal antenna**	

MODULE 5: WAVE PROPAGATION	10 Hrs
Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation, Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance – Calculations for flat and spherical earth cases, Optimum working Frequency, Virtual Height. Space Wave Propagation – Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth's Radius, Effect of Earth's Curvature, Field Strength Calculations, M-curves and Duct Propagation, Tropospheric Scattering, Related problems.	
Assignment and viva	

Text Books:

1. John D Krauss, Ronald J Marhefka, Ahmad S Khan, "Antennas for all applications " 3rd edition, Mc Graw-Hill, 2006
2. C.A Balanis, "Antenna Theory", John Wiley & Sons, 2nd ed., 2001.
3. A R Harish and M Sachidananda ,"Antenna and Wave Propagation" Oxford University Press, 2007.

References:

1. K D Prasad, SatyaPrakashan, "Antennas & Wave Propagation", Tech India Publications, New Delhi, 2001

SEMESTER	**VII SEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4704**					
TITLE OF THE COURSE	**OPTICAL COMMUNICATION AND NETWORKING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures
- To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors
- To learn the various optical source materials, LED structures, quantum efficiency, Laser diodes
- To learn the fiber optical receivers such as PIN APD diodes, noise performance in photo detector, receiver operation and configuration
- To learn the fiber optical network components, variety of networking aspects, FDDI, SONET/SDH and operational principles WDM

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Be familiar with Optical Fiber Communication System, its components and parameters	**2-Understand** **3-Apply**
CO2	Understand and measure properties of optical sources, detectors and receivers.	**2-Understand** **4- Analyze**
CO3	Design, construct and test a basic optical fiber communication link/system	**4- Analyze** **5 -Evaluate**
CO4	Evaluate Optical networks components; Design of WDM networks	**4- Analyze** **5 -Evaluate**
CO5	Apply the knowledge to control and manage the functions of optical networks.	**2-Understand** **3-Apply**

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO OPTICAL FIBERS	**8 Hrs**
Elements of Optical Fiber communication, applications of optical fiber communication, optical fiber waveguides, Optical Spectral bands, Optical fibre structure, Light Propagation in Optical fibres: Ray theory, Total Internal reflection, Skew rays, Overview of Modes: Cut-off wavelength, V number, Fiber types: SI, GI, MM, SM, Special Fibers: Polarization Maintaining fibers, Photonic Crystal fibers, Dispersion compensated Fiber.	
Assignments **Hands-on sessions** **Student seminars**	
MODULE 2: TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS	**8 Hrs**
Introduction, Difference between bounded and free space optical communication, Propagation characteristics of IR, Visible, UV in Atmosphere and space, Attenuation: Material Absorption, Scattering, bending and core cladding losses, Overview of Signal dispersion in Fibers, its limitations, Intermodal dispersion, Intra-Modal dispersion: Material dispersion, Waveguide dispersion and PMD, Inter-Modal dispersion, Nonlinear effects: Nonlinear scattering, Kerr effects, Fiber alignment and Joint Loss, Fiber Splices Optical Fiber connectors, Expanded Beam Connectors, Lensing schemes for coupling, Fiber couplers.	
Assignments **Hands-on sessions** **Student seminars**	
MODULE 3: OPTICAL SOURCES, DETECTORS, RECEIVER AND OPTICAL LINK DESIGN	**8 Hrs**
Optical Sources: Light source materials, LED Structures; LED Characteristics; Semiconductor Laser Diode, LASER Characteristics, Photo detectors, Photo detector noise, Response time, double hetero junction structure, Photo diodes, comparison of photo detectors, Optical receiver operation, Receiver design, Receiver Noise; Receiver sensitivity, Eye diagrams, Optical Link Design: Point-to point links - System considerations; Link Power budget ; Rise time budget	
Trouble-shooting of problems **Logical reasoning of concept working**	
MODULE 4: WDM CONCEPTS AND NETWORK COMPONENTS	**8 Hrs**
WDM concepts, overview of WDM operation principles, WDM standards, Principle and Operation of couplers; Isolators; Circulators; Fabry Perot Filters; Mach-Zehnder Interferometer, EDFA; Semiconductor Optical Amplifiers and Transceivers; Multiplexers, direct thin film filters, active optical components, MEMS technology, Optical MEMS switches, variable optical attenuators, tunable optical fibers, dynamic gain equalizers, optical drop multiplexers, polarization controllers, chromatic dispersion components, tunable light sources.	
Poster presentations on topics of interest **Expert lectures followed by reflection notes**	
MODULE 5: OPTICAL NETWORKS	**7 Hrs**

Network Topologies; FDDI Networks: -Frame and Token formats; Network operation, SONET/SDH-optical specifications; SONET frame structure - SONET layers- SONET/SDH networks; Optical interfaces, SONET/SDH rings; Broadcast and Select WDM networks - Single hop and Multihop networks; Wavelength routed networks; Optical CDMA.
Poster presentations on Topics of Interest **Expert lectures followed by reflection notes**

Text Books:

1. Keiser G, "Optical Fiber Communication Systems", 5th Edition, 6th Reprint, McGraw Hill Education (India), 2015.
2. Rajiv Ramaswami, Kumar N. Sivaranjan, Galen H.Sasaki "Optical Networks A practical perspective", 3nd edition, 2013

References:

1. John M. Senior, "Optical fiber Communications: Principles and Practice", Pearson Education, 3rd Edition, 2009
2. Vivekanand Mishra, Sunita P. Ugale, "Fiber Optic Communication: Systems and Components", Wiley-India, 1st edition, 2013
3. Djafar.K. Mynbaev and Lowell and Scheiner, "Fiber Optic Communication Technology", Pearson Education Asia, 9th impression, 2013
4. Partha Pratim Sahu, Fundamentals of Optical Networks and Components, 1st Edition, ISBN 9780367265458, July 10, 2020 by CRC Press, Taylor and Francis e book.

SEMESTER	**VII SEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4705**					
TITLE OF THE COURSE	**ANALOG MIXED SIGNAL VLSI DESIGN**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	5		CMOS VLSI

COURSE OBJECTIVES:

- To Understand Data converter fundamentals and Interpret Electrical noise
- To Infer DAC and ADC architectures
- To Describe Amplifiers, Multipliers, and non-linear analog circuits
- To understand the working of PLL and Synthesizers

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Summarize data converter fundamentals and Illustrate the effects of electrical noise	**2-Understand**
CO2	Model and analyze DAC and ADC architectures	**2-Understand** **3-Apply** **4- Analyze** **5 -Evaluate**
CO3	Explain amplifiers and non-linear analog circuits for any application	**4- Analyze** **5 -Evaluate**
CO4	Explain PLL and Synthesizers	**3-Apply** **4- Analyze**

COURSE CONTENT:	
MODULE 1: DATA CONVERTER FUNDAMENTALS	**08 Hrs**
Analog versus Digital Discrete Time Signals, Converting Analog Signals to Data Signals, Sample and Hold Characteristics, DAC Specifications, ADC Specifications, Mixed-Signal Layout Issues. Power Spectral Density , Circuit Noise, Calculating and Modeling Circuit Noise ,Thermal Noise , Signal-to-Noise Ratio , Averaging White Noise, Shot Noise, Flicker Noise Dynamic Range Improving SNR Using Averaging, Decimating Filters for ADCs, Interpolating Filters for DAC	

MODULE 2: DAC Architectures	**08 Hrs**
Data Converters Architectures: DAC Architectures, Digital Input Code, Resistors String, R-2R Ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, Pipeline DAC, Delta Sigma DAC, INL, DNL, Offset, Gain Error	
MODULE 3: ADC Architectures	**08 Hrs**
ADC Architectures, Flash, Pipeline ADC, Integrating ADC, Successive Approximation ADC, Sigma Delta ADC, INL, DNL, Offset, Gain Error	
MODULE 4: Amplifiers	**08 Hrs**
Common-Source (CS) Amplifiers - Miller's Theorem ,Frequency Response, Common-Source Current Amplifier, Source Follower (Common-Drain Amplifier), Common Gate Amplifier, DC Analysis, AC analysis, Transient Analysis Basic CMOS Comparator Design (Excluding Characterization), Analog Multipliers, Multiplying Quad (Excluding Simulation), Current Mirrors, Differential Amplifier	
MODULE 5: PLL and Synthesizers	**07 Hrs**
Basic Concepts, Phase Detector, Type-I PLLs -Alignment of a VCO's Phase, Simple PLL, Analysis of Simple PLL, Frequency Multiplication, Drawbacks of Simple PLL, Type-II PLLs , Phase/Frequency Detectors, Charge Pumps, Charge-Pump PLLs Integer-N Frequency Synthesizers- General Considerations, Basic Integer-N Synthesizer	

Text Books:

1. Design, Layout, Stimulation ,R. Jacaob Baker, Harry WLi, David E Boyce, CMOS Circuit, PHI Edn, 2005
2. CMOS-Mixed Signal Circuit Design, R. Jacaob Baker, (Vol ll of CMOS: Circuit Design, Layout and Stimulation), IEEE Press and Wiley Interscience, 2002.
3. RF Microelectronics, Behzad Rasavi, Prentice Hall, 2E, 2012

References:

1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, TMH, 2007.

SEMESTER	**VII SEM**

YEAR	**IV YEAR**					
COURSE CODE	**19EC4706**					
TITLE OF THE COURSE	**Embedded Linux**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**0**	**0**	**1**	**39**	**3**

Prerequisite Courses (if any)
C programming Concepts
OS Concepts
Embedded Systems Concepts

COURSE OBJECTIVES:

- To understand transition roadmap from a traditional RTOS to Embedded Linux.
- To learn architecture of the Embedded Linux OS, steps involved in building a GNU cross-platform tool chain and system emulators.
- To understand the use of Linux kernel in an embedded system, building rootfile system structure.
- To understand the Interaction between kernel space and user space, debugging and profiling of the system.
- To learn the Yocto Project for easier development of Linux-based systems for embedded products and build toolchains, bootloaders, kernels, root filesystems, Linux Distribution containing binary packages.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Apply Knowledge and understand the important elements of Embedded Linux Operating System architecture	**2-Understand** **3-Apply**
CO2	Understand the architecture and build process of. Linux based system	**2-Understand** **4- Analyze**
CO3	Create and use a cross-development environment, write the Kernel modules, evaluate system operation.	**6- Create** **5 -Evaluate**
CO4	Evaluate debugging issues encountered in devolving software for Embedded Linux System.	**4- Analyze** **5 -Evaluate**
CO5	Apply knowledge to produce tools and processes that enable the creation of Linux distributions for embedded and related software.	**2-Understand** **3-Apply**

COURSE CONTENT:

MODULE 1: INTRODUCTION TO LINUX	**8 Hrs**
Basic Operating System Concepts, History& Benefits of Linux, Fundamentals of Embedded Linux OS, Comparison of Embedded OS, Embedded Linux Applications and Products, Kernel Architecture Overview- User Space & Kernel Space, Kernel Functional Overview ,Embedded Linux Architecture.	
MODULE 2: HARDWARE SUPPORT AND SOFTWARE DEVELOPMENT TOOLS FOR EMBEDDED LINUX	**8 Hrs**
Processor Architectures, Buses and interfaces, I/O, Storage, General-Purpose Networking, Industrial-Grade Networking, System Monitoring, GNU Cross-Platform Development Toolchain, Emulators	
MODULE 3: KERNEL CONSIDERATIONS AND ROOT FILES SYSTEM	**8 Hrs**
Selecting a Kernel, Configuring the Kernel, Compiling the Kernel, Installing the Kernel, Libraries, Kernel Modules, Kernel Images, Device Files	
MODULE 4: KERNEL DEBUGGING TECHNIQUES	**7 Hrs**
GNU Debugger (GDB), Challenges to Kernel Debugging, Using KGDB for Kernel Debugging, Kernel Debugging Techniques, Hardware-Assisted Debugging	
MODULE 5: THE YOCTO PROJECT	**8 Hrs**
Yocto Project Building, Yocto Project Family, Yocto Project Terms, Bitbake Build Engine.	

Text Books:

1. Karim Yaghmour, Jon Masters, Gilad Ben-Yossef, Philippe Gerum, "Building Embedded Linux Systems", O'Reilly Media,2008.
2. Rudolf J. Streif, "Embedded Linux Systems with the Yocto Project", Pearson Education, Inc., 2016.

References:

1. P. Raghavan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications, Taylor & Francis Group, LLC, 2006.
2. Derek Molloy, "Exploring Raspberry Pi- Interfacing to the Real World with Embedded Linux", John Wiley & Sons, Inc.
3. Chris Simmonds, "Mastering Embedded Linux Programming", Second edition, Packt Publishing Ltd. Birmingham, UK, 2017.

SEMESTER	**VII SEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4707**					
TITLE OF THE COURSE	**VLSI TESTING AND TESTABILITY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	5		CMOS VLSI
2	3	19EC2303	DIGITAL DESIGN WITH VERILOG

COURSE OBJECTIVES:

- Understand the various test Generation Algorithms and Fault Simulation Techniques.
- Model Test generation strategies for combinational logic circuits, Testable combinational logic circuit design
- Infer Built-In Self-Test analysis, Test pattern generation for BIST
- Apply Fault Diagnosis Logic Level Diagnosis, Diagnosis by UUT reduction and Fault Diagnosis for Combinational Circuits

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Analyze methods and techniques for VLSI design verification and testing.	**2-Understand** **4- Analyze**
CO2	Apply fault modeling techniques to detect and correct faults in digital circuits	**3-Apply** **4- Analyze**
CO3	Understand test economy, fault modeling and simulation, defects,	**2-Understand** **4- Analyze** **5 -Evaluate**
CO4	Illustrate Automatic Test Pattern Generation strategies	**3-Apply** **4- Analyze**
CO5	Conceptualize design for testability and built-in self-test (BIST).	**3-Apply** **4- Analyze**

COURSE CONTENT:	
MODULE 1: BASICS OF TESTING AND FAULT MODELING	**07 Hrs**
Introduction to Testing - Faults in digital circuits -Modeling of faults - Logical Fault Models - Fault detection - Fault location -Fault dominance -Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation.	
MODULE 2: TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS	**08 Hrs**

Test generation for combinational logic circuits - Testable combinational logic circuit design -Test generation for sequential circuits - design of testable sequential circuits.	
Assignments followed by Viva-voce **Hands-on sessions**	
MODULE 3: DESIGN FOR TESTABILITY	**08 Hrs**
Design for Testability - Ad-hoc design - Generic scan based design - Classical scan based design - System level DFT approaches.	
Logical reasoning of concept working **Hands-on sessions**	
MODULE 4: SELF TEST AND TEST ALGORITHMS	**08 Hrs**
Built-In Self-Test - Test pattern generation for BIST - Circular BIST - BIST Architectures - Testable Memory Design - Test algorithms - Test generation for Embedded RAMs.	
Expert lectures followed by reflection notes **Minor Project on BIST**	
MODULE 5: - FAULT DIAGNOSIS LOGIC	**08 Hrs**
Level Diagnosis -Diagnosis by UUT reduction - Fault Diagnosis for Combinational Circuits - Self-checking design - System Level Diagnosis.	
Project based learning: Virtual Labs for VLSI **Minor Project to determine Faults**	

Text Books:

1. Digital Circuit Testing and Testability, P.K.Lala. Academic Press, 2002.
2. Logic Design Theory, N.N. Biswas, PHI publication
3. Switching & Finite Automata Theory, Z. Kohavi, TMH

References:

1. A.L. Crouch, "Design Test for Digital IC's and Embedded Core Systems", Prentice Hall International.
2. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House.

SEMESTER	**VII SEM**					
YEAR	**IV**					
COURSE CODE	**19EC4708**					
TITLE OF THE COURSE	**Sensors and Signal Conditioning**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

1. To give an understanding of the general concepts and terminology of measurement systems and sensors classifications.
2. To introduce the basics of various sensors and their construction.
3. To introduce the concept of signal conditioning in sensors
3. Understand recent trends in sensors technology.
4. Understand the application of sensors in multiple domains.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Grasp the principles of measurement system and the role of sensors in the measurement system.	**1-Remember** **2-Understand** **3-Apply**
CO2	Gain insight into various physical quantities which sensors are designed to measure.	**2-Understand** **4- Analyze**
CO3	Illustrate the working principle of signal conditioning circuit for different sensors.	**4- Analyze** **5 -Evaluate**
CO4	Gain insight into current trends in sensor Technologies	**2-Understand** **3-Apply**
CO5	Apply the knowledge of sensors used in various industrial domains.	**2-Understand** **4-Analyze**

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO SENSOR- BASED MEASUREMENT SYSTEM	**7 Hrs**

General Concepts and Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics of Measurement Systems, Dynamic Characteristics, Primary Sensors, Materials For Sensors, Micro sensor Technology.	
MODULE 2: RESISTIVE, REACTANCE VARIATION, ELECTROMAGNETIC SENSORS	**8 Hrs**
Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Capacitive Sensors, Variable capacitor, Differential Capacitor, Inductive Sensors, Eddy current sensors, LVDT, Electromagnetic Sensors , Sensors based on Faraday's law, sensors based on Hall Effect.	
MODULE 3: Signal Conditioning of Resistive, Reactance, Electromagnetic Sensors	**8 Hrs**
AC/DC Converters, Voltage dividers, Wheatstone bridge: Balanced Measurement, Differential Amplifiers, interference, Specific Signal Conditioners for Capacitive Sensors, Resolver-to-Digital and Digital-to-Resolver Converters	
MODULE 4: Smart Sensors and Recent Trends in Sensor Technologies.	**8 Hrs**
Smart Sensors: Introduction, Primary Sensors, Excitation, Amplification, Filters, converters, Information coding /Processing, Data communication, Automation. Recent Trends: Introduction, Film Sensors, Semiconductor IC Technology, MEMS, Nano-sensors	
MODULE 5: Sensors and their Applications	**8 Hrs**
Introduction, on-board Automobile Sensors(Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Medical Diagnostic Sensors, Sensors for Environmental Monitoring	

TEXT BOOKS:

1. Patranabis D., "Sensors and Transducers", Prentice-Hall India, 2nd Ed., 2004.
2. Ramon Pallas & John G. Webster, "Sensors and Signal Conditioning", John Wiley & Sons, 2nd Ed., 2001.

REFERENCES:

1. Webster John G., "Instrumentation and Sensors Handbook", CRC Press, 1st Ed., 1999.
2. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", Springer, 3rd Ed., 2004.
3. Shawhney A. K., "Electrical And Electronics Measurements And Instrumentation", Dhanpat Rai & Sons, 1994

SEMESTER	**VII SEM**

YEAR	**IV**					
COURSE CODE	**19EC4709**					
TITLE OF THE COURSE	**SENSORS, NETWORKS AND PROTOCOLS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- Understand the basic principles and performance issues in sensor operation.
- Understand the Embedded communication protocols
- Detailed discussion of communication in wired and wireless embedded system
- Understand the wireless network communication stack, protocols and sensor network applications

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Grasp the principles and practical implementation of interfacing the microcontroller with real world signals using sensors	**1-Remember** **2-Understand** **3-Apply**
CO2	Gain insight into various concepts of wireless and embedded Networks	**2-Understand** **4- Analyze**
CO3	Evaluate the Challenges with deploying sensors	**4- Analyze** **5 -Evaluate**
CO4	Gain insight into Ethernet	**2-Understand** **3-Apply**
CO5	Achieve insight into GSM Architecture, Protocols,	**2-Understand** **4-Analyze**

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO SENSORS	**8 Hrs**
Explanation and examples of sensors, Theory on how sensors work; Sensor arrays, Sensor Grids and WSNs, Challenges with deploying sensors - Calibrating sensors, signal	

conditioning, replacement, etc. Choosing sensors -Parameters to keep in mind, survey of sensor input mechanisms & signal conditioning	
Assignments **Poster presentations on topics of interest,** **Micro-projects, Project-based learning**	
MODULE 2: EMBEDDED COMMUNICATION PROTOCOLS	**8 Hrs**
Embedded Networking: 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.	
Trouble-shooting of problems **Assignments**	
MODULE 3: ETHERNET BASICS	**8 Hrs**
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, Internet protocol, UDP and TCP concepts, 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.	
Student seminars	
MODULE 4: WIRELESS EMBEDDED NETWORKING	**8 Hrs**
Wireless sensor networks: Introduction, Applications, Network Topology, Localization, Time Synchronization , Energy efficient MAC protocols , SMAC, Energy efficient and robust routing, Data Centric routing, Wireless LAN – IEEE 802.11 Standard-Architecture, Services – AdHoc Network , Hiper LAN, Blue Tooth.	
Poster presentations on topics of interest **Expert lectures followed by reflection notes**	
MODULE 5: MOBILE NETWORKS	**7 Hrs**
Cellular Wireless Networks, GSM Architecture, Protocols, Connection Establishment, Frequency Allocation, Routing, Handover, Security GPRA	
Poster presentations on topics of interest **Expert lectures followed by reflection notes**	

TEXT BOOKS:

1. Frank Vahid, Givargis ‘Embedded Systems Design: A Unified Hardware/Software Introduction’, Wiley Publications, 2002
2. Bhaskar Krishnamachari, ‘Networking wireless sensors’, Cambridge press 2005

REFERENCES:

1. Robert B. Northrop: “Introduction to Instrumentation and Measurements”, 2nd edition, CRC press
2. Jan Axelson, ‘Parallel Port Complete’, Penram publications, 2006
3. Dogan Ibrahim, ‘Advanced PIC microcontroller projects in C’, Elsevier 2008
4. Kaveh Pahlavan, Prasanth Krishnamoorthy, “Principles of Wireless Networks’ PHI/Pearson Education, 2003

SEMESTER	**VII SEM**
YEAR	**IV YEAR**
COURSE CODE	**19EC4710**
TITLE OF THE COURSE	**LOW POWER VLSI**

SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	5th	19EC3502	CMOS VLSI
2			

COURSE OBJECTIVES:

- To learn various sources of power dissipation in CMOS based circuits.
- To study concepts of power estimation and analysis
- To focus on architectural, behavioural and circuit level low power transforms.
- To study switched capacitance and leakage minimization techniques
- To study low energy computing techniques for digital circuits

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Identify the different sources of power dissipation in CMOS based circuits	**3-Applying**
CO2	Summarize the power analysis using simulation-based approaches and probabilistic analysis.	**2-Understand**
CO3	Apply logic-level and architecture-level techniques in various designs to optimize power consumption of the VLSI circuits.	**4- Analyze**
CO4	Utilize logic simulation methods to design Low Power VLSI circuits.	**4- Analyze** **5 -Evaluate**
CO5	Explain and construct the low energy computing techniques for digital circuits	**2-Understand** **3-Apply**

COURSE CONTENT:	
MODULE 1: POWER DISSIPATION IN CMOS	**8 Hrs**
Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits - Dynamic Power Dissipation, Short Circuit Power, Switching Power, Glitching Power, Static Power Dissipation, Degrees of Freedom, Unified Power Format, Voltage islands, power islands. Emerging Low power approaches, Physics of power dissipation in CMOS devices, Device & Technology Impact on Low Power: Transistor sizing & gate oxide thickness, Leakage current in Deep sub-micron transistors, Impact of technology Scaling, Technology & Device innovation.	
Guest Lecture followed by Reflection Notes	
MODULE 2: POWER ESTIMATION, SIMULATION POWER ANALYSIS	**7 Hrs**

Simulation based techniques, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation, Probabilistic power analysis, statistical methods	
Assignments followed by Viva-voce	
MODULE 3: SYNTHESIS FOR LOW POWER	**8 Hrs**
Behavioural, Logic and Circuit level approaches, Algorithm level transforms, Power-constrained Least squares optimization for adaptive and non-adaptive filters, Circuit activity driven architectural transformations, Device feature size scaling, Multi-Vdd Circuits, Architectural level approaches: Parallelism, Pipelining, Voltage scaling using high-level transformations, Dynamic voltage scaling, Power Management	
Hands-on sessions with spice tools/Cadence	
MODULE 4: LOW POWER CIRCUIT TECHNIQUES	**8 Hrs**
Switched Capacitance Minimization Approaches: Hardware Software Tradeoff, Bus Encoding, Architectural optimization, Clock Gating, Logic styles. **Leakage Power minimization Approaches:** Variable-threshold-voltage CMOS (VTCMOS) approach, Multi-threshold-voltage CMOS (MTCMOS) approach, Power gating, Transistor stacking, Dual-Vt assignment approach (DTCMOS).	
Hands-on sessions with spice tools/Cadence	
MODULE 5: LOW ENERGY COMPUTING	**8 Hrs**
Energy recovery circuit design, designs with reversible and partially reversible logic, energy recovery in adiabatic logic, MOS Memories, Design of peripheral circuits – address decoder, level shifter and I/O Buffer, supply clock generation. Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip& package co design of clock network. Battery driven system design, CAD tools for Low Power	
Project based learning	

Text Books:

1. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, KAP, 2002.
2. Rabaey, Pedram, “Low Power Design Methodologies” Kluwer Academic, 1997.

References:

1. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.
2. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Interscience, 2000.
3. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill, 1999.

4. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint), 1993.
5. A. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995.

SEMESTER	**VII SEM**
YEAR	**IV YEAR**
COURSE CODE	**19EC4711**

TITLE OF THE COURSE	Linux Device Driver					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**1**	**39**	**3**

Prerequisite (if any)
C programming Concepts
OS Concepts
Embedded Systems Concepts

COURSE OBJECTIVES:

- To learn the framework used in building the Linux device driver.
- To get an insight into Linux kernel programming.
- To learn the concept of designing proc and ioctl needed to build a device driver.
- To learn the techniques associated with debugging kernel programs.
- To understand the designing of USB drivers

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COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the broad concept of device drivers and build character drivers.	**2-Understand** **3-Apply**
CO2	Analyze the design of kernel modules and understand the debugging of these modules.	**2-Understand** **4- Analyze**
CO3	Handle concurrency, race condition and understand the importance of time while designing a device driver.	**4- Analyze** **5 -Evaluate**
CO4	Allocate and evaluate the dynamic memory and communication with devices though I/O ports	**4- Analyze** **5 -Evaluate**
CO5	Demonstrate and design USB drivers on a kit.	**2-Understand** **1-Create**

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO DEVICE DRIVERS, BUILDING AND RUNNING LINUX KERNEL MODULE(LKM)	**08 Hrs**
Role of device driver, Splitting the Kernel, Classes of devices and Modules, Security Issues, Version Numbering, Licence Terms, The Hello World Module, Kernel Modules V/s Application, compiling and loading modules.	
Assignments followed by Viva-voce **Hands-on sessions**	
MODULE 2: CHARACTER DRIVERS & DEBUGGING TECHNIQUES	**08 Hrs**
Explanation of char drivers, Major & Minor Numbers, Data structures : File Operations, The File Structure, The inode Structure, Char Device Registration, Open and Release Methods, Read and Write Method, Debugging by: Printing, Querying & Watching, Debugging System Faults, debuggers & related tools.	

Assignments followed by Viva-voce **Hands-on sessions** **Student seminars**	
MODULE 3: CONCURRENCY, RACE CONDITIONS & ADVANCED CHAR DRIVER OPERATIONS	**08Hrs**
Concurrency and Its Management, Semaphores and Mutexes, Spinlocks, Locking Traps, Alternatives to Locking, ioctl, Blocking I/O, poll and select, Asynchronous Notification, Seeking a Device, Access Control on a Device File	
Assignments followed by Viva-voce **Hands-on sessions**	
MODULE 4: TIME, DELAY, DEFERRED WORK & ALLOCATING MEMORY	**08 Hrs**
Measuring Time Lapses, Knowing the Current Time, Delaying Execution, Kernel Timers, Work queues, kmalloc, Lookaside Caches, get_free_page and Friends, vmalloc and Friends, Obtaining Large Buffers	
Assignments followed by Viva-voce **Hands-on sessions**	
MODULE 5: COMMUNICATING WITH HARDWARE & INTERRUPT HANDLING	**07 Hrs**
I/O Ports and I/O Memory, Using I/O Ports, An I/O Port Example, Using I/O Memory, Preparing the Parallel Port, Installing an Interrupt Handler, implementing a Handler, Top and Bottom Halves, Interrupt Sharing, Installing a Shared Handler, Interrupt-Driven I/O.	
Assignments followed by Viva-voce **Hands-on sessions**	

Text Books:

1. Jonathan Corbet, Alessandro Rubini & Greg Kroah," Linux Device Drivers ", Third Edition, O'Reilly, 2005.

References:

1. Sreekrishnan Venkateswaran, "Essential Linux Drivers", Prentice Hall, 2008.
2. John Medieu, "Linux Device Drivers Development", Packt Publishing Ltd., 2017.

SEMESTER	**VII SEM**
YEAR	**IV YEAR**
COURSE CODE	**19EC4713**
TITLE OF THE COURSE	**VLSI PROCESS TECHNOLGY**

SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	V/3rd	19EC3503	CMOS VLSI Design

COURSE OBJECTIVES:

- To understand the Fabrication of ICs and purification of Silicon in different technologies.
- To impart in-depth knowledge about Etching and deposition of different layers.
- To understand the different packaging techniques of VLSI devices.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Identify the various design limits used for fabrication.	**2 Understand**
CO2	The ability to know methodology to fabricate an IC's	**2 Understand**
CO3	outline the complexities involved in the integrated circuits.	**2 Understand**
CO4	Assess the various reliability issues in VLSI technology	**3 Applying**
CO5	Apply principles to Identify and Analyze the various steps for the fabrication of various components	**3 Applying**

COURSE CONTENT:	
MODULE 1: Crystal Growth and Oxidation	**8 Hrs**
Introduction to VLSI Technology. **Crystal Growth**: monolithic and hybrid ICs, crystal growth, Czochralski technique of crystal growth, wafer preparation and specifications, testing, measurements of parameters of crystals, Fabrication steps **Oxidation**: Theory of growth of Silicon di oxide layer, calculation of SiO2 thickness and oxidation kinetics, Dry wet and high-pressure oxidation, plasma oxidation, properties of oxidation, defects induced due to oxidation.	
Assignments followed by Viva voce	
MODULE 2: Epitaxial Process and Diffusion Process.	**8 Hrs**
Epitaxial Process: Epitaxy and its concept, Growth kinetics of epitaxy, epitaxial growth, Low temperature epitaxy, Si-epitaxy- growth chemistry of Si epitaxial layer, auto-doping apparatus for epitaxial layer, apparatus for epitaxy, MBE system **Diffusion Process:** Diffusion models of solid, Fick's theory of diffusion, Solution of Fick`s law, diffusion parameters measurements schemes	
Certification Courses followed by Viva-voce	

MODULE 3: Ion Implantation and Lithography	**8 Hrs**
Ion Implantation: Scattering phenomenon, range theory, channeling, implantation damage, ion implantation systems, Annealing **Lithography**: Photolithography and pattern transfer, Optical and non-optical lithography, electron, X-ray and ion-beam lithography, contact/proximity and projection printers, alignment.	
Assignment followed by Viva-Voca	
MODULE 4: Etching and Metallization	**8 Hrs**
Photoresist and Etching: Types of photoresist, polymer and materials, Etching- Dry & Wet etching, basic regimes of plasma etching, reactive ion etching and its damages, lift-off, and sputter etching. **Metallization**: Applications and choices, physical vapor deposition, patterning, problem areas.	
Guest Lecture followed by Reflection Notes	
MODULE 5: Packaging and Reliability	**7 Hrs**
Packaging: Package types, packaging design consideration, VLSI assembly technologies. **Yield And Reliability:** Yield loss in VLSI, yield loss modeling, reliability requirements, accelerated testing.	
Poster Presentation on Recent trends in VLSI Technology	

Text Books:

1. S.M.Sze, VLSI Technology, 2nd edition, McGraw Hill, 2003.
2. S. K. Gandhi/VLSI Fabrication Principles/Wiley/2nd edition.
3. S.A. Campbell / The Science and Engineering of Microelectronic Fabrication / Oxford 2008/2nd edition

References:

1. James D Plummer, Michael D. Deal and Peter B. Griffin, Silicon VLSI Technology: Fundamentals Practice and Modeling, 1st edition, PHI, 2000.
2. Nandita Das Gupta, VLSI technology, NPTEL Courseware.

SEMESTER	**VII SEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4714**					
TITLE OF THE COURSE	**Embedded Systems and Automation**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	2	**0**	**0**	**1**	**39**	**3**

Prerequisite Courses (if any)
Basic Programming Concepts
Embedded System Concepts

COURSE OBJECTIVES:

- To learn the basic about embedded system and robotics
- To get an insight about various open source hardware platforms used for developing robots
- To get an understanding about the working principles of sensors and actuators
- To learn about ROS framework used for programming robots
- To design and develop projects/products catering to use-cases pertaining to various domains using robots

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the importance of embedded systems and robotics in our daily life.	**2-Understand**
CO2	Identify different hardware platforms for developing robots	**4-Identify**
CO3	Understand the robot configuration and sub-systems	**2-Understand**
CO4	Understand principle of robot programming.	**2-Understand**
CO5	Design different types of robots for different purposes.	**6-Design**

COURSE CONTENT:	
MODULE 1: Embedded Systems Overview	**8 Hrs**
Embedded Systems, Processors & Controllers, Embedded Communication Interface, RTOS	
MODULE 2: Robotics Terminologies	**8Hrs**
Robot Kinematics, Degree of freedom, Forward Kinematics, Algebraic Solutions, Inverse Kinematics, Sensors, Motors, Robot Controller, Frames & Materials, Types of Robots.	
MODULE 3: Hardware Platform for Robotics	**8 Hrs**
Open-Source Hardware Features, Open-Source Hardware Licensing, Advantages and Disadvantages of Open-Source Hardware, Examples of Open Source Hardware	
MODULE 4: ROS Basics and Foundation	**8 Hrs**
Introduction, A brief history, ROS Architecture : kinematics, motion planning,	

planning scene, 3D perception, trajectory processing, ROS Visualization, ROS Environment Configuration.	
MODULE 5: Applications	**7 Hrs**
Seminars and Projects on Robotic application catering to various domains	

Text Books:

1. Dey, N. and Mukherjee, A., 2018. *Embedded systems and robotics with open source tools*. CRC Press.
2. Koubâa, A. ed., 2017. *Robot Operating System (ROS)* (Vol. 1, pp. 112-156). Cham: Springer.

References:

1. Bräunl, T., 2008. *Embedded robotics: mobile robot design and applications with embedded systems*. Springer Science & Business Media.
2. Mittal, R.K. and Nagrath, I.J., 2003. *Robotics and control*. Tata McGraw-Hill.
3. Fu, K.S., Gonzalez, R. and Lee, C.G., 1987. *Robotics: Control Sensing. Vis*. Tata McGraw-Hill Education.

SEMESTER	**VII SEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4802**					
TITLE OF THE COURSE	**WIRELESS SENSOR NETWORKS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			
2			

COURSE OBJECTIVES:

- To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
- To study the various protocols at various layers and its differences with traditional protocols.
- To understand the issues pertaining to sensor networks.
- To learn the challenges involved in managing a sensor network.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Be familiar with the basic sensor network, their architectural elements and applications	**2-Understand** **3-Apply**
CO2	Identify different issues in wireless ad hoc and sensor networks	**2-Understand** **4- Analyze**
CO3	Technical knowhow in building a WSN network.	**2-Understand** **3-Apply**
CO4	Analysis of various critical parameters in deploying a WSN	**4- Analyze** **5 –Evaluate**
CO5	Ability to solve the issues in real-time application development based on WSN	**4- Analyze** **5 –Evaluate**

COURSE CONTENT:	
MODULE 1: OVERVIEW OF WIRELESS SENSOR NETWORKS	**8 Hrs**
Introduction, Sensor network applications – Habitat Monitoring –Tracking chemical plumes – Smart transportation. Advantages of sensor networks. Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks.	

Assignments followed by Viva-voce	
MODULE 2: WIRELESS SENSOR ARCHITECTURES	**8 Hrs**
Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.	
Assignments followed by Viva-voce	
MODULE 3: NETWORKING SENSORS	**8 Hrs**
Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.	
Trouble-shooting of problems **Logical reasoning of concept working**	
MODULE 4: INFRASTRUCTURE ESTABLISHMENT	**8 Hrs**
Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	
Assignments followed by Viva-voce	
MODULE 5: SENSOR NETWORK PLATFORMS AND TOOLS	**7 Hrs**
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming	
Expert lectures followed by reflection notes	

Text Books:

1. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005.
2. Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach”, Elsevier, 2007. Keiser G, “Optical Fiber Communication Systems”, 5th Edition, 6th Reprint, McGraw Hill Education (India), 2015.

References:

1. Kazem Sohraby, Daniel Minoli, and Taieb Znati, “Wireless Sensor Networks - Technology, Protocols and Applications”, John Wiley, 2007.
2. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**19EC4803**					
TITLE OF THE COURSE	**Hardware Architecture for AI**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			Mathematics – Linear Algebra, Optimization, Probability, Statistics, Gradient Calculus
2			

COURSE OBJECTIVES:

- To introduce students to the various Mathematical concepts to be used in ML and AI.
- To learn the design of hardware architectures and accelerators for deep-learning/artificial-intelligence.
- To provide an understanding of the theoretical concepts of machine learning and prepare students for research or industry application of machine learning techniques
- To provide hands-on experience on the various programming components for Artificial Intelligence.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Be familiar with hardware architecture and computing algorithms used in AI	**2-Understand** **3- Apply**
CO2	Understand different algorithms used in Machine learning.	**2-Understand**
CO3	Understand the Architecture of Deep Neural Network	**4- Analyze** **5 -Evaluate**
CO4	Analyze the hardware platforms suitable for various ML application	**4- Analyze** **5 -Evaluate**
CO5	Understand the language and deploy it for real time application	**2-Understand** **3-Apply**

COURSE CONTENT:	
MODULE 1: Artificial Intelligence	**08Hrs**
Artificial Intelligence – stages, types and examples, Concepts of Neural Networks - architecture, training methods, back propagation algorithm. Machine Learning – types - Supervised algorithms – Classification & Regression, Unsupervised Learning algorithms, Reinforcement Algorithm, Performance metrics for Classification & Regression Algorithms	

MODULE 2: Computational Background in AI	**08Hrs**
Linear Algebra, Gradient Calculus, Optimization, Probability & statistics, Information Theory, Approximate computing and storage, Roofline Model, Cache tiling (blocking), GPU architecture, CUDA programming, understanding GPU memory hierarchy, FPGA architecture, Matrix multiplication using systolic array	
MODULE 3: Deep Learning	**08Hrs**
Convolutional neural networks (CNNs) Architecture - convolutional layer, filters, stacking, pooling layer. Recurrent neural networks (RNNs): recurrent neurons, unrolling, input and output sequences, training RNNs, LSTM cell. Representation Learning and Generative Learning: Auto encoders.	
MODULE 4: Deep learning Hardware Platforms	**08Hrs**
Deep learning on FPGAs and case study of Microsoft's Brainwave, Deep learning on Embedded System (especially NVIDIA's Jetson Platform), Deep learning on Edge Devices (smartphones), Deep learning on an ASIC (especially Google's Tensor Processing Unit.), Deep-learning on CPUs and manycore processor (e.g., Xeon Phi), Memristor-based processing-in-memory accelerators for deep-learning.	
MODULE 5: Programming & Applications of AI	**07Hrs**
Python: Basics, Numpy, Pandas, Matplotlib, Scikit-Learn, NLTK, TensorFlow and Keras, Deploy machine learning systems on IoT device (Arduino Platform and Raspberry Pi based devices) (C/C++, Python), AI based projects - Hardware/system-challenges in autonomous driving, Examples with MATLAB	

TEXT BOOKS:

. 1. Brandon Reagen, Robert Adolf, Paul Whatmough, Gu-Yeon Wei, and David Brooks Deep Learning for Computer Architects Synthesis Lectures on Computer Architecture, August 2017, Vol. 12, No. 4, Pages 1-123 (https://doi.org/10.2200/S00783ED1V01Y201706CAC041)
2. Tor M. Aamodt, Wilson Wai Lun Fung, and Timothy G. Rogers General- Purpose Graphics Processor Architectures, Synthesis Lectures on Computer Architecture, May 2018, Vol. 13, No. 2, Pages 1-140 (https://doi.org/10.2200/S00848ED1V01Y201804CAC044)

REFERENCES:

1. M. P. Deisenroth, A. A. Faisal, C. S. Ong, Mathematics for Machine Learning, Cambridge University Press (1st edition)
2. T. Mitchell, Machine Learning, McGraw Hill, 1997

3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
4. Aurélien Géron “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow,” Second Edition, O'Reilly Media, Inc., 2019.

SEMESTER	**VII SEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4804**					
TITLE OF THE COURSE	**ADVANCED EMBEDDED SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3	**0**	**0**	**0**	**39**	**3**

Prerequisite Courses (if any)
Basic Programming Concepts
Embedded System Concepts

COURSE OBJECTIVES:

i. Differentiate and analyze the types of processors used in the embedded systems.
ii. To understand the architecture and programming model of ARM Cortex M4 processor.
iii. To gain knowledge on interrupts, and low power features of CORTEX M4 processor.
iv. To incorporate embedded concepts in IoT based projects

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand embedded systems and all the components, attributes, and benefits associated with it	**2-Understand**
CO2	Understand ARM architectures, processors, and its programmer's model and Perceive the knowledge of memory mapping, bit-band operations, endianness, and reset sequence of ARM Cortex-M4 processor	**4-Identify**
CO3	Design and implement embedded systems using ARM microcontroller.	**2- Design**
CO4	Explain various interrupts and low power features of Cortex M4 processor.	**1- Explain**
CO5	Apply the knowledge of embedded system design to build systems for practical applications	**6-Apply**

COURSE CONTENT:	
MODULE 1: Introduction to Embedded Systems	**8 Hrs**
Embedded systems overview, Advantages, Components, Application Areas, Characteristics – Data Handling, Concurrent and Reactive Behavior, Fault handling, Diagnostics & Firmware updates, Design Constraints that impact Embedded systems, Microprocessor Vs Microcontroller, Options for Building Embedded systems.	
Assignments followed by Viva-voce **Student seminars**	
MODULE 2: ARM Architectures & Processors	**8 Hrs**

ARM Architectures, ARM Cortex M Series Overview, ARM Cortex M4 processor features, architectural block diagram, Programming model- thread mode, handler mode, Cortex M4 General & special registers	
Assignments followed by Viva-voce **Student seminars**	
MODULE 3: ARM Cortex-M4 Processor Architecture	**8 Hrs**
Memory Map, Bit band operations, Program Image and Endianness, Thumb Instruction sets, ARM v7-M instruction set, Types of interrupts, Interrupt Priority, Wake up interrupt Controller	
Trouble-shooting of problems **Hands-on sessions**	
MODULE 4: Design Constraints & RISC V Architecture	**8 Hrs**
Low power features of Cortex M4 Processor, Design Constraints while using Interrupts, Design Constraints when developing low power applications, RISC V Architecture	
Trouble-shooting of problems **Hands-on sessions**	
MODULE 5: Case Study	**7Hrs**
ARM Programming examples, Seminars and Projects on embedded system application catering to various domains	
Student seminars **Projects**	

Text Books:

1. Wolf, Wayne, *"Computers as components – Principles of embedded computing system design",* Morgan-Kaufmann, 2008

2. Vahid F. and Givargis T., *"Embedded system design – A unified hardware/software introduction"*, John Wiley, 2002

References:

1. Steve Furber *"ARM system-on- chip architecture",* Pearson Education, 2000
2. Gibson. J.R., *"ARM assembly language-an introduction",* Dept. of Electrical Engineering and Electronics, University of Liverpool, 2007.
3. James K. Peckol, John Weily, *"Embedded Systems - A contemporary Design Tool",* 2008.
4. Shibu K.V, "*Introduction to Embedded systems*", McGraw Hill, 2009.
5. Andrew N. Sloss, Dominic Symes, Chris Wright, "*ARM System Developer's Guide: Designing and Optimizing System Software*", Morgan Kaufmann Publishers, 2004.

SEMESTER	**VIISEM**					
YEAR	**IV YEAR**					
COURSE CODE	**19EC4805**					
TITLE OF THE COURSE	**Satellite Communication**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	V/III	19EC3501	ANALOG AND DIGITAL COMMUNICATION

COURSE OBJECTIVES:

1.To understand the basic laws corresponding to satellite orbital motion.
2. To understand the performance of satellite system and optimization.
3. To analyze the various methods of satellite access.
4. To design the earth segment with link budget calculations .
5. Review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand principle, working and operation of various sub systems of satellite as well as the earth station	**2-Understand 3-Apply**
CO2	Apply various communication techniques for satellite application	**3-Apply**
CO3	Classify different set of earth station techniques.	**4-Analyze , Classify**
CO4	Illustrate the state of art techniques used in channel allocation and multiplexing in satellite access.	**4- Analyze 5 -Evaluate**
CO5	Explain the real time satellite applications.	**4- Analyze 2-Explain**

COURSE CONTENT:	
MODULE 1: SATELLITE ORBITS	**8 Hrs**
Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non-Geo-stationary orbits – Look Angle Determination- Limits of visibility – eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.	
MODULE 2: SPACE SEGMENT AND SATELLITE LINK DESIGN	**8 Hrs**
Spacecraft Technology- Structure, Primary power, Attitude control, Station keeping , Thermal control and Propulsion, Telemetry, Tracking and command , Brief introduction to transponders.	

Satellite Link Design : Basic Transmission Theory, System Noise Temperature and G/T Ratio, Calculation of System Noise Temperature, Design of Downlinks -Link Budgets, Uplink Design, Uplink and Downlink Attenuation in Rain ,Uplink Attenuation and (C/N)up ,Downlink Attenuation and (C/N)dn , System Design for Specific Performance	
MODULE 3: EARTH SEGMENT	**7 Hrs**
Earth Station Technology-Terrestrial Interface, Transmitter and Receiver, Antenna Systems , Receive only Home TV systems, MATV, CATV, Transmit – receive earth stations, Test Equipment Measurements on G/T, C/No, EIRP, Transmission losses	
MODULE 4: SATELLITE ACCESS	**8 Hrs**
Single Access , Preassigned FDMA , Demand-Assigned FDMA , Spade System , Bandwidth-Limited and Power-Limited TWT Amplifier Operation , FDMA Downlink Analysis ,TDMA ,Reference Burst , Preamble and Postamble , Carrier Recovery , Preassigned TDMA , Demand-Assigned TDMA , CDMA- Direct sequence spread spectrum	
MODULE 5: SATELLITE APPLICATIONS	**8 Hrs**
INTELSAT Series, INSAT, VSAT, PSLV, 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, GRAMSAT, Specialized services–E –mail, Video conferencing, Internet	

Text Books:

1. Dennis Roddy, 'Satellite Communication', McGraw Hill International, 4th Edition, 2006.

2. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2nd Edition, 2003.

References:

1. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, 'Satellite Communication Systems Engineering', Prentice Hall/Pearson, 2007.

2. Madhavendra Richharia, Leslie David, "Satellite Systems for Personal Applications Concepts and Technology", Wiley-Blackwell, 2010.

3. N.Agarwal, 'Design of Geosynchronous Space Craft, Prentice Hall, 1986.

4. Bruce R. Elbert, 'The Satellite Communication Applications' Hand Book, Artech House Bostan London, 1997.

5. Tri T. Ha, 'Digital Satellite Communication', II edition, 1990.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19EC4806**					
TITLE OF THE COURSE	**VLSI - DIGITAL SIGNAL PROCESSING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3		**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV/III	19ECxxx	**PLC and SCADA**
2			

COURSE OBJECTIVES:

- To understand the various VLSI architectures for digital signal processing.
- To know the techniques of critical path and algorithmic strength reduction in the filter structures.
- To study the performance parameters, viz. area, speed and power.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To be able to design architectures for DSP algorithms	**1-Remembering**
CO2	To be able to optimize design in terms of area, speed and power.	**1-Remembering** **2-Understanding**
CO3	To be able to incorporate pipeline based architectures in the design.	**2-Understanding** **3-Applying**
CO4	To be able to carry out HDL simulation of various DSP algorithms.	**1-Remembering** **2-Understanding**
CO5		**3-Applying** **4-Analyzing**
CO6		**5-Evaluate** **6-Create**

COURSE CONTENT:	
MODULE 1: Introduction	**07Hrs**
Overview of DSP – FPGA Technology – DSP Technology requirements – Design Implementation	
MODULE 2: METHODS OF CRITICAL PATH REDUCTION	**08Hrs**

Binary Adders – Binary Multipliers – Multiply-Accumulator (MAC) and sum of product (SOP) – Pipelining and parallel processing – retiming – unfolding – systolic architecture design.	
MODULE 3: ALGORITHMIC STRENGTH REDUCTION METHODS AND RECURSIVE FILTER DESIGN	**08Hrs**
Fast convolution-pipelined and parallel processing of recursive and adaptive filters – fast IIR filters design.	
MODULE 4: DESIGN OF PIPELINED DIGITAL FILTERS	**08Hrs**
Designing FIR filters – Digital lattice filter structures – bit level arithmetic architecture – redundant arithmetic – scaling and round-off noise.	
MODULE 5: SYNCHRONOUS ASYNCHRONOUS PIPELINING AND PROGRAMMABLE DSP	**08Hrs**
Numeric strength reduction – synchronous – wave and asynchronous pipelines – low power design – programmable DSPs – DSP architectural features/alternatives for high performance and low power	

TEXT BOOKS:

. 1. Keshab K.Parhi, “VLSI Digital Signal Processing Systems, Design and Implementation”, John Wiley, Indian Reprint, 2007.

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

REFERENCES:

1. S.Y.Kuang, H.J. White house, T. Kailath, “VLSI and Modern Signal Processing”, Prentice Hall, 1995.

SEMESTER	**VIII SEM**					
YEAR	**IV**					
COURSE CODE	**19EC4807**					
TITLE OF THE COURSE	**Signal Conditioning and Data Acquisition**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	3	**0**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	3rd/IInd	19EC2301	Analog Circuits
2			

COURSE OBJECTIVES:

- To Understand the basic principles of Signal Conditioning
- To apply signal conditioning technique to measure different physical quantities.
- To Familiarize Data Acquisition Techniques in measurement system.
- To understand concepts of acquiring the data from transducers/input devices, their interfacing and instrumentation system design.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Apply basic principles of Signal Conditioning in measuring instruments	**1-Remember 2-Understand 3-Apply**
CO2	Understand the concepts of Data Acquisition Techniques	**2-Understand 4- Analyze**
CO3	Ability to apply Data Acquisition concepts to operational amplifier and their performance	**3- Apply 2 -Understand**
CO4	Understand various data transfer techniques and industrial communication system	**2-Understand 3-Apply**
CO5	Understand the components of Data Acquisition system	**2-Understand 4-Analyze**

COURSE CONTENT:	
MODULE 1: Introduction to Signal Conditioning	**8 Hrs**
Operational Amplifiers, CMRR, Slew Rate, Gain, Bandwidth. Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, Basic Bridge amplifier and its use with strain gauge and temperature sensors, Filters in instrumentation circuits	

MODULE 2: Data Acquisition Technique	**8 Hrs**
Analog and digital data acquisition, Sensor/Transducer interfacing, unipolar and bipolar transducers, Sample and hold circuits, Interference, Grounding and Shielding.	
MODULE 3: Data Acquisition System	**8 Hrs**
Data Acquisition System Overview, sensors, signals, Data Acquisition Hardware, Signal Conditioning, Data Acquisition software.	
MODULE 4: Data Transfer Techniques	**8 Hrs**
Serial data transmission methods and standards RS 232-C: specifications connection and timing, 4-20 mA current loop, GPIB/IEEE-488, LAN, Universal serial bus, HART protocol, Foundation, Fieldbus, Modbus, Zigbee and Bluetooth.	
MODULE 5: Data Acquisition Application	**7 Hrs**
Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, PC-Based data acquisition system.	

TEXT BOOKS:

1. Sawhney, A.K. and Sawhney, P., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai (2008).
2. Coughlin, R.F., Operational Amplifiers and Linear Integrated Circuits, Pearson Education (2006).
3. Kalsi, H.S., Electronic Instrumentation, Tata McGraw Hill (2002).
4. Gayakwad, R.A., Op-Amp and Linear Integrated Circuits, Pearson Education (2002).
5. Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited (2007).

REFERENCES BOOKS:

1. Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India (2003).
2. Nakra, B.C. and Chaudhry, K.K., Instrumentation, Measurement and Analysis, Tata McGraw Hill (2003).
3. Ananad, M.M.S., Electronic Instruments and Instrumentation Technology, Prentice Hall of India Private Limited (2004).