Curriculum Undergraduate Programme

Bachelor of Technology

In

Electronics & Communication Engineering

Department of Electronics & Communication Engineering

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY
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VISION

To become a globally recognized department of higher learning that will provide inter-disciplinary knowledge, human values and professional ethics among the youth, so as to serve as a valuable resource for industry and society.

MISSION

"Educate to Excel in Social Transformation"

To serve the nation and the world by graduating proficient, knowledgeable engineers in the field of Electronics, Communication and related areas through constant interaction with research organizations and industries.

Program Educational Objectives

PEO 1. To provide strong background in basic sciences, mathematics, computing and engineering principles

PEO 2. To impart in-depth knowledge to students related to core areas of Electronics and Communication Engineering so as to comprehend, analyze, design, and create novel products and solutions for real life problems

PEO 3. To provide students with an academic environment to promote teamwork, ethics, multidisciplinary approach and lifelong learning required for a successful professional career

Program Outcomes

1. Apply knowledge of mathematics, science, and engineering fundamentals in the domain of Electronics and Communication
2. Potential to analyze an engineering problem and formulate its appropriate solution
3. Ability to design systems and processes that meet the requirements of public safety and offer solutions for societal and environmental issues
4. Ability to formulate and analyze complex engineering problems by using mathematical principles and engineering fundamentals
5. Select appropriate techniques and modern automation tools for the system design and analysis
6. Understanding the contemporary issues and the impact of engineering solutions on the society
7. Skills to develop environment friendly and sustainable solutions
8. Understanding and commitment towards professional ethics, responsibilities and norms of engineering practices so as to become good citizens
9. Ability to function effectively, individually and in a team
10. Proficiency in communication, both verbal and written forms, which will enable them to compete globally
11. Recognize the need for and have the ability to engage in independent and lifelong learning and hence participate and succeed in competitive examinations, higher studies etc.
12. Willingness and ability to take up administrative responsibilities involving both project and financial management confidently

B. Tech.
(Applicable to 2012 batch onwards)

Third Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	ECX-201	Analysis and Synthesis of Networks	3	1	0	**4**	4
2.	ECX-203	Electronic Devices and Circuits	3	1	0	**4**	4
3.	ECX-205	Digital Electronics	3	1	0	**4**	4
4.	ECX-207	Communication Signals and Systems	3	1	0	**4**	4
5.	MAX-201	Mathematics-II	3	1	0	**4**	4
6.	CSX-207	Object Oriented Programming	3	0	0	**3**	3
7.	ECX-211	Analysis and Synthesis of Networks Lab	0	0	2	**1**	2
8.	ECX-213	Electronic Devices and Circuits Lab	0	0	2	**1**	2
9.	ECX-215	Digital Electronics Lab	0	0	2	**1**	2
10.	CSX-227	Object Oriented Programming Lab	0	0	2	**1**	2
		TOTAL	**18**	**5**	**8**	**27**	**31**

<u>Courses offered to other Departments</u>

For Instrumentation and Control Engineering and Electrical Engineering Departments

1	ECX-251	Electronic Devices and Analog Integrated Circuits	3	1	0	**4**	4
2	ECX-261	Electronic Devices and Analog Integrated Circuits Lab	0	0	2	**1**	2

Fourth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	ECX-202	Analog Communication Systems	3	1	0	**4**	4
2.	ECX-204	Analog Integrated Circuits	3	1	0	**4**	4
3.	CSX-206	Data Structures and Algorithms	2	0	0	**2**	2
4.	ICX-232	Electronic Measurements and Instrumentation	3	0	0	**3**	3
5.	MAX-202	Mathematics-III	3	1	0	**4**	4
6.	PHX-208	Electromagnetic Field Theory	3	1	0	**4**	4
7.	ECX-212	Analog Communication Systems Lab	0	0	2	**1**	2
8.	ECX-214	Analog Integrated Circuits Lab	0	0	2	**1**	2
9.	CSX-226	Data Structures and Algorithms Lab	0	0	2	**1**	2
10.	ICX-252	Electronic Measurements and Instrumentation Lab	0	0	2	**1**	2
		TOTAL	**17**	**4**	**10**	**25**	**29**

*** Industrial Practical Training at the end of 4th semester for minimum 04 Weeks**

<u>Courses offered to other Departments</u>

For Instrumentation and Control Engineering and Electrical Engineering Departments

1.	ECX-205	Digital Electronics	3	1	0	4	4
2.	ECX-215	Digital Electronics Lab	0	0	2	1	2

For Computer Science and Engineering Department

3.	ECX-206	Microprocessor and Programming	3	0	0	3	3
4.	ECX-216	Microprocessor and Programming Lab	0	0	2	1	2

Fifth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	ECX-301	Microprocessor and Its Applications	3	1	0	**4**	4
2.	ECX-303	VLSI Circuit Design	3	1	0	**4**	4
3.	HMX-304	Human Resource Management and Industrial Relations	3	0	0	**3**	3
4.	PHX- 301	Material Science	3	0	0	**3**	3
5.	ICX-305	Control Engineering	3	0	0	**3**	3
6.	CSX-305	Operating Systems	3	0	0	**3**	3
7.	ECX-311	Microprocessor and Its Applications Lab	0	0	2	**1**	2
8.	ECX-313	Scientific Computing Lab	0	0	2	**1**	2
9.	CSX-325	Operating Systems Lab	0	0	2	**1**	2
10.	HMX-312	Soft Skills and Personal Interview	0	0	2	**NC**	2
11.	ECX-321	Industrial Training (4 weeks)	-	-	-	**2**	-
		TOTAL	**18**	**2**	**4**	**25**	**26**

Sixth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	ECX-302	Digital System Design	3	1	0	**4**	4
2.	ECX-304	Digital Communication Systems	3	1	0	**4**	4
3.	ECX-306	Digital Signal Processing	3	1	0	**4**	4
4.	ECX-308	Advanced Microprocessors and Microcontrollers	3	1	0	**4**	4
5.	HMX-201	Engineering Economics and Industrial Management	3	0	0	**3**	3
6.	ECX-312	Digital System Design Lab	0	0	2	**1**	2
7.	ECX-314	Digital Communication Systems Lab	0	0	2	**1**	2
8.	ECX-316	Digital Signal Processing Lab	0	0	2	**1**	2
9.	ECX-318	Advanced Microprocessors and Microcontrollers Lab	0	0	2	**1**	2
		TOTAL	**15**	**4**	**8**	**23**	**27**

*** Industrial Practical Training at the end of 6th semester for minimum 06 Weeks**

Courses offered to other Departments

For Textile Technology Department

1	ECX-310	Applications of Electronics in Textiles	3	1	0	4	4
2	ECX-320	Applications of Electronics in Textiles Lab	0	0	2	1	2

Seventh Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	ECX-401	Microwave Engineering	3	1	0	**4**	4
2.	ECX-403	Biomedical Signal Processing and Telemedicine	3	1	0	**4**	4
3.	ECX-4XX	Departmental Elective-I	3	0	0	**3**	3
4.	ECX-4XX	Departmental Elective-II	3	0	0	**3**	3
5.	IDX-4XX	Open Elective-I	3	0	0	**3**	3
6.	ECX-411	Microwave Engineering Lab	0	0	2	**1**	2
7.	ECX-413	Biomedical Signal Processing and Telemedicine Lab	0	0	2	**1**	2
8.	ECX-300	Industrial Practical Training	-	-	-	**4**	-
9.	ECX-400	Project (Phase-I)	-	-	4	**2**	4
		TOTAL	**15**	**2**	**8**	**25**	**25**

List of Electives

Department Elective – I

1.	ECX-451	Advanced Signal Processing
2.	ECX-453	Satellite Communication
3.	ECX-455	Wireless Sensor Networks
4.	ECX-457	Evolutionary Algorithms based Engineering Design
5.	ECX-459	VLSI Testing
6.	ECX-461	Digital Integrated Circuits

Department Elective- II

1.	ECX-481	Computer Organization
2.	ECX-483	Technology Entrepreneurship
3.	ECX-485	Machine Learning
4.	ECX-487	GPU Computing
5.	ECX-489	Digital Signal Processors

Eighth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	ECX-402	Advanced Communication Systems	3	0	0	**3**	3
2.	ECX-404	Microelectronics	3	0	0	**3**	3
3.	ECX-4XX	Department Elective-III	3	0	0	**3**	3
4.	ECX-4XX	Departmental Elective-IV	3	0	0	**3**	3
5.	IDX-4XX	Open Elective-II	3	0	0	**3**	3
6.	ECX-400	Project (Phase-II)	-	-	8	**4**	8
		TOTAL	**15**	**0**	**8**	**19**	**23**

Departmental Elective – III

1.	ECX-432	Antenna and Wave Propagation
2.	ECX-434	Information and Coding Theory
3.	ECX-436	Pulse and Switching Waveforms
4.	ECX-438	Radar & TV Engineering
5.	ECX-440	Reliability Engineering
6.	ECX-442	Power Electronics

Departmental Elective – IV

1.	ECX-452	Computer Communication Networks
2.	ECX-454	Neural Networks and Fuzzy Logic
3.	ECX-456	Wavelet Theory and Applications
4.	ECX-458	Computer Vision
5.	ECX-460	Cognitive Radio
6.	ECX-464	Mobile Computing
7.	ECX-466	Optical Communication Systems and Networks
8.	ECX-468	Telecommunication Switching and Networks
9.	ECX-470	Mixed Signal IC Design
10.	ECX-474	Digital IC Design
11.	ECX-476	Analog IC Design
12.	ECX-478	MEMS
13.	ECX-480	RF Circuit Design
14.	ECX-482	RF Planning and Optimization
15.	ECX-484	Game Theory and Applications
16.	ECX-486	Image Processing
17.	ECX-488	Gamification

Total Credits (3rd to 8th semester) = 144

Detailed course contents of 3rd semester

ECX-201	Analysis and Synthesis of Networks	[3 1 0 4]

Course Objectives

Analysis and Synthesis of Networks is one of the fundamental courses and is a gateway course to many engineering subjects. The objective of this course is to provide the necessary background for understanding the behaviour of many electrical & electronic devices, networks and provides knowledge of network synthesis.

Course Contents

Circuit Concepts: Review of circuit concepts, sign conventions, voltage and current relations for Resistors, Inductors and Capacitors, Kirchoff's voltage law, Kirchoff's current law, Voltage division and current division, Series parallel elements, magnetically coupled circuits, Loop current and node voltage methods for network analysis, Types of Electrical Energy Sources: Independent and dependent voltage and current sources **(6)**

Network Theorems: Superposition theorem, Thevenin and Norton Theorem, Maximum power transfer theorem, Tellegen's theorem, Millman's theorem, Reciprocity theorem, Compensation theorem **(7)**

Network Graph Theory: Concept of a network graph, terminology, concept of a Tree, Incidence Matrix, Tie-Set Matrix, Cut-Set Matrix, Graph theory for electric networks analysis **(5)**

Laplace Transformation: Introduction, Advantages of Laplace transformation, Definition and basic theorems of Laplace transform, concept of complex frequency, Laplace transform of some basic functions, inverse Laplace transform, application of Laplace transform for analysis of electric circuits, convolution theorem **(3)**

Network Functions and Network Synthesis: Network functions, Impedance & Admittance function, Transfer functions, Relationship between transfer and impulse response, poles and zeros and their restrictions for different types of network functions, Network behavior from pole-zero plots, the concept of stability, Elements of Realizability, Hurwitz polynomial, Network synthesis techniques for 2-terminal network, Foster and Cauer forms. **(10)**

Passive Filters Synthesis: Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T section, IT section, terminating half section. Pass bands and stop bands. Design of constant-K, m-derived filters. Composite filters. **(5)**

Introduction to SPICE simulators and MATLAB for solving circuit problems **(4)**

Recommended Books

1. Van-Valkenberg M E "Network Analysis", PHI, New Delhi, Third Edition (1999).
2. Van-Valkenberg M E, "Introduction to Modern Network Synthesis", John Wiley & Sons (1999).
3. Nahvi M, Edminister J, "Electric Circuits (Schaum's Outline Series)", Tata McGraw Hill, Fourth Edition, (2002).
4. Syed Nasar, "3000 Solved Problems in Electric Circuits (Schaum's Solved Problems Series)", Tata McGraw Hill.
5. S P Ghosh, A K Chakraborty, "Network Analysis and Synthesis" Tata McGraw Hill (2010).
6. DeCalro and Lin "Linear Circuit Analysis", 2nd Ed. Oxford University Press, Indian Edition (2004).

ECX-203	**Electronic Devices and Circuits**	**[3 1 0 4]**

Course Objectives

This course aims to provide detailed description of basic semiconductor diodes, its application, basic of BJT, amplifiers, biasing and stability concepts. Next focus is to give the detail description about FET, FET amplifiers and it biasing and multistage amplifiers finally give the idea of advanced devices of FET family i.e. MOSFET, MESFET and CMOS devices.

Course Contents

Semiconductor Diodes: PN junction Diode - VI characteristics, qualitative and quantitative analysis of its behavior, Diode resistance, Transition capacitance and Diffusion capacitance, clippers, clampers, Special purpose diodes - Zener diode, junction diode. **(6)**

Bipolar Junction Transistor: Transistor current components, Transistor as an amplifier, Amplifier types- CE, CB, CC and their characteristics, small signal low frequency transistor model: Hybrid model of BJT, Analysis of amplifier using Hybrid model of BJT, Transistor at high frequency and hybrid pi-model, introduction to HBT. **(7)**

Transistor Biasing and Stabilization: DC operating point, DC Biasing circuits-fixed bias, emitter bias, voltage divider bias, voltage feedback, Bias stability, Stabilization against variation in I_{co}, V_{BE} and β, Bias compensation. **(6)**

Multistage and Feedback Amplifiers: Amplifier frequency response-low frequency range and high frequency, Frequency response of multistage amplifiers, various coupling methods for multistage amplifiers, Feedback concept, oscillator. **(7)**

Field-Effect Transistor: The junction FET - construction, operation, characteristics, parameters, Biasing of JFET, Small signal analysis of JFET as an amplifier- common source and common drain amplifiers, Introduction to MESFET **(7)**

Metal Oxide Semiconductor FET: MOSFET- construction, operation, characteristics, parameters, CMOS devices, CMOS inverter characteristics, metal semiconductor. **(7)**

Recommended Books

1. Millman, Jacob, Halkias Christos C and Satyabrata jit, "Electronic Devices and Circuits" 3rd edition, Tata McGraw- Hill, New Delhi, 2010.
2. Boylestad Nashelsky, "Electronic Devices and Circuit Theory" 8th edition,Pearson Education, 2004.
3. Floyd, Thomas L, "Electronic Devices" 6th edition, Pearson Education, 2002.
4. Sedra, Adel S and Smith, Kenneth C, "Microelectronic Circuits" 4th edition, Oxford University Press, New York,1997.
5. Streetman Ben J, Sanjay Banerjee, "Solid State Electronic Devices" 5th edition, PHI, 2004.

ECX-205	**Digital Electronics**	**[3 1 0 4]**

Course Objectives

The use of digital circuitry is present in virtually all aspects of our lives and its use is increasing rapidly. Thus, this course aims to introduce postulates of Boolean algebra; methods for simplifying Boolean expressions and also outline the formal procedures for the analysis and design of combinational and sequential circuits. Next focus is to get student familiarize with concepts of digital logic families, D/A & A/D converters, memories and programmable logic devices.

Course Contents

Number Systems And Boolean Algebra: Subtraction using 1's & 2's complements and using 9's &10's complements, Binary codes, Error detecting and Correcting codes, Theorems of Boolean algebra, Canonical forms, Logic gates. **(6)**

Combinational Circuits: Representation of logic functions, Simplification using Karnaugh map, Tabulation method, Implementation of combinational logic using standard logic gates, Multiplexers and Demultiplexers, Encoders and Decoders, Code Converters, Adders, Subtractors, Parity Checker and Magnitude Comparator. **(7)**

Sequential Circuits: Flip flops - SR, JK, D and T flip flops - Level triggering and edge triggering, Excitation tables - Counters - Asynchronous and synchronous type Modulo counters, design with state equation state diagram, Shift registers, type of registers, circuit diagrams. **(7)**

Digital Logic Families: Introduction to bipolar Logic families: RTL, DCTL, DTL, TTL, ECL and MOS Logic families: NMOS, PMOS, CMOS, Details of TTL logic family - Totem pole, open collector outputs, TTL subfamilies, Comparison of different logic families. **(7)**

D/A And A/D Converters: Weighted resistor type D/A Converter, Binary ladder D/A converter, Steady state accuracy test, D/A accuracy and resolution, Parallel A/D Converter, counter type A/D converter, Successive approximation A/D converter, Single and Dual slope A/D converter, A/D accuracy and resolution. **(6)**

Semiconductor Memories: Memory organization, Classification, and characteristics of memories, Sequential memories, ROMs, R/W memories, Content Addressable memories, Charged-Coupled Device memory, PLA, PAL and Gate Array. **(7)**

Recommended Books

1. Mano M. Morris, "Digital Design", 3rd edition, Pearson Education 2006.
2. Jain R. P. "Modern Digital Electronics", 3rd edition, Tata McGraw-Hill 2003.
3. Malvino and Leach "Digital principles and Applications", 5th edition, Tata McGraw Hill, 2003.
4. James W. Bignell and Robert Donovan, "Digital Electronics", 5th edition, Delmar Publishers, 2007.
5. Flecther "An Engineering Approach to Digital Design", 1st edition, PHI, 2009.
6. Tocci Ronald J. "Digital Systems-Principles and Applications" 10th edition, PHI, 2009.

ECX-207	**Communication Signals and Systems**	**[3 1 0 4]**

Course Objectives

This course aims to provide detailed description of Fourier series and Fourier transform of continuous and discrete signals along with various types of signals and system. Next focus is to get student familiarize with concepts of probability applied to signals and noise forms that can affect the systems.

Course Contents

Systems And Signal Analysis: Detailed Classification of Signals and Systems, Fourier Series and its properties, Fourier transform and its properties along with applications, Discrete Time Fourier Series (DTFS) and Discrete Time Fourier Transform (DTFT). **(10)**

Correlation and Spectral Density: Definition of Correlation and Spectral Density, Analogy between correlation, covariance and convolution, conceptual basis, auto-correlation, cross correlation, energy/power spectral density, properties of correlation and spectral density, inter relation between correlation and spectral density. **(2)**

Random Signal Theory: Introduction to Probability Theory, Definition of Probability of Random Events. Joint and Conditional Probability, Probability Mass Function, Statistical Averages. Probability Density Functions (PDF) and Statistical Averages, mean, moments and expectations, standard deviation and variance. Probability models: Uniform, Gaussian, Binomial. Examples of PDF, Transformation of Random Variables. Random Processes, Stationary and Ergodicity. **(12)**

Introduction To Noise: Thermal Noise, Shot noise, Partition noise, Flicker noise, Gaussian Noise, Noise in Bipolar Junction Transistors (BJTs), FET noise. Equivalent input noise, Signal to Noise Ratio (SNR), Noise Temperature, Noise equivalent Bandwidth, Noise Figure. Experimental determination of Noise Figure, Pulse Response and Digital Noise and its elimination. **(12)**

Signal Transmission Through Linear Networks: Convolution Theorem and its graphical interpretation. The Sampling Theorem, Low Pass and Band Pass Networks, Matched Filter, Enveloped detector. **(4)**

Recommended Books

1. B P Lathi, "Digital and Analog Communication Systems" 4th edition, Oxford University Press, 2000.
2. Ravi Kumar , " Signals and Systems" PHI learning, 2009.
3. Simon Haykin , "Signals and Systems" 2nd edition, Wiley, 2008.
4. George R Cooper, "Probabilistic methods of Signals and System Analysis" 3rd edition, 2010.
5. D Ganesh Rao and Satish Tunga, " Signals and Systems" Pearson, 2008.

MAX-201	**Mathematics-II**	**[3 1 0 4]**

Course Contents

Linear dependence of vectors and rank of matrices, linear transformations and inverse of matrices, reduction to normal form, bilinear form and quadratic form, consistency and solution of linear algebraic system of equation, Eigen values, Eigen vectors and their applications to system of ordinary differential equations, Cayley Hamilton theorem, orthogonal, unitary, hermitian and similar matrices.

Differential calculus of functions of several variables, partial differentiation, homogeneous functions and Euler's theorem, Taylor's and Maclaurin's series, Taylor's theorem for functions of two variables maxima and minima of functions of several variables, Langrange's method of multipliers.

Double and triple integrals, change of order of integration, change of variables, applications to evaluation of area, surface area, and volume.

Scalar and vector fields differentiation of vectors, velocity and acceleration, vector differential operators Del, Gradient, Divergence and Curl and their physical interpretations, formulae involving these operators, line, surface and volume integrals, solenoidal and irrotational vecotors, Green's theorem, Gauss divergence theorem, Stoke's theorem and their applications.

Formulation and classification of partial differential equations, solution of first order linear equations, standard forms of non- linear equations, Charpit's method, linear equations with constant coefficients, non- homogenous linear equations, Monge's method for non-homogenous equations of second order, separation of variables methods for solution for solution of heat, wave and Laplace equation.

Recommended Books

1. E Kreyszig,"Advanced Engineering Mathematics", 8th Ed. John Wiley, Singapore (2001)
2. R K Jain and S R K Iyengar, Advanced Engineering Mathematics", 2nd Ed, Narosa Publishing House, New Delhi (2003).
3. I A N Sneddon,"Elements of Partial Differential Equations", Tata McGraw Hill, Delhi (1974).
4. B S Grewal,"Higher Engineering Mathematics",Thirty –fifth edition, Khanna Publishers, Delhi.

CSX-207	Object Oriented Programming	[3 0 0 3]

Course Contents

Object oriented thinking: Need for OOP Paradigm, Procedural programming vs object oriented programming, object oriented concepts.
Functions: Main function, function prototyping, inline functions, reference variables, call by reference, Defaults arguments, function overloading, Math library functions.
Class: Difference between C structure and class, specifying a class, Defining member functions: inside and outside class, scope resolution operator, Array within a class, array of objects, Static data members and member functions, Object as function arguments, returning objects, Friend function, memory allocation for objects, pointer to members, pointer to object, this pointer local classes.
Constructor and destructor: Constructor, types of constructors: default, parameterized and copy constructor, constructor overloading, constructor with default parameter, dynamic initialization of objects, destructor
Operator overloading and Type Conversion: Defining operator overloading, overloading unary and binary operator, Data Conversion: Basic to User Defined, User defined to basic, Conversion from one user-defined to other.
Inheritance and polymorphism: Base class, derived class, visibility modes, derivation and friendship, Types of inheritance, Containership, virtual function binding, pure virtual functions, Abstract class, pointer to derived class
Console IO operations: C++ stream classes, Unformatted IO operations, formatted IO operations, managing output with manipulators
Working with files: Classes for file stream operations, opening and closing files, detectinf cof, File opening modes, file Pointers, Error handling during file operations, command line arguments. Templates: Class template, class template with parameter, function template, function template with parameter.

Recommended Books

1. Bjrane Stroustrup, “C++ Programming language”,3rd edition, Pearson Education Asia (1997)
2. Lafore R., “Object oriented Programming in C++”, 4th Ed. Techmedia, New Delhi (2002).
3. Yashwant Kenetkar,”Let us C++”, 1stEd., Oxford University Press (2006)
4. B.A. Forouzan and R.F. Gilberg, CompilerScience, “A structured approach using C++”, Cengage Learning, New Delhi.

ECX-211	**Analysis and Synthesis of Network Lab**	**[0 0 2 1]**

1. Verification of Loop Current and Node Voltage methods
2. To verify Thevenin Theorem and Norton Theorem for a given network
3. To verify maximum power transfer theorem and reciprocity theorem
4. To study resonance in circuits
5. To design and plot frequency response of low pass and high pass T type filters
6. To design and plot frequency response of a band pass T type filter
7. To design and plot frequency response of composite low pass filter
8. Determination of h-parameters of a network
9. To plot the transient response of a network

Experimentation to be supported by computer simulations.

ECX-213	**Electronics Devices and Circuits Lab**	**[0 0 2 1]**

1. To study bipolar transistor as a switch.

2. To plot a load line for a CE amplifier and show effect of input signal on Q-point.
3. To demonstrate use of a BJT in a CE amplifier circuit configuration and study its frequency response.
4. To demonstrate use of a BJT in a CC amplifier circuit configuration and study its frequency response.
5. To demonstrate use of a power BJT as an amplifier.
6. To study frequency response of a tuned amplifier.
7. To demonstrate and study a two stage RC coupled amplifier.
8. To demonstrate and study a Transformer coupled amplifier.
9. To demonstrate working of a JFET and study its V-I characteristics.
10. To experimentally study working of a CS JFET amplifier.
11. To demonstrate working of a LED and calculate appropriate value of series Resistance RS for it.

Experimentation to be supported by computer simulations.

ECX-215	**Digital Electronics Lab**	**[0 0 2 1]**

1. Design and verification of the truth tables of Half and Full adder circuits.
2. Design and verification of the truth tables of Half and Full subtractor circuits.
3. Design and implementation of 4 bit binary Adder/ Subtractor and BCD adder using IC7483.
4. Design and implementation of code converters using logic gates
   (i) BCD to excess-3 code
   (ii) Binary to gray code
5. Verification of the truth table of the Multiplexer using IC 74150.
6. Verification of the truth table of the De-Multiplexer using IC 74154.
7. Design and test of an SR flip-flop using NOR/NAND gates.
8. Verify the truth table of a D flip-flop (7474) and JK flip-flop (7476).
9. Design and implementation of 3-bit synchronous up/down counter.
10. Construction and verification of 4 bit ripple counter and Mod-10 / Mod-12 Ripple counters using JK flip-flop.
11. Operate the counters 7490, 7493. Verify the frequency division at each stage and with a low frequency clock (say 1 Hz) display the count on LEDs.
12. Operate the universal shift register 74194.
13. Verify the truth table of decoder driver 7447/7448. Hence operate a 7 segment LED display through a counter using a low frequency clock.
14. Design and test D/A converter using R-2R Ladder Network

Experimentation to be supported by computer simulations on SPICE simulator.

CSX-227	Object Oriented Programming Lab	[0 0 2 1]

1. Write a program to read a matrix of size m x n form the keyboard and display the same using function.
2. Program to make the use of inline function
3. Write a function power () which raise a number m to a power n. The function takes double value of m and integer value of n and returns the result. Use a default value of n is 2 to make the function to calculate squares when this argument is omitted.
4. Program to show that the effect of default arguments can be alternatively achieved by overloading.
5. Write a class ACCOUNT that represents your bank account and then use it. The class should allow you to deposit money, withdraw money, calculate interest, send you a message if you have insufficient balance.
6. Write a class STRING that can be used to store strings, add strings, equate string, output strings.
7. Create the class TIME to store time in hours and minutes. Write a friend function to add two TIME objects.
8. Create two classes DM and DB. DM stores the distance in meter and centimeters and DB stores the distance in feet and inches. Write a program two add object of DM with the object of DB class.
9. Write a program to create an abstract class named Shape that contains an empty method named number Of Sides ( ).Provide three classes named Trapezoid, Triangle and Hexagon such that each one of the classes inherits the class Shape. Each one of the classes contains only the method number Of Sides ( ) that shows the number of sides in the given geometrical figures.
10. Program to demonstrate the concept of:
    a. Default constructor
    b. Parameterized constructor
    c. Copy constructor
    d. Constructor overloading
11. Program to demonstrate the concept of destructor.
12. Program to show multiple inheritance
13. Program to show multilevel inheritance
14. Program to show hybrid inheritance
15. Program to show the concept of containership.
16. Program to overload unary operator.
17. Program to overload binary operator
18. Program to show the concept of run time polymorphism using virtual function.
19. Program to work with formatted and unformatted IO operations.
20. Program to read the name and roll numbers of students from keyboard and write them into a file and then display it.
21. Program to copy one file onto the end of another, adding line numbers
22. Write a function template for finding the minimum value contained in an array.
23. Write a class template to represent generic vector (a series of float values). Include member function to perform following tasks.
    a. Create vector
    b. Modify the value of a given element
    c. To multiply by a scalar value
    d. To display vector in the form of (10, 20, 30,……)

This is only the suggested list of experiments. Instructor may frame additional experiments relevant to the course contents.

Courses offered to other Departments

For Instrumentation and Control Engineering and Electrical Engineering Departments

ECX- 251	**Electronic Devices and Analog Integrated Circuits**	**[3 1 0 4]**

Course Objectives

This course combines two components viz electronic devices and analog integrated circuits. The course contents of the first component are designed to provide adequate knowledge on solid state devices, their physical characteristics and their basic applications in electronic circuits. The second component aims to provide detailed description of operational amplifiers. Description of some general purpose ICs has been included.

Course Contents

Introduction to Semiconductors Devices: Semiconductors, Conductor and Insulators, Intrinsic and extrinsic silicon, p-n junction, Current-Voltage characteristics of a p-n junction diode, Rectifiers-half wave and full wave, Special purpose diodes - Zener diode, Tunnel diode and Varactor diode, Photo diode, clippers-single and two level, clampers, their analysis with ideal and practical diodes. **(8)**

Bipolar Junction Transistor: Transistors-construction, operation, characteristics, parameters, Transistor as an amplifier at low frequency, Hybrid model and r_e model of BJT, Analysis of amplifier using Hybrid model and *re* model, Amplifier types-CE,CB,CC. DC operating point, Biasing circuits-fixed bias, emitter bias, voltage divider bias, bias stabilization. **(8)**

Field-Effect Transistor: The junction FET - construction, operation, characteristics, parameters, JFET as an amplifier, FET as a VVR and MOSFET- construction, operation, characteristics, parameters. **(5)**

Power and Multistage Amplifiers: Power Amplifiers, Types, analysis of Class A, B, C, AB; Multistage Amplifiers, Types of multistage couplings. Feedback Amplifier and Oscillators: Feedback concept, Analysis of various configurations of feedback in amplifiers, Criterion for oscillation and Oscillator based on RC and LC feedback circuits, crystal oscillator. **(9)**

Introduction to op-amps: Op-amp- analysis, Ideal op-amp building blocks, Open loop op-amp configurations, Practical op-amp- Offset voltage, Input bias and offset current, CMRR, Block diagram representations and analysis of configurations using negative feedback. Applications of op-amp. **(7)**

Specialized ICs: 555 Timer- Monostable multivibrator, Astable multivibrator, PLLs **(6)**

Recommended Books

1. Jacob Millman, Christos C Halkias and Satyabrata jit, “Electronic Devices and Circuits” Tata McGraw- Hill, New Delhi, 2008.
2. Boylestad Nashelsky, “Electronic Devices and Circuit Theory”, 8th edition., Pearson Education, 7thIndian Reprint, 2004.
3. Ramakant A Gayakwad, “Op-amps and Linear Integrated Circuits”, Pearson Education, 4th edition., New Delhi, 2002.
4. Adel S Sedra, and Kenneth C Smith, “Microelectronic Circuits”, Oxford University Press, New York, 4th edition, 1997.
5. Ben J Streetman and Sanjay Banerjee, “Solid State Electronic Devices”, 5th edition. PHI, 2004.

ECX-261	**Electronic Devices and Analog Integrated Circuits Lab**	**[0 0 2 1]**

1. To study bipolar transistor as a switch.
2. To plot a load line for a CE amplifier and show effect of input signal on Q-point.
3. To demonstrate use of a BJT in a CE amplifier circuit configuration and study its frequency response.
4. To demonstrate use of a BJT in a CC amplifier circuit configuration and study its frequency response.
5. To demonstrate and study a two stage RC coupled amplifier.
6. To demonstrate working of a JFET and study its V-I characteristics.
7. To demonstrate working of a Wein Bridge Oscillator.
8. To demonstrate working of an op-amp as a voltage level detector.
9. To demonstrate working of an op-amp as a square wave generator.
10. To demonstrate the operation of a 555 timer as monostable multivibrator.
11. To demonstrate the operation of a 555 timer as astable multivibrator.

Experimentation to be supported by computer simulations.

Detailed course contents of 4th semester

ECX-202	Analog Communication Systems	[3 1 0 4]

Course Objectives

This course aims to provide detailed description communication system, modulation and noise fundamental in analog communication. Next focus is to get student familiarize with concepts of AM, FM, PM modulation technique along with their transmitter and receiver system. Finally this course gives the concept of pulse modulation techniques.

Course Contents

Analog Modulation Techniques: Introduction, Theory of Amplitude Modulation; AM Power Calculations, AM Modulation with a Complex wave, Theory of Frequency Modulation (FM); Spectra of FM Signals, Narrow Band and Wide Band FM, Theory of Phase Modulation, Comparison of AM and FM, Comparison of PM and FM, Noise and Frequency Modulation, Pre-emphasis and De-emphasis. **(10)**

AM Transmission/AM Reception: Introduction, Generation of Amplitude Modulation, Basic Principles of AM Generation; Square law Diode Modulation, Vander Bijl Modulation, Suppressed Carrier AM Generation, Ring Modulator, Balanced Modulator. Tuned Radio Frequency (TRF) Receiver, Basic Elements of AM Super-heterodyne receiver; RF Amplifiers Characteristics-Sensitivity, Selectivity, Image Frequency Rejection, Mixers Tracking and Alignment, Local Oscillator, IF Amplifier, AM Detectors; Envelope or Diode Detector, AGC, AM Receiver using Transistors Communication Receiver. **(10)**

FM Transmission/FM Reception: Generation of FM by Direct Methods. Indirect Generation of FM; The Armstrong Method, FM Stereo Transmission. FM Receiver Direct Methods of Frequency Demodulation; Slope Detector, Travis Detector,Foster Seely or Phase Discriminator, Indirect methods of FM Demodulation; FM Detector using PLL and Stereo FM Multiplex Reception. **(10)**

SSB Transmission/SSB Reception: Advantages of SSB transmission, Generation of SSB; Independent Side-Band Systems (ISB), Vestigial Side-Band Modulation (VSB).SSB Product Demodulator, Balanced Modulator as SSB Demodulator, ISB/Suppressed Carrier receiver **(5)**

Pulse Modulation Transmission and Reception: Introduction, Pulse Amplitude Modulation (PAM), PAM Modulator Circuit, Demodulation of PAM Signals, Pulse Time Modulation (PTM); Pulse Width Modulation (PWM), Pulse Position Modulation (PPM) **(5)**

Recommended Books

1. George Kennedy, “Electronic Communication System” 4th edition, McGraw- Hill, 2000.
2. Gary M. Miller and Jeffery S. Beasley, “Modern Electronic Communications” PHI, 2009.
3. Simon Haykin, “Communication Systems” 3rd edition, Wiley Publishers, 2007.
4. Wayne Tomasi, “Electronics Communication systems” 5th edition, Pearson Publishers, 2008.
5. Proakis, “Communication Systems”4th Edition, McGraw-Hill Publications.

ECX-204	**Analog Integrated Circuits**	**[3 1 0 4]**

Course Objectives

This course aims to introduce the concepts of differential amplifiers, ideal and practical operational amplifiers and also the effect of negative feedback on op-amps parameters. This course also outlines the applications of op-amp circuits. Next focus is to get student familiarize with concepts of different types of filters, oscillators and some specialized ICs like- 555 timer and PLL.

Course Contents

Differential amplifiers: Introduction, Differential Amplifier configurations– Dual Input-Balanced output, Dual Input-Unbalanced output, Single Input-Balanced output, Single Input-Unbalanced output Differential amplifier with their DC and AC analysis, Differential amplifier using FET, Differential amplifier with swamping resistors, Constant current bias, Current mirror, Cascaded differential amplifier Stages, Level Translator, Cascode amplifier. **(8)**

Introduction to Op-amps: Block diagram of a typical Op-Amp, Schematic symbol, Characteristics and performance parameters of ideal Op-Amp, Open loop configurations: Differential, Inverting & Non Inverting. Practical Op-Amp: offset voltage analysis and compensation, input bias and offset current analysis and compensation, Change in Input offset voltage and Input offset current with time, Temperature and supply voltage, Common mode configuration and Common mode rejection Ratio, Frequency response, slew rate. **(8)**

Op-amp with Negative Feedback: Block diagram representation of feedback configurations, Voltage-series and Voltage–shunt feedback amplifier, Differential amplifiers-using one op-amp, two op-amps, three op-amps. **(5)**

Op-amp Applications: DC and AC amplifiers, Peaking amplifiers, Summing, Scaling and Averaging amplifiers, Differential amplifier, Instrumentation amplifiers, V to I and I to V converters, Differentiator and integrator, A to D and D to A converters, Log and antilog amplifiers, Sample and hold circuits, Schmitt trigger. **(6)**

Active Filters and Oscillators: Active filters- Low-Pass, High-Pass, Band-Pass, Band-Reject Butterworth filters, State variable filters, All pass filters, Sallen and Key structures, Introduction to Chebyshev and Cauer Filters, phase-shift & Wein bridge Oscillators, Square wave, triangular wave and saw-tooth wave generators, Voltage controlled oscillator. **(7)**

Specialised ICs: Phase Locked Loop- Operating principles and applications, Voltage Regulators - Fixed, adjustable and switching regulators, 555 Timer- its applications as Monostable and Astable multivibrators. **(6)**

Recommended Books

1. Gayakwad Ramakant A., “Op-amps and Linear Integrated Circuits”, 4th edition, Pearson Educatio Inc, Delhi, 2000.
2. Botkar K B, “Integrated Electronics”, 10th edition, Khanna Publishers, 2005.
3. Sedra, Adel S and Smith, Kenneth C, “Microelectronic Circuits”, 5th edition, Oxford Universit Press, 2005.
4. Roy Choudhary D and Jain Shail, “Linear Integrated Circuits”, 3rd edition, New Age Internationa Publishers, 2007.
5. J. Michael Jacob, Applications and design with Analog Integrated Circuits”, 2nd edition, PHI, 2004.

CSX- 206	Data Structures and Algorithms	[2 0 0 2]

Course Contents

Introduction: Basic Terminology, Elementary Data Organization, Structure operations, Algorithm Complexity and Time-Space trade-off

Arrays: Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Character String in C++, Character string operation, Array as Parameters, Ordered List, Sparse Matrices and Vectors.

Stacks: Array Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, Application of stack: Conversion of Infix to Prefix and Postfix Expressions, Evaluation of postfix expression using stack.

Queues: Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, D-queues and Priority Queues**.**

Linked list: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, Insertion and deletion Algorithms, Doubly linked list, Linked List in Array, Polynomial representation and addition, Generalized linked list, Garbage Collection and Compaction.

Trees: Basic terminology, Binary Trees, Binary tree representation, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, Traversing Threaded Binary trees, Huffman algorithm**.**

Graphs: Terminology & Representations, Graphs & Multi-graphs, Directed Graphs, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees.

Recommended Books

1. Horowitz and Sahani, “Fundamentals of data Structures”, Galgotia Publication Pvt. Ltd., New Delhi
2. R. Kruse et al, “Data Structures and Program Design in C”, Pearson Education Asia, Delhi
3. A. M. Tenenbaum, “Data Structures using C & C++”, Prentice-Hall of India Pvt. Ltd., New Delhi
4. Bruno R Preiss, “Data Structures and Algorithms with Object Oriented Design Pattern in C++”, John Wiley & Sons, Inc.
5. Gilberg Forozan, “Data Structure – A pseudo code approach with C++”, Cengage Learning, New Delhi.

ICX- 232	**Electronic Measurement and Instrumentation**	**[3 0 0 3]**

Course Contents

Measurement of Voltage and Current: Galvanometers – Ballistic, D'Arsonval galvanometer – Theory, calibration, application – Principle, construction, operation and comparison of moving coil, moving iron meters, dynamometer, induction type & thermal type meter, rectifier type – Extension of range and calibration of voltmeter and ammeter – Errors and compensation.

Electronic Instruments: Electronic voltmeter, Electronic Multimeter, CRO- study of various stages in brief, measurement of voltage, current, phase and frequency, special purpose oscilloscope. Measurement of inductance, capacitance, effective resistance at high frequency, Q meters, LCR meter

Instruments for Generation and Analysis of Waveforms: Signal generators, function generator, wave analyzer, harmonic distortion analyzer, spectrum analyzer.

Instrument Transformer: Current and potential transformers, constructional features, ratio and phase angle error.

Transducers: Principles of operation, qualitative treatment of strain gauge, LVDT, thermocouple, piezo-electric crystal and photoelectric transducers.

Data Acquisition System: Necessity of Recorders, Recording Requirements, Graphic Recorders, Strip Chart recorders, Magnetic tape Recorders, Digital tape recorders.

Display Devices: Electronic Indicating instruments, seven-segment display.

Telemetry: Introduction, Method of data transmission, Types of Telemetry systems and applications

Recommended Books

1. Northrop RB, "Introduction to Instrumentation and Measurements," CRC Press
2. Bell DA, "Electronic Instrumentation and Measurements," Prentice Hall
3. Golding E.W. & Widdis F.C., "Electrical Measurements & Measuring Instruments," AH Wheeler & Co.
4. Sawhney A.K., "Electrical and Electronic Measurements and Instrumentation," Dhanpat Rai and Sons.

MAX- 202	**Mathematics-III**	**[3 1 0 4]**

Course Contents

Limit and derivative of a complex function, analytic functions and Cauchy Riemann equations, line integral of elementary functions, Cauchy's integral theorem, Cauchy's integral formula and derivatives of analytic functions, Taylor and Laurent series, zeros and singularities, residues and residue theorem, evaluation of real improper integral, conformal mappings linear fractional transformations and mappings by elementary functions.

Series solution of differential equations, Bessel's differential equation and Bessel functions and their properties, differential equations reducible to Bessel's differential equation, Legendre's differential equation, Legendre's polynomials and their properties, Fourier-Legendre expansion of a function.

Fundamental concepts of calculus of variations, functional involving several independent functions, one end fixed and other end free problems both end free problems, constrained extrema.

Recommended Books

1. B.S. Grewal, "Higher Engineering Mathematics", Thirty –fifth edition, Khanna Publishers, Delhi
2. L E Elsgole, "Calculus of Variations", Addison-Wisley Publishing Company
3. J B Conway, "Functions of One Complex Variables", Narosa Publishing House

PHX- 208	**Electromagnetic Field Theory**	**[3 1 0 4]**

Course Contents

Electrostatic and Magnetic Fields: Poisson's and Laplace's equations in various coordinate systems, Solution of single dimensional Laplace equation, conditions at a boundary between dielectrics, Electrostatic uniqueness theorem, Energy and mechanical forces in electric field, Method of Electrical images for a point charge in the neighborhood of infinite conducting plane, application of image method for transmission line capacitance calculations, Magnetic vector potential, Magnetic Scalar potential, Energy and mechanical forces in Magnetic fields

Maxwell's equations: Equation of continuity for time varying fields, inconsistency of Ampere's law, Maxwell's equations and their physical interpretations, Maxwell's equations in Phasor form, conditions at a boundary surface

Electromagnetic Waves: TEM, Derivation of the wave equation and their general solution, plane waves in unbounded media, wave propagation in lossless and conducting medium, penetration depth, reflection and refraction of plane waves, surface impedance

Poynting Vector and flow of power: Poynting's theorem, interpretation of (Ex H) vector, Instantaneous, Average and complex Poynting vector, Power loss in a plane conductor

Transmission Lines: Distributed parameters, Transmission Line Equations, Input impedance, Lossless propagation, Line distortion and attenuation, line termination, impedance matching, standing wave ratio, Transmission Line charts (Smith Charts)

Guided Waves and Wave Guides: Waves between parallel planes, Characteristics of TE and TM waves, Velocities of wave propagation, wave impedances, Introduction to wave guides, TE and TM waves in rectangular wave guides, Circular waveguides, Impossibility of TEM waves in wave guides, Wave impedances and characteristic impedances, Transmission line analogy for wave guides, Attenuation and Q-factor of wave guides

1. Jordon E C and Balmain K G, "Electromagnetic waves and Radiating System", 2nd Ed., Prentice Hall, New Delhi (1993)
2. Carter G W, "The Electromagnetic Fields in its Engineering Aspects", Longmans, Green and Co., London (1954)
3. Hayt W H and Buck J A, "Engineering Electromagnetics", McGraw-Hill Education (India) Pvt. Ltd. (2006)
4. Wazed Miah M A, "Fundamentals of Electromagnetics", Tata McGraw-Hill, New Delhi (1982)
5. Raju G S N, "Electromagnetic Field Theory and Transmission Lines", Pearson (2006)

ECX-212	Analog Communication Systems Lab	[0 0 2 1]

1. To study Amplitude Modulation using a transistor and determine depth of modulation.
2. To study envelope detector for demodulation of AM signal and observe diagonal peak clipping effect.
3. Frequency Modulation using Voltage Controlled Oscillator.
4. Generation of DSB-SC signal using Balanced Modulator.
5. Generation of Single Side Band (SSB) signal.
6. Study of Phase Lock Loop (PLL) and detection of FM Signal using PLL.
7. Measurement of Noise Figure using a noise generator.
8. Study functioning of Super heterodyne AM Receiver.
9. Familiarization of PLL, measurement of lock/captures range, frequency demodulation, and frequency multiplier using PLL.
10. Measurement of Sensitivity, Selectivity and Fidelity of radio receivers.

Experimentation to be supported by computer simulations.

ECX-214	Analog Integrated Circuits Lab	[0 0 2 1]

1. To experimentally study the performance of inverting, non-inverting and differential amplifier-using op-amp.
2. To experimentally study the performance of op-amp as summing, scaling and averaging amplifier.
3. To demonstrate working of an op-amp as a voltage level detector.
4. To demonstrate working of an op-amp as a square wave generator.
5. To demonstrate working of an op-amp as a triangular and saw-tooth wave generator.
6. To demonstrate working of an op-amp as Schmitt trigger.
7. To demonstrate working of an op-amp as a low pass filter.
8. To demonstrate working of an op-amp as a high pass filter.
9. To demonstrate working of an op-amp as an integrator.
10. To demonstrate working of an op-amp as a differentiator.
11. To demonstrate the operation of a 555 timer as monostable multivibrator.
12. To demonstrate the operation of a 555 timer as astable multivibrator.
13. To demonstrate the operation of VCO as Voltage to frequency characteristics of 566 IC.
14. To demonstrate the operation of PLL as Frequency multiplication using 565 IC.

Experimentation to be supported by computer simulations.

CSX-226	Data Structures and Algorithm Lab	[0 0 2 1]

1. Linear Search for an array of values.
2. Binary Search for an array of values.
3. Bubble Sort for an array of values.
4. Push. Pop and Display operations of a Stack.
5. To convert an expression in infix notation into postfix notation.
6. To evaluate an expression in postfix notation.
7. Insert, Delete and Display operation on a simple queue.
8. Insert, Delete and Display operation on a circular queue.
9. Insertion, Deletion and Display of Linked List.
10. Construction of Binary Search Tree (BST).
11. Pre-order traversed of a BST.
12. In-order traversed of a BST.
13. Post-order traversed of a BST.

This is only the suggested list of experiments. Instructor may frame additional experiments relevant to the course contents

ICX-252	Electronics Measurements and Instrumentation Lab	[0 0 2 1]

At least 8 experiments are to be performed out of the following list:

1. Measurement of inductance by Maxwell's bridge
2. Measurement of small resistance by Kelvin's bridge
3. Measurement of capacitance of Schering bridge
4. Measurement of frequency by Wein's bridge.
5. Measurement of medium resistance by Whet stone's bridge
6. Determination of frequency & phase angle using CRO
7. Drawing of the BH loop using loop tracer
8. To find the Q of a coil by using LCR-Q meter
9. Study of resonance

This is only the suggested list of experiments. Instructor may frame additional experiments relevant to the course contents

Courses offered to other Departments

For Computer Science and Engineering Department

ECX-206	**Microprocessor and Programming**	**[3 0 0 3]**

Course Objectives

This course aims to provide detailed description of 8-bit microprocessor, its architecture, programming, and interfacing. This course also briefly introduce the 16-bit processors, Next focus is to get student familiarize with architecture and programming of microcontrollers.

Course Contents

Introduction to Microcomputers & Microprocessor: Digital computing, Computer languages, From large chip computers to single chip Microcomputers, Microcomputers organization, and 4- bit Microprocessors. **(4)**

Introduction to 8085 Microprocessor: Microprocessor architecture & its operations, Memory mapped and peripheral I/O, 8085 based Microcomputer, Instruction classification, Instruction format, Instruction timings, and Overview of 8085/8080A instruction set, Introduction to 16-bit microprocessors. **(7)**

Assembly Language: Simple sequence program jumps, flags, Conditional jumps, Loops, Delays, Programming techniques & indexing, debugging. **(6)**

Interrupts: 8085 interrupts, Additional I/O concepts & processes **(7)**

Interfacing and Programmable Devices: Basic interfacing concepts, Programmable parallel ports, Handshake I/O, Interfacing keyboards and displays, Introduction to PPI, Programmable interval timer, Programmable interrupt controller, SID & SOD. **(12)**

Introduction to 8051 Microcontroller: 8051 Microcontroller: Comparison of Microprocessor and Micro controller, micro controller and embedded processors, Overview of 8085 families, Introduction to 8051 Assembly programming, 8051 flag bits and PSW register. Register banks and stack. **(4)**

Recommended Books

1. Ramesh S Gaonkar, "Microprocessor Architecture- Programming & Applications with 8085/8080A" 5th Ed., Penram International Publishing (India) Pvt. Ltd.
2. James L Antonakes, "An introduction to Intel family of Microprocessors" 3rd Ed., Pearson Education.
3. Ali Mazidi, "The 8051 Microcontroller and embedded Systems" Pearson Education, 2005.
4. Kenneth J Ayala, "The 8051 Microcontroller" 3rd edition Cengage Learning Hall Douglas V, "Microprocessor and Interfacing", Revised 2nd edition, Tata McGraw Hill, 2005.

ECX-216	**Microprocessor and Programming Lab**	**[0 0 2 1]**
8085 assembly language programs like addition, subtraction, multiplication, division, sorting, ascending, descending order. Advanced programming concepts like looping, branching, and interfacing. Introduction to 8051 assembly language programs like addition, subtraction, multiplication, division, sorting, ascending, descending, advanced programming concepts *Experimentation to be supported by computer simulations using Keil Software and hardware kits.*		

Detailed course contents of 5th semester

ECX-301	Microprocessor and Its Applications	[3 1 0 4]

Course Objectives

The purpose of this course is to introduce and teach students the fundamentals of microprocessor and applications related to microprocessors; to learn the programming skills of microprocessor in assembly language and to understand the concepts of interfacing of microprocessor with peripherals. The student will be able to incorporate these concepts into their electronic designs for other courses where control can be achieved via microprocessor implementation.

Course Contents

Introduction to Microcomputers & Microprocessor: Digital computing, Computer languages, From large chip computers to single chip Microcomputers, Microcomputers organization, and 4- bit Microprocessors. **(3)**

Introduction to 8-bit Microprocessor Architecture: Microprocessor architecture & its operations, Memory, Input/output, Interfacing devices MPU, 8085 based Microcomputer, Instruction classification, Instruction format, Instruction timings, 8080 A MPU, and Overview of 8085/8080A instruction set. **(6)**

Introduction to 8085 Assembly Language Programming: Data transfer instructions, Arithmetic operations, Logic operations, Branch operations, Programming techniques using looping counting & indexing, Dynamic debugging, Time delays, Counters, Stock, Subroutines, Conditional call, and return instructions, Advanced subroutine concepts. **(6)**

Interrupts: The 8080A/8085 interrupts Restart instructions, Additional I/O concepts & processes.**(5)**

Parallel Input/ Output And Interfacing Applications: Basic interfacing concepts, Interfacing output displays, Interfacing input keyboards, Memory mapped I/O, Interfacing memory, Interfacing D/A & A/D converters, Designing a microcomputer system, Data transferring. **(8)**

General Purpose Programmable Peripheral Devices: Introduction to PPI 8255, Programmable Interval Timer/Counter 8253, 8259 A Programmable interrupt controller, DMA Controller, Display Controller, SID & SOD lines, Software controlled asynchronous serial I/O, 8251 USART, Introduction to 8086 Microprocessor. **(12)**

Recommended Books

1. Ramesh S Gaonkar "Microprocessor Architecture- Programming & Applications with 8085/8080A", Penram International Publishing (India) Pvt. Ltd, 5th Edition.
2. B. Ram "Introduction of Microprocessors & Microcomputers", Dhanpat Rai Publisher (P) Ltd, 4th Edition.
3. Rodnay Zaks and Austin Lesea "Microprocessor Interfacing Technique", BPB Publication, 1st Indian Edition (1988).
4. James L Antonakes "An introduction to Intel family of Microprocessors", Pearson Education, 3rd Edition.
5. Charles M Gilmore, "Microprocessor; Principles and Applications", McGraw Hill, 2nd Edition.
6. K Bhurchandi, A. K. Ray, "Advanced Microprocessor and Peripherals", Tata McGraw-Hill Publishing Company, 3rd Edition (2012).

ECX-303	**VLSI Circuit Design**	**[3 1 0 4]**

Course Objectives

VLSI Circuit Design is one of the fundamental courses and is a gateway course to many engineering subjects. The objective of this course is to provide the necessary background for understanding the subject matter starting from basic building block to system level VLSI circuit design.

Course Contents

Introduction: IC technology, CMOS Capabilities and Limitations, Overview of the VLSI Design Flow, Detailed ASIC Design flow **(5)**

Combinational Circuits: Static C-MOS Inverter and its characteristics, CMOS Design consideration, Transistor Sizing, Power Dissipation, Design Margin, Ratioed Logic, Pass Transistor Logic, Dynamic C-MOS design, basic principle, speed and power Dissipation of Dynamic Logic, Signal Integrity in Dynamic Design, Cascaded Dynamic Logic **(10)**

Sequential Circuits: Introduction to Sequential logic, Static Latches and registers, Dynamic Latches and Registers, synchronous timing analysis **(10)**

ASIC Design: Introduction, Custom, Semi custom Circuit Design, Cell –Based Design Methodology, Array Based Implementation Approach, Introduction to PLA, PAL, CPLD, FPGA **(8)**

Layout and Design rules: The contract between designer and process engineer. Layout design of basic digital circuits **(7)**

Recommended Books

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic "Digital Integrated Circuits- A Design Perspective", Prentice Hall, 2nd Edition (2003)
2. S M Kang and Y Lebici "CMOS Digital Integrated Circuits-analysis and design", McGraw Hill, 3rd Edition (2002).
3. Douglas R. Holberg, P. E. Allen "CMOS Analog Circuit Design" Oxford University Press, 2nd Edition, (2002).
4. Michael J S Smith "Application-Specific Integrated Circuits" Addison-Wesley Professional (1997).
5. J. Baker "CMOS: Circuit Design, Layout, and Simulation" Wiley IEEE Press, 2nd Edition, (2007).
6. B. Razavin "Design of Analog CMOS Integrated Circuits" McGraw Hill (2004).
7. Neil H. E. Weste, Kamran Eshraghian "Principles of CMOS VLSI Design", Pearson Education India, 2nd Edition, (1999).

HMX-304	**Human Resource Management & Industrial Relations**	**[3 0 0 3]**

Course Contents

Introduction: Nature, importance, objectives, scope & principles of HRM; system approach of HRM; HRM functions & its relation with other managerial functions; changing environment of HRM; challenges & emerging horizon of HRM.

Procurement: Job analysis, job description, job specification; manpower planning, Demand and Supply Forecasting; Recruitment: Recruitment Policy & Methods; Selection procedure; Techniques & types of Psychological Tests; Interviews, Placement and Induction.

Development: Employee training and development; methods of training and development; performance appraisal: traditional & modern methods; career planning & advancement: career anchors, career development-Evan's model; career counseling & modern career problems.

Compensation: Factors affecting compensation policy, methods of payment; principles of wage & salary administration, methods of wage payment, various incentive wage plan, individual and group; supplementary compensation: fringe benefits; non wage incentives, current trends in compensation.

Integration: Human relations, industrial relations: importance, causes and effects of industrial disputes; machinery for settlement of disputes in India; trade unions, function, objectives & motivation, trade union in India, weakness of trade union, collective bargaining: concept, features, process, benefits, making trade union & collective bargaining effective.

Maintenance and Separation: Employees safety, health, welfare; provisions under factory act, 1948; turnover, retirement of employees, termination of contract, discharge, dismissal, suspension, layoff, retrenchment, exit interviews

International HRM: Growth of HR challenges of international business, difference between domestic & international HRM, effect of inter-country differences on HRM, international staffing & compensation, international labour relations.

Recommended Books

1. C. B. Mamoria, 'Personnel Management' Himalaya Publication House.
2. Edwin. B. Flippo, 'Personnel Management'. Sixth Edition. Tata Mc Graw Hill.
3. C. B. Mamoria, 'Dynamics of Industrial Relations' Himalaya Publication House.
4. C. S. Venkataratnam, 'Industrial Relations'. Oxford University Press (OUP).
5. P. Jyothi and D. N. Venkatesh, 'Human Resource Management' OUP.
6. Gary Dressler, 'Human Resource Management'. (8th Ed). Pearson Education.
7. Tanuja. Agarwala, 'Strategic Human Resource Management', Oxford University Press.
8. Snell, Bohlander, 'Human Resource Management', Thomson.
9. Mathis, Jackson, 'Human Resource Management', (10th Ed). Thomson.

PHX-301	**Material Science**	**[3 0 0 3]**

Course Contents

Crystal Structure: Fundamental concepts, Crystal systems, Closed packed structures, Crystallographic planes and directions, Miller indices, Crystal defects

Electrical Properties: Classical free electron theory of metals, Quantum Theory – Particle in a box, Wave function and energy states, Finite potential barrier, tunnelling, Fermi-Dirac distribution law, Density of energy states, Classification of solids into conductors, semiconductors and insulators, Hall effect and its applications

Semiconductor Materials: Intrinsic and extrinsic materials, Electron and hole concentrations at equilibrium, Temperature dependence of carrier concentrations, Conductivity and mobility

Magnetic Properties: Basic Concepts, Soft and hard magnetic materials, Ferrites, Selection techniques of applications, Magnetic Recording, Magnetic memories

Superconductivity: Properties of superconductors, London equations, Quantum explanation of superconductivity, Applications of superconductors

Dielectric & Optical Properties: Dielectric materials, Polarization mechanisms, Dipole moment, Dielectric strength, Methods for producing polarization, Application of dielectric materials, Index of Refraction, Damping constant, Characteristic penetration depth and absorbance, Reflectivity and transmissivity, Optical storage devices

Nanomaterials: Introduction to nanotechnology, Nanowire and nanotube, Carbon nanotubes, Single wall carbon nanotubes, multiwall carbon nanotubes, Fabrications, Properties and applications

Recommended Books

1. Hummel R E, “Electronic Properties of Materials”, Narosa Publishing House, New Delhi (1997)
2. William D Callister, Jr, “Materials Science and Engineering”; John Wiley and Sons Inc, New York (2002)
3. Dekker A J, “Solid State Physics”, Macmillan India Ltd., Madras (2000)
4. Pillai S O , “Solid State Physics”, New Age International Publishers, New Delhi (1999)
5. Van Vlack L H, “Elements of Material Science and Engineering”, Addison Wesley Publishers (1980)
6. Poole C P and Owens F J, “Introduction to Nanotechnology”, Wiley Edition (2003)

ICX-305	**Control Engineering**	**[3 0 0 3]**

Course Contents

Introduction: Concepts, Plant, Systems, Servomechanism, regulating systems, disturbances, Open loop control system, closed loop systems, linear and non-linear systems, time variant &invariant, continuous and sampled data control systems, Block diagrams, some illustrative examples.

Modeling: Formulation of equation of Linear electrical, mechanical, thermal, pneumatic and hydraulic system; Electrical, Mechanical analogies, Use of Laplace transforms, Transfer function, concepts of state variable modeling, Block diagram representation, signal flow graphs and associated algebra, characteristics equation.

Time Domain Analysis: Typical test-input signals, Transient response of the first and second order systems. Time domain specifications, Dominant closed loop poles of higher order systems, Steady state error and coefficients, Pole-zero location and stability, Routh-Hurwitz Criterion

Root Locus Technique: The extreme points of the root loci for positive gain. Asymptotes to the loci, breakaway points, intersection with imaginary axis, location of roots with given gain & sketch of the root locus plot

Frequency Domain Analysis: Closed loop frequency response, bode plots, stability and loop transfer function, Frequency response specification relative stability, relation between time and frequency response for second order systems, Log-magnitude versus phase-angle plot. Nyquist criterion

Compensation: Necessity of compensation, series and parallel compensations, Compensating network, application of lag and lead compensation

Control Components: Error detectors- potentiometers and synchronous servomotor, AC and DC tachogenerators, Magnetic amplifiers.

Recommended Books

1. Ogata, K., “Modern Control Engineering,” Prentice Hall.
2. GibsenJF, “Control System Components,” Mcgraw Hill.
3. Kuo BC, “Automatic Control System,” Prentice Hall.
4. Nagrath IJ, Gopal, “Control System Engineering,” Wiley Eastern Ltd.

CSX-305	Operating Systems	[3 0 0 3]

Course Contents

Operating systems objectives, services and functions: Characteristics of Modern Operating Systems, Characteristics of Batch and multiprogramming operating systems, Comparisons between real time systems and time-sharing systems, Operating system services and kernel features

I/O management, I/O devices: Introduction to I/O management, I/O devices, Concepts of threading, Organization of I/O functions, polling, various modes of data transfer, Hardware/Software interface, I/O buffering.

Disk scheduling policies and processes: Motivation for disk scheduling policies, Introduction to processes management, operating system views of processes, various process transition states, Introduction to Processor scheduling, Introduction to various types of schedulers, Performance criteria in scheduling algorithms, Concept of FCFS scheduling algorithm, Concept of priority scheduling algorithm like SJF, Concept of non-preemptive and preemptive algorithms, Concept of round-robin scheduling algorithm, Concept of multi-level queues, feedback queues

Concurrency control schemes: Various approaches to concurrency control schemes, Concept of prouder/consumer problem, Mutual Exclusion, Concept of mutual exclusion first and second algorithm, Concept of mutual exclusion third algorithm including introduction and characteristics of semaphores, Introduction to Mutual exclusion with semaphores, Introduction to Inter-process Communication and Synchronization, Critical regions and Conditional critical regions in a Semaphore. Introduction to monitors, various modes of monitors, Issues in message implementation, Concept of mutual exclusion with messages.

Deadlocks: Concept of Deadlocks, issues related to its prevention, avoidance and detection/recovery, Concept of deadlock prevention and its avoidance, Concept of deadlock detection and recovery.

Memory Management: Need of Memory management and its requirements, paging, segmentation, concept of fragmentation. Characteristics of contiguous & non-contiguous allocation techniques, Detail study of fragmentation, Virtual memory management, introduction to page-replacement, Need of various page-replacement policies, Concept of FIFO and optimal page-replacement algorithms, Concept of LRU approximation and its page-replacement algorithm, Concept of allocation algorithms.

File management System: Need of file management, its requirements, User's and operating system's view of file system, Concept of file directories and file sharing, Motivation for disk space management, Characteristics of file related system services, Generalization of file services.

Recommended Books

1. Peterson and Silberschatz, "Operating System Concepts", Addison-Wesley 4th Edition 1994
2. Milenkoviac, "Operating Systems Concepts and Design", Tata McGraw-Hill 1992.
3. Charles Crowley, "Operating Systems a Design Oriented Approach", Tata McGraw-Hill 1996
4. Andrews S. Tanenbaum, "Modern Operating Systems", Pearson Education, 2nd edition 2001
5. W Richard Stevens, " Linux Network Programming" PHI, Ist Edition 2003

ECX-311	Microprocessor and Its Applications Lab	[0 0 2 1]

1. Simple programs for sorting a list of numbers in ascending and descending order.
2. Sorting a list without destroying the original list.
3. Code conversion - Binary to Gray/Gray to Binary.
4. Program for addition of BCD numbers.
5. Program for multiplication of 8-bit numbers using Booth's algorithm.
6. Interface an LED array and 7-segment display through 8255 and display a specified bit pattern/character sequence at an interval of 2 seconds.
7. Program for interfacing between two 8085 kits by using 8255.
8. Interface an ADC chip with microprocessor kit and verify its operation.
9. Interface an external 8253 to the microprocessor kit at the address given. Hence,
   i) generate a pulse train of specified duty cycle at the given output line,
   ii) operate as an N counter,
   iii) Count a train of pulses for a given duration.
10. Interface the given microprocessor kit to a personal computer through R.S-232C. The band rate is specified. Verify data transfer in both directions (P - PC and PC - P).
11. Interface an external keyboard to a microprocessor kit through on board 8255.

ECX-313	**Scientific Computing Lab**	**[0 0 2 1]**
Scientific Computing is an essential element of every branch of science and technology and is now being perceived as a core skill that is crucial to the construction of theories and models at a new conceptual level and therefore to the progress of many scientific agendas. The objective of this laboratory course is to use some scientific computing platform(s) [*Open-source* or *Proprietary*] for implementing numerical computations, algorithm development, simulation, testing and system evaluation.		

CSX-325	Operating Systems Lab	[0 0 2 1]

1. Simulation of the CPU scheduling algorithms a) Round Robin b) SJF c) FCFS d) Priority
2. Simulation of MUTEX and SEMAPHORES.
3. Simulation of Bankers Deadlock Avoidance and Prevention algorithms.
4. Implementation of Process Synchronization (Reader-Writer, Sleeping Barber and Dining Philosopher's Problem)
5. Simulation of page Replacement Algorithms a) FIFO b) LRU c) LFU
6. Simulation of paging techniques of memory management.
7. Simulation of file allocation Strategies a) Sequential b) Indexed c) Linked
8. Simulation of file organization techniques a) Single Level Directory b) Two Level c) Hierarchical d) DAG
9. To automate the allocation of IP addresses i.e. to set and configure the DHCP server and DHCP client.
10. To share files and directories between RedHat Linux operating systems i.e. To set and configure the NFS server and NFS clients.
11. To share files and directories between Red Hat Linux and Windows operating systems i.e. To set and configure the samba server.
12. To set and configure the DNS (Domain Name Server).
13. To set and configure the print server and to share printers between Windows and Red Hat Linux operating systems.

This is only the suggested list of experiments. Instructor may frame additional experiments relevant to the course contents.

HMX-312	Soft Skills and Personal Interviews	[0 0 2 0]
Attitude and Behaviour: Importance of Positive Attitude, Building Positive attitude, Benefits of Positive attitude, Types of personalities, People's Skills, Dealing with difficult people, Developing Interpersonal Skills **Leadership & Team Work**: Team Effort, Group Synergy, Learning to work in a team, Benefits of being a good team player, Leadership Traits, Developing Leadership **Time Management & Goal Setting**: Importance of Time Management, Time log, Scheduling things, Staying Focused, Achieving the Goal **SWOT Analysis**: Knowing Self, Self Analysis through Johari's Window **Conflict Management & Stress Management**: Curbing Aggressiveness, Types of Conflicts Handling Conflicts, Stress Determiners, Kinds of Stress, Managing Stress **Public Speaking & Presentations:** Shedding Stage Fear, Facing the Audience, Giving Effective Presentations, Using Audio &Visual Aids. **Extempore Presentations and Interactive Skills**: Building Content, Giving Effective Extemporaneous Speeches, Using the right Courtesies, Effective Strategies **Interview Skills**: Facing Interviews, Professional Attire, Kinds of Interviews, Do's and Don'ts of Interview Skills, Frequently Asked Questions, Behavioural Questions, Learning from Rejections, Mock Interviews		

Detailed course contents of 6th semester

ECX-302	Digital System Design	[3 1 0 4]

Course Objectives

This is an advanced course on digital design techniques. The objective of this course is to provide students with opportunities to learn different types of digital systems and to understand and deal with various practical issues related to their design. The students will be able to appreciate the advantages/disadvantages between the implementations using standard logic (SSI, MSI) and programmable logic (PLDs, PGAs). A great deal of emphasis will be given to Hardware Description language- VHDL and its design styles so that students can describe digital systems using HDL. The students will learn computer aided digital top-down design flow using VHDL in the lab course ECX-312.

Course Contents

Introduction to Digital Design Concepts: Review of digital design fundamentals, minimization and design of combinational circuits, sequential machine fundamentals **(6)**

Clocked Sequential Finite State Machines: State diagram, analysis of synchronous circuits, derivation of state graphs and tables, reduction of state tables, state assignment, design of sequence detectors, serial data code conversion, design of synchronous sequential state machine, design and applications of counters and shift registers **(7)**

Multi-input System Controllers Design: System controller, controller design principles, timing and frequency considerations, DFD development, controller architecture design, asynchronous input handling, state assignment concepts, flip-flop level implementation using VEM's **(7)**

Sequential Design using LSI & MSI circuits: Using decoders, multiplexers in sequential circuits, sequential network design using ROMs, PLAs and PALs, Programmable gate Arrays (PGAs) **(5)**

Asynchronous Sequential Finite State Machines: Introduction, analysis of asynchronous networks, races and cycles, derivation of primitive flow tables, reduction of primitive flow tables, state assignments, hazards, asynchronous sequential network design **(8)**

VHDL: Why VHDL? Basic Language Elements, Data objects, classes and data types, operators, overloading, logical operators, VHDL representation of Digital design entity and architectural declarations, introduction to behavioural, dataflow and structural models **(7)**

Recommended Books

1. William I Fletcher "An Engineering Approach to Digital Design", PHI, 3rd Indian reprint, (1994)
2. M Morris Mano "Digital Design", Pearson Education, 3rd Edition (2002)
3. Z Navabi "VHDL-Analysis and Modelling of Digital Systems", McGraw Hill, 2nd Edition (1997)
4. Kevin Skahill "VHDL for Programmable Logic", Pearson Education, 1st Indian Reprint (2004)
5. Jr. Charles H. Roth, "Fundamentals of Logic Design", Jaico Publishers, 4th Edition, (2002).
6. John Wakerly, "Digital Design, Principles and Practices", Pearson Education, 3rd Ed. (2002)

ECX-304	**Digital Communication Systems**	**[3 1 0 4]**

Course Objectives

Digital Communication Systems aims to provide in-depth knowledge of transmitter and receiver design. Various trade-offs discussions will further enhance the level of course. Probability of error explains more about transmission and reception loopholes. Further, information on upcoming trends in communication technology helps to update students.

Course Contents

Introduction: Block Diagram of Digital Communication System, Advantages of Digital communication system over Analog communication systems, Sampling theorem, Signal reconstruction in time domain, Practical and Flat Top Sampling, Sampling of Band-pass Signal, Aliasing Problem, Uniform and Non-uniform quantization. Signal to Quantization ratio of Quantized Signal. **(7)**

Baseband Transmission: Line Coding & its properties, various types of PCM waveforms. Attributes of PCM waveforms, M-ary Pulse Modulation waveforms, Differential pulse code modulation, Multiplexing PCM signals, Delta modulation, Idling noise and slope overload, Adaptive delta modulation, Adaptive DPCM, Comparison of PCM and DM. **(9)**

Baseband Detection: Error performance degradation in communication systems, E_b/N_O parameter, Matched filter and its derivation, Inter-Symbol Interference (ISI), Nyquist criterion for zero ISI & raised cosine spectrum, Correlation detector decision threshold and error probability for binary unipolar (on-off) signalling. **(7)**

Band-pass modulation and demodulation: Types of digital modulation, Wave forms for Amplitude, Frequency and Phase Shift Keying, Method of generation and detection of coherent & non-coherent binary ASK, FSK & PSK, Differential phase shift keying, Quadrature modulation techniques, M-ary FSK, Minimum Shift Keying (MSK), Probability of error and comparison of various digital modulation techniques. **(9)**

A base band signal receiver, Probability of error, The Optimum filter, Matched Filter, Probability of error in Matched filter, Coherent reception, Coherent reception of ASK, PSK and FSK, Non-Coherent reception of ASK, FSK, PSK and QPSK, Calculation of bit error probability of BPSK and BFSK, Error probability for QPSK. **(6)**

Multiple Access Techniques: Time division multiplexing, Frequency division multiplexing, code division multiplexing, Introduction to upcoming techniques of transmission **(2)**

Recommended Books

1. Simon Haykin, "Communication Systems", Wiley publication, 4th Edition (2004).
2. Bernard Sklar "Digital Communication-Fundamentals and Applications", Pearson Education India, 2nd Edition (2009)
3. Miller Gary M, "Modern Electronic Communication", Prentice-Hall, 6th Edition, (1999)
4. John Proakis "Digital Communications", Tata Mc Graw Hill, 5th Edition (2007).
5. Wayne Tomsi, "Electronic Communication Systems, Fundamentals Through Advanced", Pearson Education, 4th Edition, (2001).

ECX-306	**Digital Signal Processing**	**[3 1 0 4]**

Course Objectives

The Digital Signal Processing is a fundamental and immensely important signal-processing course keeping in view the modern day technological advancements. The objective of this course is to provide fundamental background for digital signal processing which later on becomes basic building block of new upcoming technologies.

Course Contents

Introduction: Signals, Systems and Signal Processing, Classification of Signals, Concept of Frequency in Continuous Time and Discrete Time Signals, Analog-to-Digital and Digital-to-Analog Conversion, Applications of Signal Processing **(4)**

Discrete Time signals and Systems: Discrete Time Signals, Discrete Time Systems, Analysis of Discrete Time Linear Time-Invariant Systems, Discrete Time Systems Described by Difference Equations, Implementation of Discrete Time systems, Correlation of Discrete Time Signals. **(6)**

The Z-transform and Its Application To The Analysis Of LTI Systems: The z-Transform, Properties of z-Transforms, Inversion of z-Transform, One-sided z-Transform, Analysis of Linear Time-Invariant Systems in the z-Domain **(5)**

Frequency analysis of signals and systems: Frequency Analysis of Continuous –Time Signals, Frequency Analysis of Discrete Time Signals, Properties of Fourier Transform for Discrete Time Signals. Frequency Domain Characteristics of Linear Time-Invariant Systems, Linear Time-Invariant Systems as Frequency-Selective Filters, Inverse Systems, and Deconvolution **(4)**

The discrete Fourier transform: its properties and applications: Frequency Domain Sampling: The discrete Fourier Transform, Properties of the DFT, Linear Filtering Methods based on the DFT. Frequency Analysis of Signals Using the DFT. **(4)**

Efficient computation of DFT: Fast Fourier transforms: Efficient Computation of DFT: FFT Algorithms, Application of FFT Algorithms, A Linear Filtering Approach to Computation of DFT. Quantization Effect in the Computation of DFT. **(4)**

Implementation of discrete time systems: Structures for the realization of Discrete Time Systems, Structures for FIR Systems, Structures for IIR Systems, Representation of Numbers, Quantization of Filter Coefficients, Round off Effect in Digital Filters **(4)**

Design of digital filters: General Considerations like causality etc., Design of FIR Filters, Design of IIR Filters from Analog Filters, Frequency Transformations, Design of Digital Filters Based on Linear Squares Method**.** **(6)**

Sampling and reconstruction of signals: Sampling of Band-pass Signals, Analog-to-Digital Conversion, Digital-to-Analog Conversion. **(3)**

Recommended Books

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Prentice Hall, (2007).
2. S. K. Mitra, "Digital Signal Processing: A Computer Based Approach", 3rd Edition, TMH (2008).
3. A. V. Oppenheim, R. W. Schafer and J. R. Buck, "Discrete-time Signal Processing", , 2nd Edition, Prentice Hall, (1999).
4. B. Widrow and S. D. Stearns, "Adaptive Signal Processing", Prentice Hall, (1985).

ECX-308	**Advanced Microprocessors and Microcontrollers**	**[3 1 0 4]**

Course Objectives

Microprocessors and Microcontrollers are widely used in modern society with applications ranging from automatic gadgets to medical applications The purpose of this course is to introduce students with the advanced technology in embedded systems. The objective is to make students understand architecture and programming of embedded processors. Students will able to interface various circuits with advanced processors.

Course Contents

Introduction to Advanced Microprocessors: An introduction to 8086, 8088, 80186-286-386-486, Pentium Processors, Dual core processors, 8086 internal architecture, Addressing modes, Instruction formats **(5)**

8086 Assembly Language Programming: 8086 flags, JUMP operations, STRING operations, CALL & RET operations, STACK ops, Instruction set of an 8086, 8086 hardware configuration, Addressing memory & ports, 8086 Interrupts and interrupt responses, Interrupt system based on 8259A **(5)**

I/O Interfaces: Asynchronous, Synchronous communication interface, Physical communication standards, 8251 A programmable communication interface, Hardware controlled serial I/O, Programmable peripheral interface, keyboard Interfacing, Interfacing to alphanumeric displays, 8279 controller, 8257 controller, Serial data transmission methods & standards **(3)**

Introduction to Micro Controllers (8051): Micro controllers & Embedded processors, Overview of 8051 family, Instruction set, Introduction to 8051 assembly language programming, Program counter, data types & directives, flag, Registers, Stack, Hardware Description, I/O Port programming, Timer and counter programming, Serial communication, Interrupt programming, Interfacing, 16 & 32 bit micro controllers, PIC and ARM controllers **(27)**

Recommended Books

1. Douglas V. Hall, "Microprocessor & Interfacing: Programming & Hardware", Tata McGraw Hill, (1992).
2. M A Mazidi, J G Mazidi, R D Mc Kinlay "The 8051 Micro controllers & Embedded Systems", 2nd Indian reprint, Pearson education, (2002).
3. Kenneth J, Ayala, "8051 Microcontroller: Architecture, Programming and Application," 2nd edition, Delmar Learning.
4. Brey "Intel Micropocessors, The 8056/8055, 80186/80188, 8028, /80386, 80486, Pentium & PentiumPro, Pentium II, III, IV: Architecture, Programming and Interfacing," 6th edition, PHI.
5. Myke Predko, "Programming and Customizing the ARM7 Microcontroller" McGraw-Hill, 3rd Edition.
6. John Morton "The PIC Microcontroller: Your Personal Introductory Course", Newnes (an imprint of Butterworth-Heinemann Ltd); 3rd Revised Edition (2005).

HMX-201	**Engineering Economics and Industrial Management**	**[3 1 0 4]**

Course Contents

Definition and Scope of Engineering Economics: Concept of revenue and costs, break-even analysis. Law of demand & supply, time value of money, present and future worth methods

Decision Making: Decision making process, decision making under risk certainty, uncertainty and conflict

Replacement and maintenance Analysis: Types of maintenance, determination of economic life of an asset, replacement of items that fail suddenly and that fail over a period of time

Methods of depreciation: Straight line method, sum-of-the year's digest method, declining balance method, sinking fund method and service output method of depreciation

Inventory control: Introduction and objective of inventory control, purchase model with instantaneous replenishment, model with shortages, price break model, ABC analysis

Forecasting: Demand forecasting by quantitative and qualitative techniques, applications of demand forecasting

Make or Buy Decision: Criteria for make or buy, approaches for make or buy decision

Value Engineering Analysis: Value analysis vs. value engineering function, aims and value engineering procedure, advantages & applications

Linear Programming: Linear programming as a tool of decision making, graphical and simplex methods and applications in decision making

Recommended Books

1. Panaeerselvam, R., (2001), 'Engineering Economics', Prentice Hall of India: New Delhi
2. Smith G.W., (1973), 'Engineering Economics', Iowa State Press: Iowa
3. Grant, E.L., Irevan, W.G. and Leanenworh, R.S., (1976), 'Principles of Engineering Economy'. Ronald Press: New York
4. Lee S.M. Moore and Taylor, (2005), 'Management Science'
5. Jaha, H.A , (2005), 'Operations Research: An Introduction', Prentice-Hall of India: New Delhi
6. Vohra , N.D., (2006), 'Quantitative Techniques in Managerial Decision Making'. Tata McGraw Hill: New Delhi
7. Mehta, P.L., (2006), 'Managerial Economics', Sultan Chand & Sons: New Delhi.
8. Dougherty, Christopher (2007), 'Introduction to Econometrics', Oxford University Press: New Delhi.

ECX-312	**Digital System Design Lab**	**[0 0 2 1]**

1. Familiarization with CAD (Xilinx or equivalent) top-down design flow of digital systems
2. Familiarization with FPGA Boards
3. Design of combinational logic circuits- Logic gates, Half adder, Full adder, MUX, DEMUX, Encoder, Decoder, etc. using different modeling styles in VHDL i.e. data flow, behavioral and structural
4. Design of Sequential logic - Flip-Flops, Registers, Counters etc. using different modeling styles
5. Design of sequence detectors
6. In addition to the above experiments, each student will be required to take up a project involving the design of an FSM

The list of experiments given above is only suggestive. The instructor may add more design problems.

ECX-314	**Digital Communication Systems Lab**	**[0 0 2 1]**

1. Study of analog time division multiplexer
2. Study of pulse code modulation and demodulation
3. Study of delta modulation and demodulation and observe effect of slope overload
4. Study pulse data coding techniques for NRZ formats
5. Data decoding techniques for NRZ formats
6. Study of amplitude shift keying modulator and demodulator
7. Study of frequency shift keying modulator and demodulator
8. Study of phase shift keying modulator and demodulator

The list of experiments given above is only suggestive. The instructor may add more design problems. Experimentation to be supported by computer simulations.

ECX-316	**Digital Signal Processing Lab**	**[0 0 2 1]**

1. Plot of standard signal waveforms
2. To compute convolution of two discrete-time signals
3. To compute convolution of two continuous signal using your own code
4. To compute cross-correlation of two discrete time signals
5. To compute FFT of a signal and noise-mixed signal
6. To design of Butter-Worth Filter (Analog/Digital domain)
7. To design of Chebyshev Filter (Analog/Digital domain)
8. Filter design using “FIR1”, “FIR2” and using “FDA tool”
9. File handling in Matlab.
10. Filtering of noise-mixed ECG Signal

Experimentation to be supported by computer simulations.

ECX-318	**Advanced Microprocessors and Microcontrollers Lab**	**[0 0 2 1]**
1. 8 bit multiplication and division. 2. 16 bit multiplication and division. 3. Waveform generation using 8255 and DAC. 4. Interfacing of ADC 0809. 5. Interfacing of traffic light controller. 6. Interfacing using SID and SOD lines. 7. Interfacing using 8253. 8. Study of micro controller kits. 9. Programming exercises on 8051/8031 micro controller. 10. Interfacing using 8251. 11. Stepper motor interface. 12. Interfacing of 7 segment LED displays.		

Courses offered to other Departments

For Textile Technology Department

ECX-310	Application of Electronics in Textiles	[3 1 0 4]
Course Objectives		
The objective of this course is 1) To understand the basic application areas of electronics in textiles 2) To obtain a basic level of Digital Electronics knowledge and set the stage to perform the analysis and design of digital electronic circuits. 3) To introduce basic postulates of Boolean algebra 4) To outline the formal procedures for the analysis and design of combinational circuits 5) To introduce the basic concepts of microprocessor, assembly language programming and basic interfacing concepts.		
Course Contents		
Boolean algebra and logic gates: Introduction to Boolean algebra, Theories of Boolean algebra, Logic circuits and logic gates, Minimization of Boolean expressions **(3)** **Digital Logic Circuits: I**ntroduction to Adder and Subtractor circuits, Multiplexers, Demultiplexers, Encoders and Decoders, Semiconductor memories like ROM and RAM, Introduction to A/D and D/A converters **(6)** **Microprocessors:** Evolution of microprocessor, System block diagram, Microprocessor operation, hardware /software requirements, from large computers to single chip microcomputers, machine language and assembly language, The 8085 MPU and 8080 MPU, Instruction classification, Instruction format, Introduction to 8085/8080 basic instructions, writing and executing an 8085 based assembly language program, Dynamic debugging, Basic Interfacing concepts. **(16)** **Electronics in Textile machines:** Overview of electronic and control in modern textile testing equipment and machines, Control elements, Systems and examples, Automation by microprocessors and microcontrollers, Motor and power drives, power control devices etc, Optical sensors, Resistance temperature detectors, Limit switches and stop motion, Auto levelling , Electronic yarn cleaners, PLC(Perfect Length Count) Controllers, Continuous bobbin feeder(CBF), Electronic tensioners etc. **(11)** **Wearable Electronics**: Multifunctional textiles with incorporated electronics for integrated communication, Music, Health monitoring, Defence, Support functions, Wearable computers etc. **(4)**		
Recommended Books		
1. Malvino P and Leach, "Digital principle and applications", 5th Ed., Tata McGraw Hill, New Delhi, (2003). 2. Gaonkar S R, "Microprocessor Architecture, Programming and Applications with 8085/8080A", 5th edition Prentice Hall private Ltd., New Delhi, (2000). 3. X. Tao, Xiaoming Tao, "Smart Fibres, Fabrics and Clothing", Woodhead publishing limited, (2001). 4. Tac Xiaoming, "Wearable Electronics and photonic", Woodhead publishing limited, (2005). 5. Cooper W D, Helfrick A D, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall, (1990).		

ECX-320	**Application of Electronics in Textiles Lab**	**[0 0 2 1]**

1. Verification of truth tables of various logic gates.
2. Verification of different theorems of Boolean algebra.
3. Verification of truth table of adder circuit.
4. Verification of truth table of subtractor circuit.
5. Verification of truth table of multiplexer 74150.
6. Verification of truth table of demultiplexer 74154.
7. Write a program to add two hexadecimal numbers and store the sum into a memory location.
8. Write a program to find the larger of two 8-bit numbers.
9. Write a program to find the smallest of two 8-bit numbers
10. Write a program to sort a list of numbers in ascending and descending order.
11. Write a program to multiply two 8-bit numbers.
12. Write a program to find the 2's complement of 8-bit number.
13. Write a program to load the data byte in some register, mask the higher order bits and display the lower order bits in some memory location.
14. The block of data is stored in the memory location starting from XX55 to XX5A. Write a program to transfer the data to the locations XX80 to XX85 in the reverse order.
15. Study of electronic components of textile testing equipment.
16. Study of limit switches and stops motions of spinning machines.
17. Study of electronic components on winding and weaving machines.

Detailed course contents of 7th semester

ECX-401	Microwave Engineering	[3 1 0 4]

Course Objectives

The aim of this course is a) to understand the basic properties and application areas of microwave, b) to understand the principles underlying microwave devices and networks, c) to have fundamental understanding of microwave components and circuits in terms of scattering parameters, and d) io learn the principle of transmission lines, waveguides, microwave network analysis and its application to impedance matching

Course Contents

Microwave Tubes: UHF limitations in conventional tubes, Analysis and operation of two-cavity klystron and reflex Klystron, Admittance diagram of Klystron. Analysis and operation of a travelling wave magnetron, Performance Charts of magnetron tubes, Travelling wave tube- its principle and operation. **(10)**

Microwave Components: Coupling-probes and Coupling-loops, Klystron Mount, Slide Screw Tuner, Detector Mount, Attenuator-Variable type and fixed type, Phase shifters, Waveguide corners, bends, twists, Matched Termination, Short circuit plunger, Waveguide tees- E, H, Magic, Hybrid rings, Directional Coupler-multi-hole directional coupler and cross directional coupler, Isolator, Circulator, Frequency meter- indirect type and direct type, PIN modulator, Gunn oscillator, Antennas. **(5)**

Microwave Semiconductor Devices: Classification of Microwave Devices; Crystal Diode-its principle; Point Contact diode; Tunnel Diode; Gunn Diode- two valley structure, mode of operation, circuit realization; IMPATT Diode- circuit realization; PIN diode-basic principle of operation , equivalent circuit , and applications as switch, modulator, attenuator and phase shifter; Microwave Bi-polar and Field effect Transistors-Characteristics and performance; Parametric amplifiers. **(10)**

Microwave Network Theory: Symmetrical Z and Y Matrix for reciprocal network. Scattering matrix representation of multiport network, Properties of S-parameters. Relationship of Z, Y and ABCD parameter with S-parameters. **(7)**

Microwave Measurements: Tunable detector, slotted line carriage, Measurement of VSWR and Reflection coefficient, Impedance using slotted line, Use of smith chart, Impedance matching, Double and triple stub tuners, Quarter wave Transformer, Measurement of frequency and wavelength, Measurement of microwave power-low, Medium and high, Use of bolometer, thermistor, calorimeter. **(8)**

Recommended Books

1. A J Reich “Microwave principles”, Van Nostrand, Affilated East-West press Pvt. Ltd., New Delhi.
2. R E Collin “Fundamentals of Microwave Engg”, McGraw-Hill, 2nd Edition (2001).
3. S Y Liao “Microwave Devices and Circuits”, Prentice hall of India (1995).
4. A Das and S K Das “Microwave Engineering” Tata McGraw-Hill Publishing Company Limited (2001).
5. K C Gupta, “Microwave”, New Age International (1983).

ECX-403	**Biomedical Signal Processing and Telemedicine**	**[3 1 0 4]**

Course Objectives

This course on Biomedical Signal Processing and Telemedicine is basic course towards application of signal processing techniques in biomedical applications. The objective of this course is to provide fundamental background for biomedical signal processing leading towards automatic disease diagnostics.

Course Contents

Introduction to Biomedical Signals: The nature of biomedical signals, examples of biomedical signals, action potential, electroneurogram (ENG), electromyogram signal (EMG), electrocardiogram (ECG), electroencephalogram (EEG), event related potentials (ERPs), The electrogastrogram (EGG), phonocardiogram (PCG), carotid pulse (CP), speech signal, objectives of biomedical signal analysis, difficulties in biomedical signal processing, what is medical instrument, computer aided diagnosis. **(7)**

Electrocardiography: Basic electrocardiography, ECG leads systems, ECG signal characteristics, concurrent, coupled and correlated processes. **(3)**

Artefacts in Biosignals: Random noise, structured noise and physiological interference, stationary Vs non stationary processes. Noise in event related potentials, high frequency noise in ECG, motion artefacts in ECG, power-line interference in ECG signals, maternal interference in fetal ECG. **(3)**

Basics of Digital Filtering: Digital filters, z transform, elements of a digital filter, types of digital filters, transfer function of a difference equation, the z-plane pole-zero plot, the rubber membrane concept. **(3)**

Finite Impulse Response Filters: Characteristics of FIR filters, smoothing filters, notch filters, derivatives, window design, frequency sampling, minimax design **(4)**

Infinite Impulse Response Filters: Generic equations of IIR filters, simple one-pole example, integrators, design methods for two-pole filters. **(3)**

Integer Filters: Basic design concept, low-pass integer filters, high-pass integer filters, band-pass and band-reject integer filters, the effect of filter cascades, others fast-operating design techniques **(3)**

Adaptive Filters: Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering. **(3)**

Signal Averaging: Basics of signal averaging, signal averaging as a digital filter, a typical average, software for signal averaging, limitations of signal averaging. **(2)**

ECG QRS Detection: Power spectrum of the ECG, band pass filtering techniques, differentiation techniques, template matching techniques, A QRS detection algorithm. ECG interpretation, ST-segment analyzer, portable arrhythmia monitor. **(3)**

Telemedicine: Introduction to Telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health, Tele care, origins and Development of Telemedicine, Scope, Benefits and limitations of Telemedicine. Tele radiology: Basic parts of Teleradiology system: Image Acquisition system, Display system, Communication network, Interpretation. Tele Pathology: Multimedia databases, color images of sufficient resolution: Dynamic range, spatial resolution, compression methods, Interactive control of colour, controlled sampling, security and confidentiality tools. Tele cardiology, Teleoncology, Telesurgery. **(6)**

Recommended Books

1. Willis L. Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall of India.
2. Rangaraj M. Rangayyan, “Biomedical Signal Analysis - A case-Study Approach”, Wiley India.
3. D C Reddy, “Biomedical Digital Signal Processing”, McGraw Hills.
4. J L Prince and J Links, “Medical Imaging Signals and Systems”, Pearson Prentice Hall.

ECX-411	Microwave Engineering Lab	[0 0 2 1]

1. Study of Microwave components and Instruments.
2. To study the characteristics of reflex Klystron.
3. Tuning of Klystron Mechanical and Electronics Methods.
4. To study the Characteristics of Crystal Detector.
5. Study of E-plane Tee, H-plane Tee, and Magic Tee.
6. To measure the Frequency using direct reading frequency meter and compare it with indirect frequency meter.
7. To measure VSWR, Insertion loss and attenuation of fixed and variable attenuator.
8. Measurement of Directivity and Coupling coefficient of a directional coupler.
9. To plot and study the V-I characteristics of a Gunn diode.
10. To match impedance for maximum power transfer using a slide screw tuner.
11. Calibration of the attenuation constant of an attenuator.
12. Determination of a radiation Characteristics and gain of an antenna.
13. Measurement of Q of a cavity by slotted line method.
14. Introduction to MIC.

ECX-413	**Biomedical Signal Processing and Telemedicine Lab**	**[0 0 2 1]**

1. To record single lead electrocardiogram at a desired sampling frequency.
2. To record standard 12-lead electrocardiogram at a desired sampling frequency.
3. To remove base wander and high frequency noise from ECG using appropriate digital filters for extracting process able ECG signal.
4. To determine heart rate from a recorded ECG.
5. To record a single lead and multilead EEG signal at desired sampling frequency.
6. To compute FFT of recorded ECG signal for extracting frequencies in ECG signal.
7. To record continuous blood pressure.
8. To determine effect of various filters for various artifacts.

Experimentation to be supported by computer simulations.

Department Elective- I

ECX-451	Advanced Signal Processing	[3 0 0 3]

Course Objectives

The Advanced Signal Processing is a signal processing course keeping in view the modern advancements. The objective of this course is to provide advanced signal processing techniques background which are essentially required in modern technologies.

Course Contents

Discrete Fourier Transform And Fast Fourier Transform: Introduction to DFT, Efficient computation of DFT, Properties of DFT, FFT algorithms, Decimation in Time Algorithms, Decimation in Frequency algorithms. **(4)**

Design Of Digital Filters: Design of FIR Filters using windows, Structure of Symmetric FIR filters, Structure of Antisymmetric FIR filters Design of IIR filter in the Frequency domain, Design of IIR filter using bilinear transformation, Design of IIR filter using Matched Z-transform, Realization of FIR and IIR systems **(6)**

Multirate Signal Processing: Introduction to multirate DSP, Decimation and interpolation, Filter Design and Implementation for Sampling Rate Conversion, Multistage Implementation of Sampling Rate Conversion, Sampling Rate Conversion of Band-pass Signals, Sampling Rate Conversion by Arbitrary Factor, Application of multirate signal processing. **(8)**

Linear Estimation And Prediction: Innovations Representation of Stationary Random Process, Forward and Backward Linear Prediction, Solution of Normal Equations, Properties of Linear Prediction-Error Filters, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction. **(8)**

Power Spectrum Estimation: Estimation of Spectra from Finite Duration Observations of Signals, Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum Variance Spectral Estimation **(7)**

Adaptive Filter: Forward and backward linear prediction WIENER filters, Adaptive channel equalization, Adaptive echo cancellation, Adaptive noise cancellation, FIR adaptive filters, RLS algorithm, Steepest Descent Methods. **(7)**

Recommended Books

1. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, Pearson Prentice Hall, (2007).
2. S. K. Mitra, “Digital Signal Processing: A Computer Based Approach”, 3rd Edition, TMH, (2008).
3. A. V. Oppenheim, R. W. Schafer and J. R. Buck, “Discrete-time Signal Processing”, 2nd Edition, Prentice Hall, (1999).
4. M. H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley & Sons, Inc., (2002).
5. S. Haykin, “Adaptive Filter Theory”, Prentice Hall, (2001).
6. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, (1992).

ECX-453	**Satellite Communication**	**[3 0 0 3]**

Course Objectives

This course provides an introduction to the fundamentals of orbital mechanics and launchers, link budgets, modulation, coding, multiple access techniques, propagation effects, and earth terminals. This course provides an understanding how analog and digital technologies are used for satellite communications networks.

Course Contents

Introduction: Origin and brief history of satellite communications, an overview of satellite system engineering, satellite frequency bands for communication. **(5)**

Orbital Theory: Orbital mechanics, locating the satellite in the orbit w.r.t. Earth looks angle determination. Azimuth & elevation calculations. **(5)**

Spacecraft Systems: Attitude and orbit control system, telemetry, tracking and command (TT&C), communications subsystems, transponders, spacecraft antennas. **(5)**

Satellite Link Design: Basic transmission theory, noise figure and noise temperature, C/N ratio, satellite down link design, satellite uplink design. **(5)**

Modulation, Multiplexing, Multiple Access Techniques: Analog telephone transmission, Fm theory, FM Detector theory, analog TV transmission, S/N ratio Calculation for satellite TV linking, Digital transmission, baseband and bandpass transmission of digital data, BPSK, QPSK, FDM, TDM, Access techniques: FDMA, TDMA, CDMA. **(8)**

Encoding & FEC for Digital Satellite Links: Channel capacity, error detection coding, linear block, binary cyclic codes, and convolution codes. **(6)**

Satellite Systems: Satellite Earth station Technology, satellite mobile communication, VSAT technology, Direct Broadcast by satellite (DBS),GPS system. **(6)**

Recommended Books

1. Timothy Pratt, Charles W. Bostian “Satellite Communication” John Wiley & sons publication (2002).
2. Timothy Pratt, Charles W. Bostian, Jeremy Allnutt “Satellite Communications” 2nd ed., Wiley, John & Sons, (2002).
3. Gerard Maral, Michel Bousquet “Satellite Communications Systems: Systems,Techniques and Technology” , Wiley, John & Sons, 4th edition, (2002).
4. J Martin “Communication satellite systems”, Prentice Hall publication (1978).
5. Dennis Roddy “Satellite Communication”, McGraw-Hill, 4th Edition (2006).

ECX-455	**Wireless Sensor Networks**	**[3 0 0 3]**

Course Objectives

Study of wireless sensor networks course will give the students a wide idea of sensor networks, sensor node hardware architecture, network protocols as well as the applications of wireless sensor networks.

Course Contents

Introduction: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks **(8)**

Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts. **(9)**

Deployment and Configuration: Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, self configuring localization systems, sensor management **(8)**

Network Protocols: Issues in designing MAC protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network. Department of Electronics and Communication Engineering Routing protocols: Issues in designing routing protocols, Classification of routing protocols, Energy-efficient routing, Unicast, Broadcast and multicast, Geographic routing. **(9)**

Data Storage and Manipulation: Data centric and content based routing, storage and retrieval in network, compression technologies for WSN, Data aggregation technique. **(3)**

Applications: Detecting unauthorized activity using a sensor network, WSN for Habitat Monitoring. **(3)**

Recommended Books

1. Holger Kerl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Network", John Wiley and Sons, (2005).
2. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, "Wireless Sensor Network", Springer 1st Ed., (2004).
3. Feng Zhao, Leonidas Guibas, " Wireless Sensor Network",Elsevier, 1st Ed. (2004).
4. Kazem, Sohraby, Daniel Minoli, Taieb Zanti, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., (2007).
5. B. Krishnamachari, " Networking Wireless Sensors", Cambridge University Press.
6. N. P. Mahalik, "Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications" Springer Verlag.

ECX-457	**Evolutionary Algorithms based Engineering Design**	**[3 0 0 3]**

Course Objectives

The objective of this course is to address the optimization problems through the use of evolutionary algorithms that mimic natural evolutionary principles. In this course, a number of popular evolutionary algorithms would be discussed with the help of case studies. Some high performance computing platforms supporting evolutionary algorithms would also be presented.

Course Contents

Introduction to Optimization: What is optimization, categories of optimization, minimum seeking algorithms **(6)**

Natural Optimization Methods: Simulated annealing, evolutionary algorithms (GAs, EP, ES, GP, PSO, BBO etc.), a simple evolutionary algorithm, Selection Schemes, Crossovers, Mutation, Applications **(8)**

Muti-Objective Evolutionary Optimization: Multi-Objective Optimization Problem, Principles of Multi-Objective Optimization, Difference with Single-Objective Optimization, Dominance and Pareto-Optimality, Some applications of Multi-Objective Evolutionary Algorithms **(9)**

High Performance Computing for Evolutionary Algorithms: Some HPC paradigms viz. Cluster computing, GPU computing. **(8)**

Case Studies for Engineering Design **(9)**

Recommended Books

1. Kalyanmoy Deb, “Multi Objective Optimization using Evolutionary Algorithms”, John Wiley and Sons, (2001).
2. David A Coley, “An introduction to Genetic Algorithms for Scientists and Engineers”, World Scientific Publishing Company, (1997).
3. Mitsuo Gen, Runwei Cheng, “Genetic Algorithms and Engineering Design”, Wiley-Interscience, (1997).
4. Thomas Back, “Evolutionary Algorithms in Theory and Practice: Evolution Strategies, Evolutionary Programming, Genetic Algorithms”, Oxford University Press, (1996).
5. William B. Langdon, Riccardo Poli, “Foundations of Genetic Programming”, Springer, (2010).

ECX-459	**VLSI Testing**	**[3 0 0 3]**

Course Objectives

VLSI testing is one of the fundamental courses to check the functionality of integrated circuits. The objective of this course is to understand the process of testing, familiar with terms used in testing, diagnosis & repair of faults and ensure product quality.

Course Contents

Introduction -Scope of testing and verification in VLSI design process. Problem in analog and digital testing. **(6)**

Logic simulation & **Fault modelling:** Circuit Modelling Compiled simulation Event-driven simulation Simulation Techniques. Fault detection and redundancy. Fault equivalence and fault dominance. Stuck-at faults, bridging faults, transistor faults, delay faults etc. Fault Detection using Boolean Difference. Path Sensitization. Fault Collapsing. **(8)**

Testing Algorithm for Combinational Circuits: Introduction to combinational circuit, Problems in combinational circuit testing, D-Algorithm, Boolean Difference, Podem; Random, Deterministic and Weighted Random Test Pattern Generation; ATPG. **(7)**

Testing Generation for Sequential Circuit: Models of Sequential Circuits, State Table Method, Self-Initializing Test Sequences, Undetectability, Distinguishing and Synchronizing Sequences. Complexity of Sequential ATPG. **(7)**

PLA Testing: Cross Point Fault Model and Test Generation PAL Testing. **(6)**

Memory Testing: Different method of memory testing, Marching Tests; Delay Faults; BIST for testing of logic and memories, Recent Trends in VLSI Testing. **(6)**

Recommended Books

1. M. Bushnell and V. D. Agrawal "Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI Circuits", Kluwer Academic Publishers, (2000).
2. M. Abramovici, M. A. Breuer and A. D. Friedman "Digital Systems Testing and Testable Design", IEEE Press, (1990).
3. T.Kropf "Introduction to Formal Hardware Verification", Springer Verlag, (2000).
4. P. Rashinkar, Paterson and L. Singh "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers, (2001).
5. J.M. Rabaey, A. Chandrakasan and B. Nikolic "Digital Integrated Circuits- A Design Perspective", PHI, 2nd Edition, (2003).

ECX-461	**Digital Integrated Circuits**	**[3 0 0 3]**

Course Objectives

Objective of the course is to make students able to characterise the MOS transistors and CMOS logic through various metrics, Design a multi-transistor CMOS circuit to meet a target set of specifications. Calculate and analyze propagation delay and power/energy consumption of CMOS circuits, Calculate and analyse noise margins of CMOS circuits, Optimise for performance logic circuits.

Course Contents

MOS Inverter: Introduction to resistive - load inverter, inverter with n-type MOSFET load, CMOS inverter Switching Characteristics and Interconnects Effects: Introduction, Delay time definitions, Calculation of delay times, Inverter design with delay constraints, Estimation of interconnect parasitic **(11)**

Sequential MOS Logic Circuits: Introduction, SR latch circuits, Clocked latch and Flip-flop circuits, CMOS D-latch and edge -triggered flip-flop. **(12)**

Semiconductor Memories: Introduction, Dynamic random access memory (DRAM), Static random access memory (SRAM), Non-volatile memory. **(7)**

Low Power CMOS Logic Circuits: Introduction, Overview of power consumption, Switching power dissipation of CMOS inverter, Estimation and optimization of switching activity. **(10)**

Recommended Books

1. Rabaey J.M, Chandrakasan A, Nikolic B , “Digital Integrated Circuits- A Design Perspective”, Second Edition, Prentice Hall.
2. S M Kang and Y Lebici, “CMOS Digital Integrated Circuits-analysis and design”, 3rd Edition, McGraw Hill.
3. Pucknell D A and Eshraghian K, “Basic VLSI Design”, Prentice Hall India, New Delhi (2003).
4. Glaser L and Dobberpuhl D,“The Design and Analysis of VLSI Circuits”, Addison Wesley (1985).
5. Weste N and Eshranghian K, “Principles of CMOS VLSI Design”, Pearson Education Asia (2001).

Department Elective- II

ECX-481	Computer Organization	[3 0 0 3]

Course Objectives

This course provides an In-depth knowledge on computer organization, assembly level organization and different type of micro programmed architectures.

Course Contents

Digital Logic: Fundamental building blocks (logic gates, flip-flops, counters, registers, PLA); logic expressions, minimization, sum of product forms; register transfer notation; physical considerations (gate delays, fan-in, fan-out). **(4)**

Data Representation: Bits, bytes, and words; numeric data representation and number bases; fixed- and floating-point systems; signed and twos-complement representations; representation of nonnumeric data (character codes, graphical data); representation of records and arrays. **(6)**

Assembly Level Organization: Basic organization of the von Neumann machine; control unit; instruction fetch, decode, and execution; instruction sets and types (data manipulation, control, I/O); assembly/machine language programming; instruction formats; addressing modes; subroutine call and return mechanisms; I/O and interrupts. **(5)**

Memory Systems: Storage systems and their technology; coding, data compression, and data integrity; memory hierarchy; main memory organization and operations; latency, cycle time, bandwidth, and interleaving; cache memories (address mapping, block size, replacement and store policy); virtual memory (page table, TLB); fault handling and reliability. **(5)**

Interfacing and Communication: I/O fundamentals: handshaking, buffering, programmed I/O, interrupt-driven I/O; interrupt structures: vectored and prioritized, interrupt acknowledgment; external storage, physical organization, and drives; buses: bus protocols, arbitration, direct-memory access (DMA); introduction to networks; multimedia support; raid architectures. **(5)**

Functional Organization: Implementation of simple data paths; control unit: hardwired realization vs. micro-programmed realization; instruction pipelining; introduction to instruction-level parallelism (ILP). **(5)**

Multiprocessor And Alternative Architectures: Introduction to SIMD, MIMD, VLIW, EPIC; systolic architecture; interconnection networks; shared memory systems; cache coherence; memory models and memory consistency. **(5)**

Performance Enhancements and Contemporary Architectures: RISC architecture; branch prediction; prefetching; scalability. Hand-held devices; embedded systems; trends in processor architecture. **(5)**

Recommended Books

1. William Stallings, “Computer Organization and Architecture”, Prentice-Hall, 5th Edition (1999).
2. Morris Mano M, Charles R Kime, “Logic and Computer Design Fundamentals”, Prentice-Hall (2000).
3. Andrew S Tanenbaum, “Structured Computer Organization”, PHI, 4th Edition (1999).
4. Linda Null, Julia Lobur, “The Essentials of Computer Organization and Architecture,” Jones & Bartlett Publishers (2003).
5. Carpinelli John D., “Computer Systems Organization and Architecture,” Addison Wesley (2000).

ECX- 483	**Technology Entrepreneurship**	**[3 0 0 3]**

Course Objectives

Technology and enterprises are both an important part of our world's economic growth story as well as the place where many entrepreneurs realize their dreams. The main objective of this course is to cover the challenges involved in technology entrepreneurship.

Course Contents

Venture Opportunity, Concept and Strategy: Economic growth and Technology Entrepreneur, Opportunity and the Business Model, Competitive Strategies, Innovation Strategies **(8)**

Venture Formation and Planning: Risk and Return, Business Plan, Types of Ventures, Legal Formation and Intellectual Property **(8)**

Detailed Functional Planning for the Venture: Marketing and Sales Plan, Acquiring and organising resources, Management of Operations **(8)**

Financing and Building the Venture: Profit and Harvest, Financial plan, Sources of Capital, Presentations and Deal Negotiations, Leading venture to success **(8)**

Case Studies **(8)**

Recommended Books

1. Thomas N. Duening, R. A Hisrich and M. A Lechter, "Technology Entrepreneurship: Creating, Capturing, and Protecting Value", Academic Press, (2003).
2. Thomas Byers, Richard Dorf and Andrew Nelson, "Technology Ventures: From Idea to Enterprise", McGraw-Hill Science/Engineering/Math; 3rd edition, (2010).
3. Scott A. Shane, "Technology Strategy for Managers and Entrepreneurs", Prentice Hall; 1st edition, (2008).
4. William D. Bygrave and Andrew Zacharakis, "Entrepreneurship", Wiley, 2nd edition, (2010).
5. Kathleen Allen, "Entrepreneurship for Scientists and Engineers", Prentice Hall; 1st edition (2009).

ECX-485	**Machine Learning**	**[3 0 0 3]**

Course Objectives

The use of Machine learning is present in virtually all aspects of our lives and its use is increasing rapidly. Thus, this course aims to introduce postulates of learning systems, *viz*., Decision tree, Bayesian, Instance based learning. It also outlines the learning sets of rules. Next focus is to get student familiarize with concepts of support vector machine.

Course Contents

Introduction: Well-Posed Learning Problems, Designing a Learning System, Perspectives and Issues in Machine Learning. **(6)**

Decision Tree Learning: Introduction, Decision Tree Representation, Appropriate problem for Decision tree Learning, The Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Leaning, Inductive Bias in Decision Tree Leaning, Issues in Decision Tree Leaning**. (7)**

Bayesian Learning: Introduction, Bayes Theorem, Bayes Theorem and Concept Learning, Bayes Optimal Classifier, Native Bayes Classifier, An Example: Learning to Classify Text. **(7)**

Instance-Based Learning: Introduction, K-Nearest Neighbour Learning, Distance-Weighted Nearest Neighbour Algorithm. **(6)**

Learning Sets of Rules: Introduction, Sequential Covering Algorithms, Learning Rule Sets: Summary, Learning First-Order Rules, Learning Sets of First-Order Rules: FOIL, Induction as Inverted Deduction, Inverted Resolution. **(7)**

Support Vector Machine: Maximum margin linear separators, Quadractic programming solution to finding maximum margin separators, Kernels for learning non-linear functions, multi-class support vector machine. **(7)**

Recommended Books

1. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, 2nd edition (2004).
2. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1st edition (1997).
3. Richard O. Duda, Peter E. Hart & David G. Stork, “Pattern Classification”, Wiley & Sons, 2nd edition (2001).
4. Richard S. Sutton and Andrew G. Barto, “Reinforcement learning: An introduction”, MIT Press, 2nd Edition (1998).
5. Nello Christanini, John Shawe-Tayer, “An Introduction to Support Vector Machines”, Cambridge University Press, 1st edition (2000).

ECX-487	**GPU Computing**	**[3 0 0 3]**

Course Objectives

Graphics processing units (GPUs) aren't just for graphics anymore. These high-performances, many-core processors are routinely used to accelerate a wide range of science and engineering applications. The objective of this course is to study GPU architecture and get familiar with the various development platforms so as to harness the power of GPU for science and engineering applications.

Course Contents

Introduction to GPU Basics: Introduction to trends in graphics processing unit (GPU) hardware, progression of NVIDIA GPUs, background information & history on GPGPU (general purpose GPU) computing, hardware considerations in GPU design, General Purpose GPU computing community & resources, CUDA programming basics, CUDA programming model and terminology, Asynchronous CPU/GPU compute model, Work flow for a GPGPU computation, Allocating storage arrays on the GPU device, Transferring data between host and device, The CUDA thread hierarchy, Invoking a CUDA kernel through special syntax. **(12)**

Memory Hierarchy, Optimizations and Libraries: A simple CUDA kernel to add two vectors together, Catching CUDA errors, Timing CUDA kernels, How to compile and link CUDA programs using the nvcc compiler, Non-uniform memory architecture of GPGPU devices, Overview of NVIDIA's CUDA Toolkit, the nvcc compilation chain and intermediate compiler files, Debugging kernels with the NVIDIA's CUDA gdb debugger, Profiling CUDA kernels with NVIDIA's Visual Profiler. **(12)**

Programming Tools and Math Libraries: Building blocks for high-performance computing, CUDA Programming Tools, Profiling tools, Debugging tools and strategies, Standard libraries. **(8)**

Background to OpenCL: OpenCL standard for heterogeneous computing on multicore architectures, CUDA vs. OpenCL (syntax, functionality, terminology, memory models), CUDA vs. OpenCL case examples. **(8)**

Recommended Books

1. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands-on Approach", Morgan Kaufmann, (2010).
2. Jason Sander, "CUDA by Example: An Introduction to General-Purpose GPU Programming", Addison-Wesley Professional, (2010).
3. Rob Farber, "CUDA Application Design and Development", Morgan Kaufmann, (2011).
4. Benedict Gaster, "Heterogeneous Computing with OpenCL", Morgan Kaufmann, (2011).

ECX-489	Digital Signal Processors	[3 0 0 3]

Course Objectives

The Digital Signal Processors are made up of DSP Computational Building Blocks. The objective of this course is to provide basic knowledge about various computational building blocks for processing a desired signal.

Course Contents

Introduction To Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Digital filters, Decimation and interpolation, Analysis and Design tool for DSP Systems MATLAB, DSP using MATLAB. **(4)**

Computational Accuracy In DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter. **(4)**

Architectures For Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing. **(5)**

Execution Control And Pipelining: Hardware looping, Interrupts, Stacks, Relative Branch support Pipelining and Performance, Pipeline Depth, Interlocking, Branching effects, Interrupt effects, Pipeline Programming models. **(5)**

Programmable Digital Signal Processors: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline Operation of TMS320C54XX Processors. **(7)**

Implementations Of Basic DSP Algorithms: The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing. **(5)**

Implementation Of FFT Algorithms: An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX, Computation of the signal spectrum. **(4)**

Interfacing Memory And I/O Peripherals To Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA). A Multichannel buffered serial port (McBSP), McBSP Programming, a CODEC interface circuit, CODEC programming, A CODEC-DSP interface example. **(6)**

Recommended Books

1. Lapsley, “DSP Processor Fundamentals, Architectures & Features”, S. Chand & Co, (2000).
2. B. Venkata Ramani and M. Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications”, TMH, (2004).
3. Jonatham Stein, “Digital Signal Processing”, John Wiley, (2005).

Detailed course contents of 8th semester

ECX-402	Advanced Communication Systems	[3 0 0 3]

Course Objectives

An advance communication system is one of the important courses and provides low-cost solutions in Value Added Networks. The objective of this course is to provide the necessary background for understanding the behaviour of data communication networks and advance wireless communication networks.

Course Contents

Networks & Services: Network Transmission System Design Services, Characterization of networks & teleservices, The Telephone Network - Past, Present & Future, Network issues. Basic principle of ISDN - E Mail - Voice mail, digital switching, Multiplexing. **(6)**

Data Communication Networks: Basic principles of data communication: data transmission formats, synchronous and asynchronous transmission, error correcting and detecting codes. Digital transmission aspects, Signals and Impairments, Speech coding, Linear predictive coders (LPC), Multipulse excited LPC. **(8)**

GSM: Global system for mobile, GSM services and features, GSM system architecture, GSM radio subsystem, GSM Channel Types: GSM Traffic Channels, GSM Control Channel, Frame structure for GSM, Signal Processing in GSM. **(6)**

CDMA: Spread spectrum Communication (Direct sequence and frequency hopped spread spectrum, CDMA Digital cellular standard, frequency and channel specifications, Forward CDMA channel, Reverse CDMA Channel **(6)**

Modern wireless communication Systems: Integrated Services Digital Network – ISDN, Broadband Access Networks, wireless local loops, wireless local area networks, Bluetooth, Personal area networks, Orthogonal frequency division multiplexing networks, advantages of OFDM. **(10)**

Network Aspects: Intelligent Network, Network Management, and Introduction to Network management softwares **(4)**

Recommended Books

1. Theodore S. Rappaport, “Wireless Communications: Principles and Practice” 2nd Edition (2008).
2. Andrew J Viterbi, “CDMA Principles of spread spectrum communications”, Addition Wesley (1995).
3. J S Lee and L E Miller, “CDMA systems engineering handbook”, Artech House, (1998).
4. Marvin K Simon, Jim K Omura, Robert A Scholtz, Bary Klevit, “Spread Spectrum Communications”, (1995).
5. Sergio Verdu, “Multiuser Detection”, Cambridge University Press (1998).
6. Andrew S Tanenbaum, “Computer Network”, Pearson/ PHI, 4th edition (2009).

ECX-404	**Microelectronics**	**[3 0 0 3]**

Course Objectives

VLSI technology has become a major driving force in the development of all types of electronic systems. This course will introduce the fundamental concepts and techniques involved in the fabrication of VLSI (Very Large Scale Integration) circuits. These include crystal growth, wafer preparation, epitaxy, diffusion, lithography, oxidation, etching etc.

Course Contents

Electronic-Grade Silicon: Crystal growth-Czochralski, LCE, Zone-refining and floating zone. Wafer preparation. Epitaxy, VPE, LPE, MBE, MOCVD. **(5)**

An Overview Of IC Technology, And Its Requirements: Unit steps used in IC Technology: Wafer cleaning, , oxidation, characterization of oxide films, diffusion, ion implantation, annealing-RTA. Photo-lithography, E-beam lithography and newer lithography techniques for VLSI/ULSI; mask generation, wet and dry etching. **(7)**

CVD and LPCVD techniques for deposition of poly silicon, silicon nitride and silicon dioxide. Metallization and passivation. **(5)**

Special Techniques For Modern Processes: self-aligned silicides, shallow junction formation, nitride oxides etc. process flows for CMOS and bipolar IC processes. **(7)**

Plasma And Rapid Thermal-Processing: Plasma etching, RIE techniques, RTP for annealing, growth and deposition of films testing, bonding, packaging. Evaluation and measurement techniques. **(7)**

Thin Film And Thick Film Technology: hybrid circuits, circuit elements: Diodes, resistors, capacitors, inductors, contacts and interconnections **(4)**

Sub Micron Device Physics and Technology: Review of basic device physics, MOS capacitor and transistor theory, Moore law on technology scaling, Short channel effects, sub threshold leakage, Punch through, DIBL, High field mobility, Velocity saturation and overshoot. **(5)**

Recommended Books

1. G S May and S M Sze, “Fundamentals of Semiconductor Fabrication”, John Wiley & Sons, India, (2004).
2. S M Sze, “VLSI Technology”, McGraw Hill, 2nd International Edition (1988).
3. S K Ghandhi, “VLSI fabrication Principles”, John Wiley Inc., New York (1983).
4. B G Streetman, “Solid State Electronics Devices”, Prentice Hall of India, New Delhi, (1995).
5. C Y Chang and S Sze, “ULSI Technology”, McGraw-Hill Companies Inc. (1996).

Department Elective- III

ECX-432	Antenna and Wave Propagation	[3 0 0 3]

Course Objectives

Study of Antenna and wave propagation enables student to learn various types of antennas, antenna arrays and antenna parameters as well as propagation of waves through different media. The objective of this course is to give detailed knowledge of parameters to be considered while designing antennas.

Course Contents

Radiation: Review of electromagnetic fields, Displacement current, Maxwell's equations in free space, plane wave & uniform plane wave in free space. Electromagnetic radiations, Physical concept of radiation, Retarded potential, Radiation from a Hertizian dipole, monopole and a half wave dipole, Fields in the vicinity of an antenna and far field approximation. **(7)**

Antenna Parameters: Introduction, Isotropic radiators, Radiation pattern, Gain, Directive gain, Directivity, Reciprocity theorem & its applications, effective aperture, radiation resistance, terminal impedance, noise temperature, elementary ideas about self & mutual impedance, front-to-back ratio, antenna beam width, antenna bandwidth, antenna beam efficiency, antenna beam area or beam solid angle, polarization, antenna temperature. **(9)**

Antenna Arrays: Introduction, various forms of antenna arrays, arrays of point sources, non-isotropic but similar point sources, multiplication of patterns, arrays of n-isotropic sources of equal amplitude and spacing (Broad-side & End-fire array cases), array factor, directivity and beam width, array of n-isotropic sources of equal amplitude and spacing end-fire array with increased directivity, scanning arrays, Dolph-Tchebysceff arrays, tapering of arrays, binomial arrays, continuous arrays, rectangular arrays, super-directive arrays. **(9)**

Practical Antennas: Aperture Antennas, loop antennas, slot radiators, scanning antennas, signal processing antennas, travelling wave antennas, Smart Antennas. long wire antenna, V-antenna, Rhombic antenna, Folded dipole antenna, Yagi-Uda antenna, and helical antenna, slot antenna, micro strip or patch antennas, and turnstile antenna, frequency independent antennas, and microwave antennas, antenna measurement. **(8)**

Wave Propagation: Introduction, structure of atmosphere, basic idea of ground wave, surface wave, and space wave propagation, troposphere propagation and duct propagation. **(7)**

Recommended Books

1. Krauss J D, "Antennas", McGraw - Hill Inc., New York, 4th Ed. (1991).
2. Balanis A Constantine, "Antenna Theory, analysis and design", Wiley, New York,2nd Ed. (1997).
3. Prasad K D, "Antenna and Wave Propagation", Satya Prakashan, New Delhi, 3rd Ed., (1996).
4. Stutzman W L, Thieele G A, "Antenna Theory and Design", Wiley, New York, 2nd Ed. (1997).
5. Gosling William, "Radio Antennas and Propagation", Newens., UK, Ist Ed. (1998).

ECX-434	**Information and Coding Theory**	**[3 0 0 3]**

Course Objectives

The aims of this course are to introduce the principles and applications of information theory. The course will study how information is measured in terms of probability and entropy, and the relationships among conditional and joint entropies; how these are used to calculate the capacity of a communication channel, with and without noise; coding schemes, including error correcting codes.

Course Contents

Information Theory: Definition of Information, Entropy, Mutual Information, Properties of Mutual Information, Fundamental Inequality, I.T. Inequality, Divergence, Properties of Divergence, Divergence Inequality, Relationship between entropy and mutual information, Chain Rules for entropy, relative entropy and mutual information. **(3)**

Channel Capacity: Uniform Dispersive Channel, Uniform Focusing Channel, Strongly Symmetric Channel, Binary Symmetric Channel, Binary Erasure Channel. Channel Capacity of the all these channels, Channel Coding Theorem, Shannon-Hartley Theorem. **(6)**

Data Compression: Kraft inequality, Huffman codes, Shannon-Fano coding, Arithmetic Coding**. (7)**

Linear Block Codes: Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the MacWilliams identities; Perfect codes. Cyclic Codes, BCH codes; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes **(8)**

Decoding of BCH codes: Berlekamp's decoding algorithm, Massey's minimum shift-register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm **(8)**

Convolution codes: Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm, Turbo Codes, Concatenated Code **(8)**

Recommended Books

1. Arijit Saha, “Information Theory, Coding & Cryptography”, Pearson Education (2013).
2. Ranjan Bose, “Information Theory, Coding and Cryptography”, Tata Mc-Graw Hill, 2nd Edition (2008).
3. Thomas M. Cover, Joy A. Thomas, “Elements of Information Theory”, Wiley India Pvt. Ltd, 2nd Edition (2013).
4. David Williams, “Information Theory”, Kindle Edition, Amazon (2012).
5. J.Mary Jones, “Information and Coding Theory”, Springer (2000).

ECX-436	**Pulse and Switching Waveforms**	**[3 0 0 3]**

Course Objectives

Objectives of this course are to introduce the students the circuit configurations used for generation and processing of pulse and switching waveforms. Mathematical and theoretical foundations of switching techniques are covered extensively so the students will be able to design linear and non-linear wave shaping circuits, and apply the fundamental concepts of wave shaping for various switching and signal generating circuits.

Course Contents

Introduction to Pulse waveforms: Functions, signals and waveforms, classification and analysis of pulse waveforms, passive and active pulse circuits, periodic waveforms, Fourier series, Fourier transform, Laplace transform, Laplace transform pair, use of Laplace transform, transfer function, frequency function of pulse waveforms. **(7)**

Linear Wave Shaping: Low pass & high pass circuits & their response to different input waveforms viz. step, pulse, ramp, exponential etc. Low pass circuit as differentiator, high pass circuit as integrator. Compensated attenuator, Pulse transformer. **(8)**

Non-Linear Wave Shaping: Clipping circuits: series diode clipper, shunt diode clipper, transistor clipper. Two level clipping. Comparators, Clamping circuits, Clamping circuit Theorem **(7)**

Multivibrators: Bistable multivibrator, fixed bias, self-bias transistor binary circuits, concept of speed-up capacitor. Triggering of binary, Schmitt Trigger. **(7)**

Monostable and Astable Multivibrators: Circuit explanation & waveforms, trigging of monostable multivibrator, timing considerations. **(5)**

Time–base generators: General features of a time-base signal, methods of generating time-base waveform, Miller and Bootstrap time-base generators, Current time-base generators. **(6)**

Recommended Books

1. Millman and Taub, “Pulse, Digital and Switching Waveforms”, Tata McGraw-Hill Edition, (1991).
2. Aggarwal K K and Rai, “Wave Shaping and Digital Circuits”, Khanna Publishers, Reprint (1992).
3. Straus, “Wave Generation and Shaping”, McGraw Hill.
4. Bakshi U A and Godse A P, “Waveshaping Techniques,” Technical Publications, 1st Edition, Pune (2003).
5. Boylestad Nashelsky, “Electronic Devices and Circuit Theory,” Pearson education, Eighth Edition, 7th Indian reprint, (2004)

ECX-438	Radar and TV Engineering	[3 0 0 3]

Course Objectives

This course aims to introduce the working principle of radar, CW and FM radar, MTI their frequencies and application of radar. This course also outlines the different types of radars. Next focus is to get student familiarize with concepts of TV engineering by explaining the working principle of monochrome and colour television receivers.

Course Contents

Radar Engineering

Introduction: Working Principle of Radar, Radar Frequencies, Radar Equation, Minimum Detectable signal, integration of radar pulses, Pulse repetition frequency and range ambiguities, Applications of Radar **(6)**

CW and Frequency Modulated Radar: Doppler effect, CW Radar, FM-CW radar. **(4)**

MTI and Pulse Doppler Radar: Principle And Working, Delay-Line Cancellers. **(4)**

Tracking Radars: Angular Tracking Systems: Conical Scan and Monopulse, Range and Velocity Tracking Systems, Fundamentals Of Electronic Warfare, Instrument Landing Systems. **(6)**

TV Engineering

Signal Transmission and Channel Bandwidth: Sound and Picture transmission, Signal Standards, Scanning process, Interlaced Scanning, Resolution, Video Bandwidth, Construction of Composite Video Signal, Vestigial Sideband transmission, Negative transmission, Complete Channel Bandwidth. **(7)**

Monochrome TV Receivers: Block diagram of TV receiver, Antenna, Balun, R.F Tuner- Block Diagram of VHF and UHF tuners, Video I.F amplifier, Video Detector, Video Amplifier, A.G.C circuits, Sound I.F, Picture tube, Horizontal and Vertical deflection circuits. **(7)**

Colour Television: Colour fundamentals, Mixing of Colour, Chromaticity Diagram, Colour T.V Transmission and Reception. **(6)**

Recommended Books

1. Skolnik, “Introduction to Radar Systems”, Tata McGraw Hill, 3rd edition (2001).
2. Peyton Z. Peebles, Jr, “Radar Principles”, John Wiley and Sons, 1st edition (2008).
3. Nagaraja, “Elements of Electronic Navigation”, Tata McGraw Hill, 2nd edition (2004).
4. R R Gulati, “Monochrome and Colour Television engineering”, New Age International publishers, Revised 2nd edition (2005).
5. Arvind Dhake, “Television and Video Engineering”, Tata McGraw Hill, Revised 2nd edition (1999).

ECX-440	**Reliability Engineering**	**[3 0 0 3]**

Course Objectives

This is an interdisciplinary course. Objectives of this course are to enable the students to summarize reliability engineering and its management throughout the product life cycle; and to perform reliability engineering analysis. The students will be able to define the concepts and terms used for describing, interpreting and communicating qualitatively and quantitatively hazard, safety, reliability and risk and relate them to different subject domains. They will learn to apply approaches of selecting measures to improve safety and reliability.

Course Contents

Introduction: Definition for Reliability, Static and Dynamic Reliability Need for reliability Engineering, success and failure models, Causes of failures, catastrophic failures and degradation failures Characteristic types of failures, useful life of components, Exponential case of chance failure, Reliability Measures; MTBF, MTTR, hazard rate, probability distribution function, Derivation for exponential distribution function, other kinds of distributions, Binomial, Poisson uniform, Raleigh, Weibull, Gamma distribution, marks, Chains, failures data analysis. **(8)**

Series Parallel Systems: Reliability Block Diagrams, series systems, parallel systems, K-out of-M systems, open and short circuits failures, standby systems. **(5)**

Reliability Analysis of Non-Series Parallel System: Boolean algebra Method, Outset approach, delta star method, logical signal relation method, Bay's Theorem Method. **(5)**

Reliability Prediction: objective of reliability prediction, classification, and information sources for failure rate data, prediction methodologies, general requirements, Role and limitations of Reliability prediction. **(5)**

Reliability Allocation: subsystems reliability improvement, allocation for new units, criticality. **(3)**

Maintainability and Availability: forms of maintenance, measures of Maintainability and availability, maintainability function, availability function, two unit parallel system with repair, Markov Model for two unit systems, preventive maintenance, provisioning of spares. **(5)**

Reliability Testing: kinds of testing, component reliability measurements, parametric methods, confidence limits, accelerated testing, equipment acceptance testing, standard life testing plans, accelerated life testing, system safety analysis-FMECA, risk priority number and its allocation. **(5)**

Economics of Reliability Engineering: Reliability cost, Life Cycle Costing, effect of reliability on cost, reliability achievement cost models, reliability Utility cost models, Replacement policies. **(4)**

Recommended Books

1. Agarwal K K, "Reliability Engineering", Kluwer Academic Press, USA, 1st Edition (1993).
2. Balagurusamy E, "Reliability Engineering", Tata McGraw Hill, 4th Reprint (2003).
3. Srinath L S, "Reliability Engineering", East West Press Pvt. Ltd, 3rd Edition (1991).
4. Dr Brijendra Singh, "Quality Control and Reliability Analysis", Khanna Publishers (1998).
5. E E Lewis, "Introduction to Reliability Engineering", John Wiley and Sons (1987).

ECX-442	**Power Electronics**	**[3 0 0 3]**

Course Objectives

This course aims to introduce the concepts of semiconductor switching devices, power rectification, regulated power supplies and inverters. This course also outlines the concepts of induction and dielectric heating. Next focus is to get student familiarize with concepts of different types of motors, *i.e.*, DC and AC motors.

Course Contents

Semiconductor Switching Devices: Review of Thyristor, two transistor Model of SCR, classification and V-I characteristics, junction temperature, gate circuit ratings, triggering process, UJT and characteristics, UJT as a relaxation oscillator, triggering UJT using SCR, turn off methods, fast recovery diodes, schottky diodes, Series and parallel connections of SCR, DIAC, TRIAC, Power MOSFETS, application of SCR. **(7)**

Power Rectification: Classification of rectifiers, half, full, three-phase rectifier, semi converters, full converters, freewheeling diodes, circuits using SCR, voltage multiplying rectifier circuits, transformer utility factor. **(5)**

Regulated Power Supplies: Classification of voltage regulators, short period and long period accuracy of voltage regulator, D.C. voltage regulators, complete series voltage regulator circuit with ICs, SMPS basic principles, step up and step down circuits, UPS. **(5)**

Inverters: Introduction, simple Inverters and Power Inverter using SCR, output voltage control in inverter waveform control, PWM inverters, reduction of harmonies with the help of PWM inverters. **(5)**

Induction and Dielectric Heating: Induction heating effect of frequency power requirements, merits and application of induction heating, Dielectric heating, dielectric properties of a few typical materials, thermal losses, application of dielectric heating, skin effect, high frequency sources for induction and dielectric heaters. **(6)**

Electronic Control of D.C. Motors: Introduction, control of D.C. shunt motor, full wave D.C. shunt motor control overload projection, universal motor control, electronic control for reversing motor control using SCR, choppers, their classifications and applications. **(6)**

Electronic Control of A.C. Motors: Instability of D.C. motors, variable speed induction motor drives, T.N. characteristics of I.M. invertors for driving the motor, speed control of I.M. using various methods, cyclo-converters, their classifications and applications. **(6)**

Recommended Books

1. M H Rashid, “Power electronics”, PHI, 2nd Edition (1998).
2. G K Mithal, “Industrial electronics”, Khanna Publishers, Delhi, 18th Edition (1998).
3. S N Biswas, “Industrial electronics”, Dhanpat Rai and Company, Delhi, 3rd Edition (2000).
4. P S Bhimbra, “Power electronics”, Khanna Publishers, Delhi, 3rd Edition (2002).
5. M D Singh, Khanchandani K B, “Power electronics”, TMH, 6th reprint (2001).

Department Elective-IV

ECX-452	Computer Communication Networks	[3 0 0 3]

Course Objectives

This course provides an In-depth knowledge on computer networks and provides a good background for advanced studies in communication networks.

Course Contents

Introduction to computer networks, Basic concepts of analog and digital signals, Data transmission concepts, analog &digital transmission, transmission impairments .Introduction To Parallel Distributed Processing**,** Application of network, Multiprocessing and multitasking, Multiplexing techniques. **(5)**

OSI Reference Model: Communication protocols and standards, design issues, OSI reference model, TCP/IP reference model, Comparison of the OSI and TCP/IP reference model. **(4)**

Theoretical Basis For Data Transmission: Maximum Data Rate of a Channel Base Band Coaxial cable, broadband coaxial cable, FDDI, mobile telephone systems. **(6)**

Data link layer design issues: framing, error control, flow control, error detection and correction, elementary data link protocol: An Unrestricted Simplex Protocol, Stop-and-Wait Protocol, Sliding Window protocol. **(5)**

Medium access Control Sub layer: The Channel Allocation problem, Multiple Access protocols: ALOHA, Carrier sense multiple access, Collision free protocols, Limited connection Protocols, Wavelength Division Multiple Access Protocols. **(5)**

Network Layer: Store and forward Packet Switching, Connection Oriented And Connection Less Service, Service primitives, Routing Algorithms: The Optimality Principle, Shortest Path Routing, flooding, Distance vector routing and Link state routing. The IP Protocol, IP addresses, IPv4 and IPv6. **(6)**

Transport Services: Transport service primitives, Addressing, Connection establishment, connection Release, Flow Control and Buffering, Multiplexing, Crash recovery. Introduction to internet transport protocols: UDP, Remote procedure call, Real time transport protocols. **(6)**

Application Layer: The Domain Name System (DNS), Electronic Mail, The world wide Web, and Multimedia: Digital Audio, Audio Compression, Voice over IP, Video On Demand. **(4)**

Network Security: Cryptography: Substitution Ciphers and transposition ciphers, Cryptographic principles, Public Key Algorithms, Digital Signatures, E-mail Security, Social issues. **(4)**

Recommended Books

1. Andrew S Tanenbaum, “Computer Network”, 4th edition, Pearson/ PHI (2009).
2. Dimitri Bertsekas & Robert Gallager, “Data Network”, PHI, 2nd Edition (1992).
3. Gilli Wates, “Computer Communication Network”, McGraw- Hill.
4. William Stallings, “Data & Computer Communications”, Pearson Education, 6th Edition (2004).
5. Fayez Gebali, “Computer Communication Networks, Analysis and Design, North Star Digital Design, Inc., 3rd Edition (2005).

ECX- 454	**Neural Networks and Fuzzy Logic**	**[3 0 0 3]**

Course Objectives

The course will teach a variety of contemporary approaches to neural networks and fuzzy logic for various applications and introduce the theory underlying these approaches. Students would be introduced to the fundamental concepts of neural networks and fuzzy logic in detail. After taking this course, the student will be ready to understand the structure, design, and training of various types of neural networks and fuzzy logic based systems and will be ready to apply them to the solution of problems in a variety of domains.

Course Contents

Neural Networks

Neurons and neural networks, basic models of artificial neural networks: simple layer perception, feed forward multilayer perceptron, Hopfield networks, competitive learning networks, applications of neural networks for matrix algebra problems, adaptive filtering and adaptive pattern recognition, dynamic system identification, dynamic system modelling using recurrent neural networks, approximation/optimization problems, VLSI implementation of neural networks. **(20)**

Fuzzy Logic

Fuzzy Logic: Basic concepts of Fuzzy logic, Fuzzy vs Crisp set, Linguistic variables, membership functions, operations of Fuzzy sets, Fuzzy if-then rules, Variables inference techniques, defuzzification techniques, basic Fuzzy interference algorithm, application of fuzzy logic, Fuzzy system design implementation, useful tools supporting design. Type-2 fuzzy logic systems. **(20)**

Recommended Books

1. Simon Haykin, “Neural Networks and Learning Machines”, PHI, (2009).
2. Laurene V Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Prentice Hall, (1993).
3. Sandaya Samarasinghe, “Neural Networks for Applied Sciences and Engineering: From Fundamentals to Complex Pattern Recognition”, Auerbach Publications, (2006).
4. George J. Klir, “Fuzzy Sets and Fuzzy Logic: Theory and Applications”, PHI, (1995).
5. John Yen, Reza Langari, “Fuzzy Logic: Intelligence, Control, and Information”, PHI, (1998).
6. Oscar Castillo, Patricia Melin, “Type-2 Fuzzy Logic: Theory and Applications”, Springer, (2010).

ECX-456	**Wavelet Theory and Applications**	**[3 0 0 3]**

Course Objectives

The course introduces the theoretical fundamentals along with wide range of applications including communication, audio, speech, image and video. This course provides a coherent approach to study wavelets and its application in various fields. Student will get necessary background for advance studies in digital signal processing and other multimedia signal processing subjects.

Course Contents

Introduction: Basics of Functional Analysis, Stationary and Non-stationary Processes, Transform, Fourier Transform, Spectral Theory, Short Time Fourier Transform, Wavelets over FT and STFT, Wavelets Applications. **(12)**

Wavelet Transform: Continuous Wavelet Transform, Types of wavelets, Time-Frequency Resolution, Discrete Wavelet Transform DWT, Sub-band Coding, Multi-resolution Analysis, Wavelet Coefficients Estimation, Inverse DWT, Applications of DWT and IDWT in Signal and Image Processing. **(12)**

Un-decimated Wavelet Transform: Algorithme `a Trous, Estimation of Wavelet Coefficients, Inverse Un-decimated Wavelet Transform, Applications, Matched Wavelets. **(10)**

Application of Wavelet Transforms: Wavelet denoising speckles Removal, Edge Detection and Object Isolation, Image Fusion, Object Detection by Wavelet Transform of Projections, Communication application. **(6)**

Recommended Books

1. James S. Walker, "A Primer on Wavelets and Their Scientific Applications", Chapman & Hall/CRC, CRC Press, 2nd Edition (Studies in Advanced Mathematics)" (2008).
2. Lokenath Debnath "Wavelet Transforms & Time-Frequency Signal Analysis**",** Birkhauser Boston (2001).
3. Stephane Mallat "A Wavelet Tour of Signal Processing, Third Edition: The Sparse Way", Elsevier, Academic Press (2008).
4. Albert Boggess, Francis J. Narcowich "A First Course in Wavelets with Fourier Analysis" John Wiley & Sons (2009).
5. Raghuveer M. Rao, Ajit S. Bopardikar "Wavelet Transforms: Introduction to Theory & Applications", Addison-Wesley (1998).

ECX- 458	**Computer Vision**	**[3 0 0 3]**

Course Objectives

Computer vision is one of the introductory vision courses related to the application point of view in many engineering fields. The objective of this course is to model the real world or to recognize objects from digital images or videos acquired using sensors.

Course Contents

Introduction to computer vision: Course introduction, Basic of image processing, computer verses human, Graphics and vision, Image Representation and Basic Structures **(5)**

Image Formation and Filtering: Image geometry, Radiometry, Digitization, Cameras, Camera models and optics, Light and color, Convolution and Image filtering, Image pyramids and applications **(5)**

Feature Detection and Matching: Edge definition and detection, Edge operators, Interest points and corners, Local image features, Hough transform **(7)**

Image Segmentation: Fundamentals, Segmentation methods, Use of motion in segmentation. **(4)**

Multiple Views and Motion: Stereo, Epipolar Geometry and Structure from Motion, Detection and tracking of point features, optical flow **(6)**

Object Tracking: Kalman filter, condensation, tracking humans **(4)**

Recognition: Recognition overview and bag of features, Large-scale instance recognition, Detection with sliding windows: Viola Jones, character classification, pedestrian and face recognition, Modern object detection **(5)**

Introduction to Computer vision and image processing toolbox in MTALAB for simulating Algorithms **(4)**

Recommended Books

1. R. Szeliki, “Computer Vision: Computer Vision: Algorithms and Applications”, (2010).
2. R. Hartley and A. Zisserman, “Multiple View Geometry in Computer Vision”, Cambridge University Press, (2003).
3. Ballard D., Brown C., “Computer Vision”, Prentice Hall.
4. D. A. Forsyth and J. Ponce, “Computer Vision: A Modern Approach”, Prentice Hall, Upper Saddle River, N.J., (2003).

ECX-460	**Cognitive Radio**	**[3 0 0 3]**

Course Objectives

This course gives a thorough knowledge of spectrum scarcity, cognitive radio concepts, principles, standards, spectrum policy issues and product implementation details. The course combines a discussion of existing literature with current challenges of cognitive radio technology to create an integrated approach that is useful for students engaged in solving the problems in implementation of cognitive radios.

Course Contents

Spectrum Scarcity: history and background leading to cognitive radios, Software define radios (SDRs), basic architecture of SDR, power control in cognitive transceivers, Dynamic Spectrum Access, new opportunities, spectrum management. **(6)**

Cognitive Radios: Scarcity problems, network protocols, standardization, security issues.

Spectrum Sensing: ideal spectrum sensing, Spectrum sensing techniques: Transmission detection (Energy detection, cyclostationary detection, matched filter detection), feature based detection, interference detection, spectrum sensing in fading environment. **(10)**

Cooperative Sensing: importance of cooperative sensing, advantages of spectrum sensing, need of co-operations, centralized cooperative sensing, distributed spectrum sensing. Fusion rules: hard fusion, soft fusion rules. **(10)**

Spectrum Management: Spectrum handoff management, spectrum mobility, spectrum sensing in ad-hoc network, spectrum sharing. **(5)**

Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential) **(8)**

Recommended Books

1. Bruce A. Fette, “Cognitive Radio Technolog, Elsevier Publication” 2nd Edition, (2009).
2. Natarajan Meghanathan and Yenumula B. Reddy “Cognitive Radio Technology Applications for Wireless and Mobile Ad Hoc Networks” (2013).
3. Ekram Hossain, Dusit Niyato, Zhu Han, “Dynamic Spectrum Access and Management in Cognitive Radio Networks”, Cambridge University Press, (2009).
4. Kwang-Cheng Chen, Ramjee Prasad “Cognitive radio networks”, ‚John Wiley & Sons Ltd., (2009).
5. Huseyin Arslan “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, Springer, (2007).
6. Linda Doyle, “Essentials of Cognitive Radio”, Cambridge University Press, (2009).

ECX-464	**Mobile Computing**	**[3 0 0 3]**

Course Objectives

Mobile computing is a young and dynamic field. The objective of mobile computing is to develop system and application level software for small, battery powered terminals equipped with the wireless network connection.

Course Contents

Introduction to Mobile Communications and Computing: novel applications, limitations, and architecture. Mobile services, mobile system architecture, Radio interface, Protocols, Localization and calling, Handover, Security, and New data services. **(5)**

Medium Access Control and Network Layer: Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), Multiplexing techniques. **(5)**

Mobile Network Layer: Mobile IP (Goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunneling and encapsulation, optimizations), Dynamic Host Configuration Protocol (DHCP) **(5)**

Mobile Transport Layer : Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP. **(5)**

Database Issues: Hoarding techniques, caching invalidation mechanisms, client server computing with adaptation, power-aware and context-aware computing, transactional models, query processing, recovery, and quality of service issues. **(5)**

Data Dissemination: Communications asymmetry, classification of new data delivery mechanisms, pushbased mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques. **(5)**

Mobility and location based services: Data acquisition of location Information, GIS, Location Information Modeling, Localization and internationalization. **(5)**

Protocols and Tools: Wireless Application Protocol-WAP. (Introduction, protocol architecture, and treatment of protocols of all layers), Bluetooth (User scenarios, physical layer, MAC layer, networking, security, link management) and J2ME. **(5)**

Recommended Books

1. Jochen Schiller,"Mobile Communications", Addison-Wesley., second edition, (2004).
2. Stojmenovic and Cacute, "Handbook of Wireless Networks and Mobile Computing", Wiley, (2002).
3. Reza B'Far, "Mobile Computing Principles: Designing and developing mobile Application with uml AND xml", Cambridge University, (2004).
4. H. Labiod, H. Afifi and C. De Santis, Wi-Fi, Bluetooth, Zigbee and Wimax, Springer.
5. Marcus Taylor, Understanding WAP: Wireless Applications, Devices and services, Artech House Publishers, (2000).

ECX-466	Optical Communication Systems and Networks	[3 0 0 3]

Course Objectives

This course provides knowledge about various types of optical sources and detectors available at receivers. It also imparts knowledge about communication system based on optical fiber and various techniques of multiplexing. Apart from this, various networking models for optical communication taught to complete all aspects of this subject.

Course Contents

Optical Sources: Optical source properties, what is inside an LED? What causes the LED to emit light and what determines the color of the light?, how much energy does an LED emit?, finding the energy from the voltage, finding the frequency from the wavelength of light, operating wavelength of optical sources, semiconductor light-emitting diodes and laser diodes, semiconductor material and device operating principles, light-emitting diodes, surface-emitting LEDS, edge-emitting LEDS, super luminescent diodes, laser diodes, comparison of LED and ILD. Fiber optic transmitters, basic optical transmitters, direct versus external modulation, fiber optic transmitter applications, digital applications, analog applications. **(8)**

Optical Detectors: Basic Information on light detectors, Role of an optical detector, Detector characteristics: Responsivity, Noise Equivalent Power, Detectivity, Quantum efficiency, Detector response time, Linearity, Spectral response, Noise considerations: Johnson noise, Shot noise, 1/*f* noise, Photon noise, The PN junction photo diode - PIN photodetectors - Avalanche photo diode construction characteristics and properties, APD Specifications, Applications of APD - comparison of performance noise sources - simple - simple model of photo receiver - Its equivalent for circulation of noise SNR, Optical Receivers. **(8)**

Optical Fiber Communication System: telecommunication, local distribution series, computer networks local data transmission, Digital optical fiber communication system, first & second-generation system, future system **(5)**

Advanced Multiplexing Strategies: Optical TDM, subscriber multiplexing (SCM), WDM and Hybrid multiplexing methods **(5)**

Optical Switching & Networks: Transport Networks, Applications, Requirements, Architectures, Technologies, and Solutions, Introduction to Optical Access Networks **(5)**

Fiber Optic System Design Considerations and Components: Components: Indoor Cables, Outdoor Cables, Cabling Example**,** Power Budget, Bandwidth and Rise Time Budgets, Electrical and Optical Bandwidth, Connectors, Fiber Optic Coupler **(5)**

Optical Networking: Data communication networks, network topologies, MAC protocols, Network Architecture- SONET/TDH, optical transport network, optical access network **(4)**

Recommended Books

1. Silvello Betti, Giancarlo De Marchis and Eugenio Iannone, "Coherent Optical Communications Systems", John Wiley, (1995).
2. Casimer Decusatis, "Handbook of Fiber Optic Data Communication" 2nd edition, Academic Press.
3. Ivan Kaminow, "Fiber Optical telecommunications IV A" Academic Press (2002).
4. Ivan Kaminow, "Fiber Optical telecommunications IV B" Academic Press (2002).
5. Vivek Alwyn "Optical Design and Implementation" Cisco Press (2004).

ECX-468	**Telecommunication Switching and Networks**	**[3 0 0 3]**

Course Objectives

This course provides an In-depth knowledge on telecommunication switching and a good background for advanced studies in communication networks.

Course Contents

Telecommunications Transmission: Basic Switching System, Simple Tele-phone Communication, evolution of switching systems -Stronger switching systems. **(3)**

Switching Used in telecommunications cross bar switching, Electronic Switching – Space Division Switching, Time Division Switching –Time Division space switching, Time Division Time Switching, Time multiplexed space switching, Time multiplexed Time Switching, Combination Switching. **(6)**

Control of Switching Systems: Call processing functions, common control, and stored program control (For all type of switching systems). **(5)**

Speech Digitization and Transmission: Quantization Noise, Companding, Differential Coding, Vocodors, Pulse Transmission, Line Coding, NRZ and RZ Codes, Manchester Coding, AMI Coding, Walsh Codes, TDM**.** **(7)**

Traffic Engineering: Grade of Service and Blocking Probabity – Telephone Networks, Subscriber Loops, Switching Hierchy and Routing, Transmission Plans and Systems, Signaling Techniques, In Channel, Common Channel. **(6)**

Telephone Networks and Signaling: Introduction, subscriber loops systems, switching hierarchy, transmission and numbering plans, common channel signaling principles, CCITT signal. **(6)**

Data Networks: Data transmission in PSTNs, Switching Techniques for data transmission, Data communication architecture, Satellite based Data networks. **(7)**

Recommended Books

1. Flood J E, "Telecommunications switching, traffic and networks", first Indian reprint, Pearson education Asia, (2001).
2. Viswanathan T, "Telecommunication switching systems and networks", 17th Indian reprint, PHI, India, (2003).
3. Bosse J G van, Bosse John G., "Signaling in Telecommunication Networks", Wiley, John & Sons, (1997).
4. Bruce S. Davie, Paul Doolan, Yakov Rekhtor, "Switching in IP Networks: IP Switching, Tag Switching, and Related Technologies", Elsevier Science & Technology Books, (1998).
5. Joseph Yu Hui, "Switching and Traffic Theory for Integrated Broadband Networks", Kluwer Academic Publishers, (1990).

ECX-470	**Mixed Signal IC Design**	**[3 0 0 3]**

Course Objectives

The primary objective of this course is to give an overview of analog and mixed signal VLSI design. To provide background information on various MOSFET issues, modelling and circuit design using CMOS technology. Focus on some of the basic principle associated with mixed signal IC design along with some DAC and ADC. However, a large part of the subject mainly concentrates on specific examples of Op-amp and specialized IC's.

Course Contents

Introduction: Introduction to analog VLSI and mixed signal issues in CMOS technologies **(5)**

MOS transistor: Introduction, Short channel effects, current source & current mirror CMOS circuit **(6)**

Basic Integrated Circuit Devices and Modeling: MOS and BJT transistor modeling, CMOS and bipolar processing – CMOS and analog layout consideration **(6)**

MOS and CMOS sample and hold circuit – bipolar and BiCMOS sample and hold – switched capacitor circuits – data converters **(5)**

D/A and A/D converters : introduction A/D and D/A, various type of A/D converter, ADCs, ramp, tracking, dual slope, successive approximation and flash types, Multi-stage flash type ADCs **(5)**

OP-AMP : Op-amp- analysis, approximations and modelling; Ideal op-amp building blocks, Open loop op-amp configurations, Practical op-amp- Offset voltage analysis and compensation, Input bias and offset current analysis and compensation, frequency response, slew rate, Block diagram representations and analysis of configurations using negative feedback, Designing of Op-amp. **(7)**

Specialized IC's: 555 Timer-Monostable, multivibrator, astable multivibrator, Applications and Phase locked loop-Operating principles and applications of PLL. **(6)**

Recommended Books

1. D. A. Johns and K. Martin, "Analog Integrated Circuit Design", Wiley Student Edition, (2002).
2. P. R. Gray and R. G. Meyer, "Analysis and design of Analog Integrated circuits", 4th Edition, Wiley Student Edition, (2001).
3. R.Jacob Baker,H.W.Li, and D.E. Boyce, "CMOS Circuit Design, Layout and Simulation", Prentice-Hall of India, (1998).
4. Mohammed Ismail and Terri Faiz, "Analog VLSI Signal and Information Process", McGraw-Hill Book company, (1994).
5. B. Razavi, "RF Microelectronics", Prentice-Hall PTR, (1998).
6. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design", 2nd edition, Oxford University Press, (1997).

ECX-474	**Digital IC Design**	**[3 0 0 3]**

Course Objectives

This course focuses on IC design of modern digital circuits. Digital circuits will be introduced and analyzed. Design of CMOS based combinational and sequential digital integrated circuits are covered. It provides exposure to the semi custom and full custom design and circuits with which digital systems are implemented. Emphasis is also given on the programmable logics devices.

Course Contents

Introduction: Digital IC, Digital Combinational and sequential circuit, issue in digital IC design, Quality metrics of Digital Design. **(6)**

Designing Combinational Logic Gate in CMOS : Static C-MOS Inverter and its characteristics, CMOS Design consideration Transistor Sizing, Power Dissipation, Design Margining, Ratioed Logic, Pass Transistor Logic, Dynamic C-MOS design, basic principle, speed and power Dissipation of Dynamic Logic, Signal Integrity in Dynamic Design, Cascaded Dynamic. **(7)**

Designing Sequential Logic Circuits: Introduction, Static Latches and registrars, Dynamic Latches and Registers, Alternative Register Styles, Pipelining. **(7)**

Implementation Strategies for Digital ICS: Custom, Semi custom Circuit Design, Cell –Based Design Methodology, Array Based Implementation Approach**,** Layout. **(6)**

Designing Memory: Memory Classification, Memory Architecture and Building Block,Read only Memories, Nonvolatile Read Write Memories, Read-Write Memories, Memory Peripheral Circuits **(7)**

Programmable logic devices: Introduction to PLA, PAL, PLD/CPLD, PGA/ FPGA, ASIC their applications and Architecture. **(7)**

Recommended Books

1. J.M. Rabaey, A. Chandrakasan and B. Nikolic, “Digital Integrated Circuits- A Design Perspective”, PHI, 2nd Edition (2003).
2. D.A. Pucknell and K. Eshraghian, “Basic VLSI Design”, PHI (1995).
3. E.D. Fabricius, “Introduction to VLSI Design”, McGraw Hill (1991).
4. N. H. E. Weste and K. Eshraghian, “Principles of CMOS VLSI Design - a System Perspective”, Pearson Education Asia, 2nd Edition, (2002).
5. S. M. Kang and Y. Leblevici, “CMOS Digital Integrated Circuits Analysis and Design”, 3rd Edition, McGraw Hill (2003).
6. W. Wolf, “Modern VLSI Design - System on Chip design”, Pearson Education, 3rd Edition, (2004).

ECX-476	**Analog IC Design**	**[3 0 0 3]**

Course Objectives

Analog VLSI subject deals with analysis and design of analog CMOS Integrated Circuits. An ability to analyze basic amplifier stages, differential amplifier stage, current mirrors, and active loads. Students should be able to make choices among these building blocks. Analyze various single-stage and two-stage op-amp circuits.

Course Contents

Review of MOS Devices: MOS transistor models. NMOS, PMOS, CMOS, Introduction to analog VLSI and mixed signal issues in CMOS technologies **(6)**

Basics of system hardware design methodology: Hierarchical design using top-down and bottom-up methodology **(6)**

Basic Electrical Properties And Circuit Concepts: Basic Electrical Properties of MOS circuits: MOS transistor operation in linear and saturated regions, MOS transistor threshold voltage. MOS switch and inverter, latch-up in CMOS inverter; sheet resistance and area capacitances of layers, wiring capacitances MOS models, SPICE Models **(10)**

Circuit Characterization and Performance Estimation: Estimation of R, C, L, Switching Characteristics-delay models. Power dissipation. ; MOSFET scaling - constant-voltage and constant-field scaling **(6)**

CMOS Analog blocks: Current Sources and Voltage references. Differential amplifier and OPAMP design **(6)**

Practical Aspects and Design Verification: Semi-custom and cell library based design. Design of. Hardware description languages for high level design. Logic, circuit and layout verification. Analog Testing, Layout issues. Introduction to different tool used in Analog design **(6)**

Recommended Books

1. Weste N and Eshranghian K, “Principles of CMOS VLSI Design”, Pearson Education Asia (2001).
2. Glaser L and Dobberpuhl D, “The Design and Analysis of VLSI Circuits”, Addison Wesley (1985).
3. Rabaey J, “Digital Integrated Circuits: Design perspective”, Prentice Hall India (1997).
4. Perry D, “VHDL”, McGraw-Hill International, 2nd Edition (1995).
5. D. A. Johns and K. Martin, “Analog Integrated Circuit Design”, Wiley Student Edition (2002).
6. P. R. Gray and R. G. Meyer, “Analysis and design of Analog Integrated circuits” 4th Edition, Wiley Student Edition (2001).

ECX-478	**MEMS**	**[3 0 0 3]**

Course Objectives

The course aims to give the students a basic knowledge about state-of-the-art MEMS including technology, device architecture, design and modelling, scalability, figures of merit and RF IC novel functionality and performance. Reliability and packaging are also considered as key issues for industrial applications.

Course Contents

Introduction to Microelectromechanical Systems (MEMS) and MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes for Micromachining - Basic Process Tools, Advanced Process Tools,MEMS Structure and Systems: General Design Methodology, Techniques for Sensing and Actuation, Passive MEM Structures, Sensors. Actuators, Mechanical Vibrations, Computer-Aided Design of MEMS and tools **(15)**

Applications of MEMS in RF/Microwave – The MEMS Switch and its Design Consideration. The MEM Resonator and its Design Considerations, Micromachining-Enhanced Planar Microwave Passive Elements. Other MEMS Based RF/Microwave Circuits and Systems **(15)**

Packaging & Reliability for MEMS - Key Design and Packaging Considerations. Die-Attach Processes. Wiring and Interconnects. Types of Packaging Solutions. Reliability and Failure Analysis **(10)**

Recommended Books

1. Nadim Maluf and Kirt Williams, "An Introduction to Microelectromechanical Systems Engineering", Artech, 2nd Edition (2004).
2. Hector J. De Los Santos " Introduction to Microelectromechanical Microwave Systems", Artech, 2nd Edition (2004).

ECX-480	**RF Circuit Design**	**[3 0 0 3]**

Course Objectives

This course aims at design and analysis of high speed RF circuit and systems. The course is aimed at the understanding the concept of an RF system, its main constituting circuit blocks, and the particular problems associated with operation at a high speed. This is necessary and essential in understanding and designing today's communication systems.

Course Contents

Introduction: Importance of RF Design, RF Behavior of Passive Components, Chip Components and Circuit Board Considerations, General Transmission Line Equation, Micro Strip Transmission Lines.
Single and Multi Port Networks: Interconnecting Networks, Network Property and Application, Scattering Parameters **(7)**
Active RF Component and Modeling: Semiconductor Basics, RF Diode, Bipolar Junction Transistor, RF Field Effect Transistors, High Electron Mobility Transistor, Diode Models, Transistor Models **(8)**
Matching & Biasing Network & RF Filter: Overview of RF Filter design, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise, Amplifier design in various technologies, Design of Mixers at GHz frequency range, various mixers- working and implementation **(8)**
Oscillators: Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Radio frequency Synthesizers- PLL, Various RF Synthesizer architectures and frequency dividers, Power Amplifier design, Design issues in integrated RF filters. **(7)**
RF Transistor Amplifier: Characterstics of Amplifiers, Amplifiers Power Relation, Stability Considerstions, Constant Gain, Noise Figure Circles, Constant VSWR Circles, Broad Band, High Power and Multistage Amplifiers **(6)**
Oscillators and Mixers: Basic Oscillator Model, High Frequency Oscillator Configuration, Basic Characteristics of Mixers **(4)**

Recommended Books

1. Reinhold Ludwig, Pavel Bretchko, “RF Circuit Design”, 1st Indian Reprint, Pearson Education Asia (2001).
2. B Razavi, “Design of Analog CMOS Integrated Circuit”, Mc Graw Hill (2000).
3. R. Jacob Baker, H.W. Li, D.E. Boyce, “CMOS Circuit Design, layout and Simulation”, PHI (1998).
4. Y. P. Tsividis, “Mixed Analog and Digital Devices and Technology”, TMH (1996).
5. Thomas H. Lee, “Design of CMOS RF Integrated Circuits”, Cambridge University Press (1998).

ECX-482	**RF Planning and Optimization**	**[3 0 0 3]**

Course Objectives

This course aims for students, especially those with technology background of wireless communications engineering and practice. This course provides the basic RF fundamental principles and advanced technologies to have students able to perform planning, designing and network optimization for wireless networks.

Course Contents

Overview of Mobile networks: Introduction, Mobile Network Evolution, Information Theory, 2G and 3G mobile networks. **(10)**

GSM Network Planning and Optimization: Basic of Radio Network Planning, Pre-planning, Detailed planning, Network optimization, Basic of Transmission Network Planning, Pre-planning, Detailed planning & optimization. Core Network Planning, Pre-planning, Detailed planning & Optimization **(10)**

2.5G Network Planning and Optimization: GPRS Network Planning and Optimization, EDGE Network Planning and Optimization **(10)**

3G Network Planning and Optimization: Basic of Radio Network Planning, Pre-planning, Detailed planning & optimization, 3G Transmission Network Planning, Asynchronous Transfer Mode (ATM), Dimensioning, Microwave Link Planning, Detailed planning & optimization. 3G core Network Planning & Optimization **(10)**

Recommended Books

1. R. Mishra, "Fundamentals of Cellular Network Planning and Optimization: 2G/2.5G/3G. Evolution to 4G:", Wiley (2004).
2. J. Laiho, A. Wacker, and T. Novosad "Radio network planning and optimization for UMTS:", Wiley (2006).
3. S. P. Singh, "RF Planning, Design and Optimization of Cell-site in Tele-communications", California State University, Sacramento (2005).

ECX-484	**Game Theory and Applications**	**[3 0 0 3]**

Course Objectives

Game theory is a study of strategic decision-making that has attracted much interest because of its many applications to social, economical, political and engineering problems. The objective of this course is to introduce students to the principal ideas and applications of game theory.

Course Contents

Introduction to Game theory: What is Game theory? Where did games theory come from? Why is Game theory relevant to wireless communication and networking? Proper use of game theory? Introduction to example: Power control, Routing, Trust management **(8)**

Decision Making and Utility Theory: Preference relationships, Existence of ordinal utility representation: Finite X, Countable X, Uncountable X, Uniqueness of utility Functions, The von Neumann- Morgenstern Axioms **(8)**

Strategic From Games: Definition of strategic Form games, dominated Strategies and iterative deletion of dominated Strategies, mixed Strategies. Nash Equilibrium: Dealing with mixed Strategies, decision of Nash Equilibrium. Existence of Nash Equilibriums **(8)**

Role of pricing: Application of game theory, Pricing of Network Resources, Flow control **(8)**

Case studies for engineering and management applications. **(8)**

Recommended Books

1. Allen B. MacKenzia and Luiz A. Dasilva, “Game theory for wireless Engineers”, A publication in the Morgan and claypool Publisers, (2006).
2. Shaun P. Hargreaves- Heap and Yanis Varoufakis, “Game Theory A critical Introduction”, Taylor and Francis group Publication, (2004).
3. Edward C. Rosenthal, “Game Theory The Fascinating math behind decision Making”, Marie Butler Knight Publisher (2011).
4. William Poundstone, “Game theory in everyday Life”, Published by Basic books, (2008).
5. Drew Fudenberg, Jean Tirole, “Game theory”, Library of congress cataloging in publication, (2005).

ECX-486	**Image Processing**	**[3 0 0 3]**

Course Objectives

This course will provide students fundamentals of Digital Image Processing and its applications. This course incorporates the concepts of image enhancement, image restoration, segmentation and image compression. Students will be able to perform image manipulations and analysis in many different fields like object recognition, medical image processing, representation of images etc.

Course Contents

Digital Image Fundamentals: Digital Image Processing: Definition, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of visual perception – Image sampling and Quantization, Basic relationship between pixels – Basic geometric transformations - Introduction to Fourier Transform and DFT – Properties of 2D Fourier Transform – FFT – Separable Image Transforms -Walsh – Hadamard – Discrete Cosine Transform, Haar. **(8)**

Image Enhancement Techniques: Spatial Domain methods: Basic grey level transformation, Histogram Equalization, Image Subtraction, Image averaging, Spatial filtering: Smoothing, sharpening filters – Laplacian filters, Frequency domain filters: Smoothing – Sharpening filters, Homomorphic filtering. **(6)**

Image Restoration: Model of Image Degradation/restoration process, Noise models, Inverse filtering, Least mean square filtering, Blind image restoration, Singular value decomposition. **(4)**

Image Compression: Lossless compression: Variable length coding, LZW coding, Bit plane coding, Predictive coding-DPCM, Lossy Compression: Transform coding, Wavelet coding, Basics of Image compression standards: JPEG, MPEG. **(7)**

Image Segmentation and Representation: Point, Line and Edge Detection, Thresholding, Hough Transforms, Region Based Segmentation, Boundary representation, Boundary descriptors, Regional Descriptors. **(7)**

Morphological Image Processing: Preliminaries. Dilation and Erosion. Opening and Closing. The Hit-or-Miss Transformation. Some Basic Morphological Algorithms. Extensions to Gray-Scale Images. **(4)**

Object Recognition: Pattern and pattern classes, recognition based on Decision Theoretic Methods, Structural Methods. **(4)**

Recommended Books

1. Gonzalez, Woods, “Digital Image Processing”, Pearson Education Asia, Ninth Indian Reprint, (2004).
2. Millman Sonka, Vaclav hlavac, Roger Boyle, “Image Processing Analysis and Machine Vision” Broos/colic, Thompson Learning, (1999).
3. A. K. Jain, “Fundamentals of Digital Image processing” PHI, (2002).
4. Chris Solomon and Toby Breckon, “Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab”, Wiley Blackwell, (2011).
5. Maria Petrou and Costas Petrou, “Image Processing: The Fundamentals”, 2nd Edition, Wiley Blackwell, (2010).
6. Jayaram, S. Esakkirajan and T. Veera Kumar, “Digital Image Processing”, Tata McGraw-Hill Education, (2011).

ECX-488	**Gamification**	**[3 0 0 3]**

Course Objectives

This course will introduce the concepts of Gamification. This course also incorporates the rules and goals of the game elements. Students will be able to understand its design process through case studies.

Course Contents

What is Gamification: Introduction, What is Gamification? Gamification in Action, Gamification versus Serious Games, Growth of Gamification, Who is using Gamification? **(10)**
Game Elements: Introduction, Goals, Rules, Reward Structures, Feedback, Levels, Storytelling. (10) **Gamification Design Process:** Game Mechanics, Players motivation, Points, Levels, Leaderboards, Badges, Onboarding, Challenges and Quests. **(8)**
Gamification for Problem Solving in different domains (Case Studies) (12)

Recommended Books

1. Gabe Zichermann and Joselin Linder, "The Gamification Revolution: How Leaders Leverage Game Mechanics to Crush the Competition", McGraw-Hill; 1st edition, (2013).
2. Karl M. Kapp, "The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education", Pfeiffer; 1st edition, (2012).
3. Kevin Werbach and Dan Hunter, "For the Win: How Game Thinking Can Revolutionize Your Business", Wharton Digital Press, (2012).
4. Andrzej Marczewski, "Gamification: A Simple Introduction & a Bit More", Kindle edition, (2013).
5. Karl M. Kapp, "The Gamification of Learning and Instruction Field book: Ideas into Practice, Pfeiffer; 1 edition, (2013).