PUNJAB TECHNICAL UNIVERSITY

Scheme& Syllabus of B. Tech. Electronics & Communication Engineering [ECE]

Batch 2011

By

Board of Studies Electronics & Communication Engineering

Third Semester **Contact Hours: 29 Hrs.**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTAM-301	Engineering Mathematics-III	4	1	-	40	60	**100**	**5**
BTCS-305	Object Oriented Programming using C++	3	1	-	40	60	**100**	**4**
BTEC-301	Analog Devices & Circuits	3	1	-	40	60	**100**	**4**
BTEC-302	Digital Circuit and Logic Design	3	1	-	40	60	**100**	**4**
BTEC-303	Network Analysis and Synthesis	3	1	-	40	60	**100**	**4**
BTEC-304	Lab Analog Devices & Circuits	-	-	2	30	20	**50**	**1**
BTEC-305	Lab Digital Circuit and Logic Design	-	-	2	30	20	**50**	**1**
BTCS-309	Lab Object Oriented Programming	-	-	4	30	20	**50**	**2**
Workshop Training *					60	40	**100**	
	TOTAL	**16**	**5**	**8**	**350**	**400**	**750**	**25**

***The marks will be awarded on the basis of 4 weeks workshop training conducted after 2nd Semester**

Fourth Semester **Contact Hours: 32 Hrs**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTEE-402	Linear Control Systems	4	1	-	40	60	**100**	**5**
BTEC-401	Analog Communication Systems	3	1	-	40	60	**100**	**4**
BTEC-402	Signal & Systems	3	1	-	40	60	**100**	**4**
BTEC-403	Electromagnetics & Antennas	4	1	-	40	60	**100**	**5**
BTEC-404	Electronic Measurement & Instrumentation	3	1	-	40	60	**100**	**4**
BTEC-405	Pulse Wave Shaping and Switching	3	1	-	40	60	**100**	**4**
BTEC-406	Lab Analog Communication Systems	-	-	2	30	20	**50**	**1**
BTEC-407	Lab Electronic Measurement & Instrumentation	-	-	2	30	20	**50**	**1**
BTEC-408	Lab Signal & Systems using MATLAB/Mentor DSP	-	-	2	30	20	**50**	**1**
General Fitness					100	NA	**100**	
	TOTAL	**20**	**6**	**6**	**430**	**420**	**850**	**29**

Fifth Semester **Contact Hours: 30 Hrs**

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BTCS-304	Data Structures	3	1	-	40	60	**100**	**4**
BTEC-501	Digital Communication System	3	1	-	40	60	**100**	**4**
BTEC-502	Digital Signal Processing	4	1	-	40	60	**100**	**5**
BTEC-503	Linear Integrated Circuit	3	1	-	40	60	**100**	**4**
BTEC-504	Micro processors & Micro controllers.	4	1	-	40	60	**100**	**5**
BTEC-505	Lab Digital Signal Processing	-	-	2	30	20	**50**	**1**
BTEC-506	Lab Linear Integrated Circuit	-	-	2	30	20	**50**	**1**
BTEC-507	Lab Digital Communication System	-	-	2	30	20	**50**	**1**
BTEC-508	Lab Hardware Programme & Interfacing	-	-	2	30	20	**50**	**1**
Industrial Training *					60	40	**100**	**1**
	TOTAL	**17**	**5**	**8**	**380**	**420**	**800**	**26**

***The marks will be awarded on the basis of 06 weeks workshop training conducted after 4th Semester**

Sixth Semester **Contact Hours: 30 Hrs**

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BTCS-401	Operating Systems	3	1	-	40	60	**100**	**4**
BTEC-601	Microwave & Radar Engineering	4	1	-	40	60	**100**	**5**
BTEC-602	Wireless Communication System	3	1	-	40	60	**100**	**4**
BTEC-603	Engineering Economics & Industrial Management	3	1	-	40	60	**100**	**4**
BTEC-604	VLSI Design	4	1	-	40	60	**100**	**5**
BTEC-XXX	Elective-I	3	1	-	40	60	**100**	**4**
BTEC-605	Lab VLSI	-	-	2	30	20	**50**	**1**
BTEC-606	Lab Microwave Engineering	-	-	2	30	20	**50**	**1**
General Fitness					100	NA	**100**	
	TOTAL	**20**	**6**	**4**	**400**	**400**	**800**	**28**

Seventh / Eighth Semester **Contact Hours: 30 Hrs.**

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BTCS-403	Computer Networks	3	1	-	40	60	**100**	**4**
BTEC-701	Embedded Systems	3	1	-	40	60	**100**	**4**
BTEC-702	Optical Communication	3	1	-	40	60	**100**	**4**
BTEC-YYY	Elective-II	3	1	-	40	60	**100**	**4**
BTEC-ZZZ	Elective-III	3	1	-	40	60	**100**	**4**
BTEC-703	Lab Wireless and Optical Systems & Networks	-	-	2	30	20	**50**	**1**
BTEC-704	Lab Embedded Systems	-	-	2	30	20	**50**	**1**
BTEC-705	Major Project	-	-	6	100	50	**150**	**3**
General Fitness					100	NA	**100**	
	TOTAL	**15**	**5**	**10**	**460**	**390**	**850**	**25**

Seventh / Eighth Semester

Course Component	Internal Marks	External Marks	Total Marks
For Software Training *	150 Marks	100 Marks	250 Marks
For Industry Oriented Project Training	300 Marks	200 Marks	500 Marks

Note:

*The institution may provide training on any of the softwares from amongst

- ORCAD,
- MATLAB,
- Mentor DSP,
- MULTISIM,
- OPTSIM,
  OPTISYSTEM
- NS2
- OPNET etc.
- QUALNET
- ULTIBOARD
- XILINX
- MODELSIM/ QUESTA SIM

KIEL etc.

Departmental Elective - I (Common Code XXX)

BTEC 901 Relational Data Base Management System
BTEC 902 Micro Electronics
BTEC 903 Industrial Electronics
BTEC 904 Digital System Design
BTEC 905 Intellectual property rights & patent systems
BTEC 906 Intelligent Instrumentation
BTEC 907 Information Theory & Coding
BTIT 702 Software Project Management

Departmental Elective -II (Common Code YYY)

BTEC 908 CMOS based design
BTEC 909 Biomedical signal processing
BTEC 910 Satellite Communication
BTEC 911 Artificial Intelligence Techniques & Applications
BTEC 912 Speech & image Processing
BTEC 913 Human Resource Management
BTEC 914 Computer organization and Architecture
BTIT 501 Cyber Law & IPR

Departmental Elective - III (Common Code ZZZ)

BTEC 915 Electromagnetic interference & compatibility
BTEC 916 Neural Networks & Fuzzy logic
BTEC 917 Robotics
BTEC 918 Operation Research
BTEC 919 Mobile Computing
BTEC 920 Wireless Sensor network
BTEC 921 Numerical Methods

Third Semester

BTAM301 Engineering Mathematics-III

Unit I Fourier Series: Periodic functions, Euler's formula. Even and odd functions, half range expansions, Fourier series of different wave forms.

Unit II Laplace Transforms: Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations.

Unit III Special Functions: Power series solution of differential equations, Frobenius method, Legendre's equation, Legendre polynomial, Bessel's equation, Bessel functions of the first and second kind. Recurrence relations, equations reducible to Bessel's equation.

Unit IV Partial Differential Equations: Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients.

Unit V Applications of PDEs: Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables.

Unit VI Functions of Complex Variable: Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions; Conformal Mapping: Definition, standard transformations, translation, rotation, inversion, bilinear. Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proofs), singular points, poles, residue, Integration of function of complex variables using the method of residues.

Suggested Readings/ Books:

- Kreyszing, E., Advanced Engineering Mathematics, Eighth edition, John Wiley, New Delhi.
- Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, New Delhi.
- Ian N. Sneedon, Elements of Partial Differential Equations, McGraw- Hill, Singapore, 1957.

Peter. V. O'Nil, Advanced Engineering Mathematics, Wadsworth Publishing Company. Taneja, H. C., Engineering Mathematics, Volume-I & Volume-II, I. K. Publisher.

- Babu Ram, Advance Engineering Mathematics, Pearson Education.
- Bindra, J. S., Applied Mathematics, Volume-III, Kataria Publications.
- Advanced Engineering Mathematics, O'Neil, Cengage Learning.

BTCS 305 Object Oriented Programming Using C++

Unit I Object-Oriented Programming Concepts: Introduction, comparision between procedural programming paradigm and object-oriented proramming paradigm, basic concepts of object-oriented programming — concepts of an object and a class, interface and implementation of a class, operations on objects, relationship among objects, abstraction, encapsulation, data hiding, inheritance, overloading, polymorphism, messaging.

Unit II Standard Input/Output: Concept of streams, hierarchy of console stream classes, input/output using overloaded operators >> and << and memberv functions of i/o stream classes, formatting output, formatting using ios class functions and flags, formatting using manipulators.

Unit III Classes and Objects: Specifying a class, creating class objects, accessing class members, access specifiers, static members, use of *const* keyword, friends of a class, empty classes, nested classes, local classes, abstract classes, container classes, bit fields and classes**.**

Unit IV Pointers and Dynamic Memory Management: Declaring and initializing pointers, accessing data through pointers, pointer arithmetic, memory allocation (static and dynamic), dynamic memory management using *new* and *delete* operators, pointer to an object, *this* pointer, pointer related problems - dangling/wild pointers, null pointer assignment, memory leak and allocation failures**.**

Unit V Constructors and Destructors: Need for constructors and destructors, copy constructor, dynamic constructors, explicit constructors, destructors, constructors and destructors with static members, initializer lists.

Unit VI Operator Overloading and Type Conversion: Overloading operators, rules for overloading operators, overloading of various operators, type conversion - basic type to class type, class type to basic type, class type to another class type.

Unit VII Inheritance: Introduction, defining derived classes, forms of inheritance, ambiguity in multiple and multipath inheritance, virtual base class, object slicing, overriding member functions, object composition and delegation, order of execution of constructors and destructors.

Unit VIII Virtual functions & Polymorphism: Concept of binding - early binding and late binding, virtual functions, pure virtual functions, abstract clasess, virtual destructors.

Unit IX Exception Handling: Review of traditional error handling, basics of exception handling, exception handling mechanism, throwing mechanism, catching mechanism, rethrowing an exception, specifying exceptions.

Unit X Templates and Generic Programming: Template concepts, Function templates, class templates, illustrative examples.

Unit XI Files: File streams, hierarchy of file stream classes, error handling during file operations, reading/writing of files, accessing records randomly, updating files.

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

1) Gain **knowledge** on basics of object oriented programming.
2) **Understand** template, file handling, exception handling concepts.

Suggested Readings/ Books:

- Lafore R., **Object Oriented Programming in C++**, Waite Group.
- E. Balagurusamy, **Object Oriented Programming with C++**, Tata McGraw Hill.
- R. S. Salaria, **Mastering Object-Oriented Programming with C++**, Salaria Publishing House.

Bjarne Stroustrup, **The C++ Programming Language**, Addison Wesley.

- Herbert Schildt, **The Complete Reference to C++ Language**, McGraw Hill-Osborne.
- Lippman F. B, **C++ Primer,** Addison Wesley.

BTEC301 Analog Devices & Circuits

Unit I Semiconductor diode Theory of PN junction diode, Band structure of open circuited PN junction, Volt Ampere Characteristics, Temperature Dependence of PN diode, LED, LCD and Photo-diodes, Tunnel diode, Zener diode as Voltage Regulator.

Unit II Transistors, Characteristics and Biasing Transistor, Types of Transistor, Transistor current components, Transistor as an Amplifier, Transistor characteristics in CB, CE and CC modes. Operating point, bias stability, various biasing circuits, stabilization against Ico, V_{BE} and beta, Construction, Characteristics & applications of Junction Field Effect Transistor (JFET), UJT and MOSFET.

Unit III Large Signal Amplifiers: Class A direct coupled with resistive load, Transformer coupled with resistive load, harmonic distortion, variation of output power with load, Push-Pull Amplifiers, operation of class- B push-pull amplifier, crossover distortion, transistor phase inverter, complementary- symmetry amplifier.

Unit IV Feedback Amplifiers and Oscillator: Feedback Concept, Effect of negative feedback on gain, bandwidth, stability, distortion and frequency Response, Sinusoidal Oscillators, Sinusoidal oscillators; criterion for oscillation, Different types of oscillators: RC Phase Shift, Wein Bridge, Hartley, Colpitts and Crystal Oscillators. Derivation of expression for frequency and amplitude of these oscillators.

Unit V Low & High Frequency Transistor Model: Transistor Hybrid Model, h parameter equivalent circuit of transistor, Analysis of transistor amplifier using h-parameters in CB, CE and CC configuration, The high frequency T model, hybrid pi CE transistor model, hybrid pi conductance in terms of low frequency h parameters.

Course Outcomes: This course aims to expose the students to the principles of Analog Devices and basic circuits to acquaint beginners to various Technical concepts, in the core of **Design, Implementation, Research & Invention** of various Electronic Systems.

Suggested Readings/ Books:

- Electronic Devices & Circuits by Millman- Halkias, Tata Mcgraw Hill
- Electronic Devices & Circuits Theory by Boylested, Pearson Education.
- Electronic Fundamentals & Application, by J.D. Ryder, PHI.
- Electronic Devices, by Floyd, Pearson Education.
- Electronics Devices & Circuits by J.B.Gupta, Katson.

BTEC302 Digital Circuit and Logic Design

Unit I Number System and Binary Code: Introduction, Binary, Octal and Hexadecimal Number System (Conversion, Addition & Subtractions). Signed and unsigned numbers, Binary Subtractions using 1's and 2's compliment, ASCII code, Excess 3 code, Grey code, BCD code and BCD additions.

Unit II Minimization of logic function: OR, AND,NOT,NOR,NAND,EX-OR, EX-NOR, Basic theorem of Boolean Algebra, Sum of Products and Product of Sums, canonical form, Minimization using K-map and Q-M method.

Unit III Combinational Circuits: Introduction, Combinational circuit design, Encoders, decoders, Adders, Sub tractors and Code converters. Parity checker, seven segment display, Magnitude comparators. Multiplexers, De-multiplexer, Implementation of Combinational circuit using MUX.

Unit IV Sequential Circuits: Introduction, flip flops, Clocked flip flops, SR, JK, D, T and edge triggered flipflops. Excitation tables of Flip flops. Shift Registers, Type of Shift Registers, Counter, Counter types, counter design with state equation and state diagrams.

Unit V D/A and A/D Converters: Introduction, Weighted register 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.

Unit VI Semiconductor Memories: Introduction, Memory organisation, Classification and characteristics of memories, Sequential memories, ROMs, R/W memories. Content addressable memories. PLA and PAL.

Unit VII Logic Families: RTL, DCTL, DTL, TTL, ECL, CMOS and its various types, Comparison of logic families.

Course Outcomes:

CO1:-Students will be able to represent numerical values in various number systems and perform number conversions between different number systems.

CO2:-Students will demonstrate the knowledge of:

- operation of logic gates (AND, OR, NAND, NOR, XOR, XNOR) using IEEE/ANSI standard symbols
- Boolean algebra including algebraic manipulation/simplification, and application of DeMorgan’s theorems
- Karnaugh map reduction method.

CO3:-Students will demonstrate the knowledge of operation of basic types of flip-flops, registers, counters, decoders, encoders, multiplexers, and de-multiplexers.

CO4:-Students will be able to analyze and design digital combinational circuits including arithmetic circuits (half adder, full adder, multiplier).

Suggested Readings / Books:

- Morris Mano, **Digital Design**, Prentice Hall of India Pvt. Ltd
- Donald P.Leach and Albert Paul Malvino, **Digital Principles and Applications**, 5 ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
- R.P.Jain, Modern **Digital Electronics**, 3 ed., Tata McGraw-Hill publishing Company limited, New Delhi, 2003.
- Thomas L. Floyd, **Digital Fundamentals**, Pearson Education, Inc, New Delhi, 2003
- Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, **Digital System -Principles and Applications**, Pearson Education.
- Srivastava/Srivastava/Srivastava**, Digital Design: HDL Based Approach,** Cengage Learning.
- Roth, **Fundamentals of Logic Design,** Cengage Learning

BTEC303 Network Analysis and Synthesis

Unit I Circuit Concepts: Independent and dependent sources, Signals and wave forms: Periodic and singularity voltages, step, ramp, impulse, doublet, loop currents and loop equations, node voltage and node equations, Network Theorems: Superposition, Thevenin's, Norton's, Maximum Power Transfer, and Reciprocity.

Unit II Time and Frequency Domain Analysis: Representation of basic circuits in terms of generalized frequency and their response, Laplace transform of shifted functions, transient and steady response, Time domain behaviors from poles and zeros, Convolution Theorem.

Unit III Network Synthesis: Network functions, Impedance and admittance function, Transfer functions, Relationship between transfer and impulse response, poles and zeros and restrictions, Network function for two terminal pair network, Sinusoidal network in terms of poles and zeros, Real liability condition for impedance synthesis of RL and RC circuits, Network synthesis techniques for 2-terminal network, Foster and Cauer forms.

Unit IV: Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T-section, π-section, terminating half section, Pass bands and stop bands, Design of constant-K, m-derived filters, Composite filters.

Course Outcomes:

1) The student gain **skills** on analysis of electrical networks using complex frequency approach and Laplace transform. The student is capable of applying such approaches to two port networks.

2) Students can perform mathematical transformations to describe the **behavior** of networks which are represented using differential equations.

3) Students are able to perform reduction of the circuit; they **develop** an ability to choose an appropriate analytical method.

Suggested Readings/ Books:

- Bird John, *Electrical Circuit Theory and Technology*, 2nd Ed., Newnes.
- Chakraborty, Abhijit, *Circuit Theory*, 2nd Edition, Dhanpat Rai, 2001.

Chaudhury D. Roy, *Networks and Synthesis*, New Age International.

Edminister J.A., *Electric Circuits*, 4th Edition, Tata McGraw Hill, 2002. Iyer

T.S.K.V., *Circuit Theory*, Tata McGraw Hill, 2006.

- Mohan, Sudhakar Sham, *Circuits and Networks Analysis and Synthesis*, 2nd Edition, Tata Mc Graw Hill, 2005.

Van Valkenberg, M.E., *Network Analysis and Synthesis*, PHI learning, 2009.

BTEC304 Lab Analog Devices & Circuits

1. Study of Zener regulator as voltage regulator
2. Study of Half wave, full wave & Bridge rectifiers.
3. To plot the input and output characteristics of CE configuration.
4. To study the characteristics of a Class- A amplifier.
5. To study the characteristics of Class- B amplifier.
6. To study the characteristics of Class- B push-pull amplifier.
7. To study the characteristics of complementary symmetry amplifier.
8. To study the response of RC phase shift oscillator and determine frequency of oscillation.
9. To study the response of Hartley oscillator and determine frequency of oscillation.
10. To study the response of Colpitt's oscillator and determine frequency of oscillation.
11. To study the response of Wien Bridge oscillator and determine frequency of oscillation

BTEC-305 Lab Digital Circuit and Logic Design

1. Study of Logic Gates: Truth-table verification of OR, AND, NOT, XOR, NAND and NOR gates; Realization of OR, AND, NOT and XOR functions using universal gates.
2. Realization Half Adder / Full Adder using Logic gates.
3. Realization Half Subtractor / Full Subtractor using Logic gates
4. Design 4-Bit Binary-to-Gray & Gray-to-Binary Code Converter.
5. Design 4-Bit magnitude comparator using logic gates.Multiplexer: Truth-table verification and realization of Half adder and Full adder using MUX.
6. Demultiplexer: Truth-table verification and realization of Half subtractor and Full subtractor using DEMUX.
7. Flip Flops: Truth-table verification of RS, JK , D, JK Master Slave Flip Flops.

8. Design MOD-7 Synchronous up-counter using JK/RS/D Flip Flops.
9. Shift Register: Study of shift right, SIPO, SISO, PIPO, PISO & Shift left operations using IC7495 chip.

BTCS 309 Object Oriented Programming Using C++ Lab

1. **[Classes and Objects]** Write a program that uses a class where the member functions are defined inside a class.
2. **[Classes and Objects]** Write a program that uses a class where the member functions are defined outside a class.
3. **[Classes and Objects]** Write a program to demonstrate the use of static data members.
4. **[Classes and Objects]** Write a program to demonstrate the use of const data members.
5. **[Constructors and Destructors]** Write a program to demonstrate the use of zero argument and parameterized constructors.
6. **[Constructors and Destructors]** Write a program to demonstrate the use of dynamic constructor.
7. **[Constructors and Destructors]** Write a program to demonstrate the use of explicit constructor.
8. **[Initializer Lists]** Write a program to demonstrate the use of initializer list.
9. **[Operator Overloading]** Write a program to demonstrate the overloading of increment and decrement operators.
10. **[Operator Overloading]** Write a program to demonstrate the overloading of binary arithmetic operators.
11. **[Operator Overloading]** Write a program to demonstrate the overloading of memory management operators.
12. **[Typecasting]** Write a program to demonstrate the typecasting of basic type to class type.
13. **[Typecasting]** Write a program to demonstrate the typecasting of class type to basic type.
14. **[Typecasting]** Write a program to demonstrate the typecasting of class type to class type.
15. **[Inheritance]** Write a program to demonstrate the multilevel inheritance.
16. **[Inheritance]** Write a program to demonstrate the multiple inheritance.
17. **[Inheritance]** Write a program to demonstrate the virtual derivation of a class.
18. **[Polymorphism]** Write a program to demonstrate the runtime polymorphism.
19. **[Exception Handling]** Write a program to demonstrate the exception handling.
20. **[Templates and Generic Programming]** Write a program to demonstrate the use of function template.
21. **[Templates and Generic Programming]** Write a program to demonstrate the use of class template.

22. **[File Handling]** Write a program to copy the contents of a file to another file byte by byte. The name of the source file and destination file should be taken as command-line arguments,
23. **[File Handling]** Write a program to demonstrate the reading and writing of mixed type of data.

Fourth Semester

BTEE 402 Linear Control Systems

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

Unit II Modeling: Formulation of equation of linear electrical, mechanical, thermal, pneumatic and hydraulic system, electrical, mechanical analogies. Transfer function, Block diagram representation, signal flow graphs and associated algebra, characteristics equation.

Unit III 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.

Unit IV 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 and sketch of the root locus plot.

Unit V Frequency Domain Analysis: Closed loop frequency response, Bode plots, stability and loop transfer function. Frequency response specifications, Relative stability, Relation between time and frequency response for second order systems. Log. Magnitude versus Phase angle plot, Nyquist criterion for stability.

Unit VI Compensation: Necessity of compensation, series and parallel compensation, compensating networks, applications of lag and lead-compensation.

Unit VII Control Components: Error detectors - potentiometers and synchros, servo motors, a.c. and d.c. techno generators, Magnetic amplifiers.

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

1) **Apply** systems theory to complex real world problems in order to obtain models that are expressed using differential equations, transfer functions
2) **Predict** system behavior based on the mathematical model of that system where the model may be expressed in time or frequency domain
3) **Analyze** the behavior of closed loop systems using tools such as root locus, Routh Hurwitz, Bode and Nyquist criteria.

Suggested Readings / Books

- Dorf Richard C. and Bishop Robert H., *Modern Control System*, Addison -Wesley, Pearson New Delhi
- Ogata K., *Modern Control Engineering* ‖, Prentice Hall,
- Kuo B. C., *Automatic Control System* ‖, Prentice Hall
- Nagrath I.J. and Gopal M., *Control System Engineering*, Wiley Eastern Ltd.
- Singh / Janardhanan, Modern Control Engineering, Cengage Learning
- Kilian, Modern Control Technology: Components and Systems, Cengage Learning

BTEC 401 Analog Communication Systems

Unit I Base Band Signals and Systems: Introduction, Elements of communication system, Noise & its types; Noise Figure & noise factor, Noise equivalent temperature. Modulation & Demodulation, Mixing; Linear &

Nonlinear, need of modulation, types of modulation systems, basic transmission signals, Frequency multiplexing technique.

Unit II Analog Modulation Techniques: Introduction, theory of amplitude modulation; AM power calculations, AM current calculations, AM modulation with a complex wave, theory of frequency modulation; mathematical analysis of FM, spectra of FM signals, narrow band of FM, Wide band FM, Theory of phasemodulation, phase modulation obtained from frequency modulation, comparison of AM & FM, Comparison of PM & FM.

Unit III AM Transmission: Introduction, generation of Amplitude Modulation, Low level and high level modulation, basic principle of AM generation; square law modulation, Amplitude modulation in amplifier circuits, suppressed carrier AM generation (Balanced Modulator) ring Modulator, Product Modulator/balanced Modulator.

Unit IV AM Reception: Receiver Parameters; Selectivity, Sensitivity, Fidelity, Tuned Ratio Frequency (TRF) Receiver, Super heterodyne Receiver; Basic elements of AM super heterodyne Receiver; RF Amplifier, Neutralization of RF Amplifiers, Class of operation of RF Amplifiers, High power RF Amplifiers, Image Frequency Rejection, Cascade RF Amplifier, methods of increasing Bandwidth, frequency Conversion and Mixers; Additive Mixing, Bipolar Transistor Additive Mixer, self exicted Additive Mixers, multiplicative mixing, Multiplicative Mixer using dual gate MOSFET, Tracking & Alignment, IF Amplifier, AM detector; square law detector, Envelope or Diode detector, AM detector with AGC, Distortion in diode detectors, AM detector Circuit using Transistor, Double hetro-dyne receiver, AM receiver using a phase locked loop (PLL), AM receiver characteristics.

Unit V FM Transmission: FM allocation standards, generation of FM by direct method, varactor diode Modulator, Cross by Direct FM Transmitter, Phase-Locked-Loop Direct FM Transmitter, Indirect generation of FM; Armstrong method, RC phase shift method, Frequency stabilised reactance FM transmitter.

Unit VI FM Reception: Frequency demodulators, Tuned circuit frequency discriminators; Slope Detector, Balance Slope Detector, Foster Seeley discriminator, Ratio Detector, FM detection using PLL, Zero crossing detector as a Frequency Demodulator, quadrature FM demodulator, pre emphasis and de emphasis, limiter circuits, FM Capture effect, FM receiver, FM stereo transmission and reception, Two way FM Radio Transmitter and Receiver.

Unit VII SSB Transmission: Introduction, Single Side band systems, AM-SSB; Full carrier, Suppressed carrier , reduced carrier, Independent side band, and Vestigial side band, Comparison of SSB Transmission to conventional AM, Generation of SSB; Filter method, Phase Shift Method, Third Method.

Unit VIII SSB Reception: SSB Product Demodulator, Balanced Modulator as SSB Demodulator, Single Side band receivers; Single side band BFO Receivers, Coherent Single side band BFO Receivers, Single Side band Envelop detection receiver, Multi Channel Pilot Carrier SSB Receiver.

Unit IX Pulse Modulation Transmissions and Reception: Introduction, Sampling Theorem Pulse Amplitude Modulation (PAM), Natural PAM Frequency Spectra for PAM , Flat-top PAM, Sample and hold circuits, Time division Multiplexing, PAM Modulator Circuit, Demodulation of PAM Signals, Pulse Time Modulation (PTM); Pulse Width Modulation(PWM), Pulse Position Modulation (PPM), PPM Demodulator.

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

1) To **develop** the concept of analog communication System.
2) To **understand** different types of noise and predict its effect on various analog communication systems
3) To **design** the major building blocks of communication system

Suggested / Recommended Books:

- Electronic communication Systems by Kennedy & Davis, Tata Mcgraw Hill.
- Analog Communication Systems by Manoj Kumar & Manisha, Satya Prakashan, New Delhi, 2nd Edition.
- Electronic Communication System, Tomasi, Pearson Education.
- Electronic Communication, Roddy, Pearson Education.
- Analog Communication Systems by Symon Hykens, John Wiley & Sons .
- Principles of Communication System, Taub & Schilling, Tata Mc-Graw Hill.

BTEC402 Signals & Systems

Unit I Classification of Signals and Systems: Continuous time signals (CT signals), discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Exponential, Classification of CT and DT signals - periodic & aperiodic, random &deterministic signals, Even& Odd Signals, Energy & Power Signals, Description of continuous time and discrete time systems.

Unit II Analysis of Continuous Time Signals: Fourier series analysis, Spectrum of C.T. signals, Fourier Transform and its properties in Signal Analysis, Power Spectral Density and Energy spectral density.

Unit III Linear Time Invariant -Continuous Time Systems: Linear Time invariant Systems and their properties. Differential equation & Block diagram representation, Impulse response, Convolution integral, Frequency response (Transfer Function), Fourier transforms analysis.

Unit IV Analysis of Discrete Time Signals: Sampling of CT signals and aliasing, DTFT and its properties, Z-transform and properties of Z-transform.

Unit V Linear Time Invariant - Discrete Time System: Difference equations, Block diagram representation, Impulse response, Convolution sum, LTI systems analysis using DTFT and Z-transforms.

Unit VI Random Signal Theory: Introduction to probabilities, Definition, probability of Random events, Joint and conditional probability, probability Mass function statistical averages. Probability density functions and statistical averages. Examples of P.D. function, transformation of random variables random processes, stationary, True averages and Ergodic.

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

1) **Classify** signals and systems and perform operations like folding, shifting, scaling etc. on them.
2) **Apply** Fourier series and Fourier transform to represent continuous and discrete time signals.
3) **Solve** and apply DTFT and Z transform to analyze linear time invariant discrete time system:
4) **Explain** the behavior of random signals in terms of probability functions

Suggested Readings / Books:

- Signals and Systems by Allan V.Oppenheim, S.Wilsky and S.H.Nawab, Pearson Education.
- Fundamentals of Signals and Systems by Edward W Kamen & Bonnie's Heck, Pearson Education.
- Communication Signals & System by Simon Haykins, John Wiley & Sons.
- Signals and Systems by H P Hsu, Rakesh Ranjan, Schaum's Outlines, Tata McGraw Hill.
- Digital Signal Processing by S Salivahanan, A. Vallavaraj, C. Gnanapriya, McGraw Hill International.
- Signals and Systems by Simon Haykins and Barry Van Veen, John Wiley & sons, Inc.
- Signal, System & Transforms, Phillips, Pearson Education.
- Roberts, Signals & Linear Systems, by Robert A. Gabel and Richard A., John Wiley.
- Signals & systems, by Rodger E. Ziemer, William H. Tranter, D. Ronald Fannin. Pearson Education.

BTEC403 Electromagnetics & Antennas

Unit I Electromagnetic Waves: Maxwell's equations in differential and integral forms Wave equation and its solution in different media, polarization. Plane wave propagation in a dielectric medium, Reflection and transmission of an EM waves. Surface impedance, Poynting theorem.

Unit II Waveguides and Transmission Lines: Waves between parallel planes. TE, TM and TEM Waves, velocities of propagation, Attenuation in parallel plane guides, wave impedance. Circuit representation of parallel plane transmission lines. Low loss transmission lines. Distortion less condition. Smith charts. Rectangular and circular wave guides. Wave impedance and characteristics impedances. Transmission line analogy for wave guides.

Unit III Antennas: introduction, concept of radiation in single wire, two wire, and dipole, Antenna parameters, Retarded potential, infinitesimal dipole. Current distribution of short dipole and half wave dipole, Far-field, Radiating near-field and reactive near-field region, Monopole and Half wave dipole.

Unit IV Antenna Arrays: Array of two point sources, Array factor, Array configurations, Hansen-woodyard end fire array, n-element linear array with uniform amplitude and spacing, n-element linear array with nonuniform spacing, Analysis of Binomial and Dolph-Tschebysceff array, Scanning Array, Super directive array. **Unit V Aperture Antennas:** Field Equivalence principle, Rectangular and circular aperture antennas, Horn antenna, Babinet's Principle, Slot Antenna, Reflector antenna.

Unit VI Wave Propagation: Free space equation, Reflection from earth's surface, Surface and Space wave propagation, Range of space wave propagation, Effective earth's radius, Duct propagation, Troposphere propagation. Structure of ionosphere, propagation of radio waves through ionosphere, Critical frequency, Maximum usable frequency, Optimum working frequency, lowest usable high frequency, virtual height, Skip Distance, Effect of earth's magnetic field.

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

1) **Recognize** the need of electromagnetic wave theory including the Maxwell equations in different form, Waveguides and Transmission Lines analogy with waveguide. .
2) **Explain** the various type of antennas and application in the field of communication engineering.
3) **Aware** of different wave propagation including free space equation, Surface and Space wave propagation and ionosphere propagation

Suggested Readings / Books:

Electromagnetics and radiating systems, Jordan E.C., PHI.
- Antenna Theory, Balanis C.A, John Wiley & sons.
- Antenna and wave propagation, R.L.Yadava, PHI
- Problem and solutions in electromagneics, W H Hayt and J A buck, Tata McGraw Hill
- Antenna Theory, Krauss J.D., McGraw Hill.
- Shen/Kong/Patnaik, Engineering Electromagnetics, Cengage Learning.

BTEC-404 Electronics Measurements and Instrumentation

Unit I Fundamentals: Generalized instrumentation system - Units and Standards, Calibration Methods, Standards of measurements, Classification of errors, error analysis. Static Characteristics- Accuracy, Precision, sensitivity, linearity, resolution, hysteresis, threshold, input impedance, loading effects etc. Dynamic Characteristics.

Unit II Electronic Meters: Electronic Analog voltmeter: DC voltmeters-Choppers type-DC amplifier, solid state voltmeter, Differential voltmeter, peak responding voltmeter, True RMS voltmeter, calibration of DC voltmeters. Digital Voltmeter:- Introduction, Ramp Techniques, dual slope, integrating type DVM, Successive approximation type DVM, Resolution and sensitivity of digital meters, general specification of a DVM. CRO's study of various stages in brief, measurement of voltage, current phase and frequency, special purpose oscilloscope.

Unit III Measuring Instruments: Principle of operation of galvanometer, PMMC, Moving Iron instruments, Resistance measurements using Wheatstone bridge, Kelvin Double Bridge, Ohm meter, AC bridges: Maxwell bridge, Maxwell wein bridge, Hey's Bridge, Schering Bridge, Anderson Bridge, Campbell Bridge.

Unit IV Instrumentation for Generation and Analysis of Waveforms: Signal generators: Fixed and variable AF oscillators, AF sine and square wave generator, Function generator: Square and pulse generator, Sweep generator, wave analyzer, harmonic distortion analyzer, spectrum analyzer, spectrum analysis.

Unit V Storage and Display Devices: Necessity of recorders, recording requirements, graphic recorders, strip chart recorders, magnetic tape recorders, digital tape recorders. Electronic indicating instruments, seven segment display, fourteen segmental display Nixie tube.

Unit VI Transducers and DATA Acquisition Systems: Strain gauge, LVDT, thermocouple, piezoelectric, crystal and photoelectric transducers and their applications. Data acquisition systems.

Unit VII Telemetry: Introduction, method of data transmission, types of telemetry systems and applications.

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

1) **Identify** electronics/ electrical instruments, their use, peculiar errors associated with the instruments and how to minimize such errors.
2) **Explain** the industrial and laboratory applications of such instruments.
3) **Understand** the basic design techniques of electronic equipments.

Suggested Readings / Books:

- Electrical and Electronic Measurements and Instrumentation, by K. SAWHNEY.
- Electronic Instrumentation and Measurement Techniques, by D Cooper.

- Electronic Instrumentation, by H.S. Kalsi, Tata McGraw Hill
- Applied Electronics Instrumentation and measurement, David Buchla, Wayne Melachlan:

Electronics Measurement and Instrumentation,Oliver by B.H and Cag J.M. McGrawHill.

Element of Electronic Instrumentation & Measurment, by Carr, Pearson Education.

- Electronic Measurments & Instrumentation, by Kishore, Pearson Education.
- Process Control Systems and Instrumentation, Bartelt, Cengage Learning

BTEC405 Pulse Wave Shaping and Switching

Unit I Introduction to Basic Elements and Waveforms: Passive and Active circuit elements, AC through inductor and capacitor, AC through Resistor-inductor and resistor-capacitor in series, Series and parallel resonance circuit, Different input signals, Average and RMS value.

Unit II Bistable Multivibrators: Role of feedback in electronic circuits, Fixed bias and self-bias bistable multivibrator, Speed-up Capacitors, unsymmetrical and symmetrical triggering, Application of Trigger input at the base of OFF Transistor, Application of Trigger input at the base of ON Transistor, Bisatble multivibrator as T Flip-Flop, Schmitt trigger circuit, Calculation of Upper Tripping Point and Lower Tripping Point.

Unit III Monostable and Astable Multivibrators: Collector Couple and Emitter Coupled Monostable multivibrator, Expression for Gate width, Astable Collector coupled and emitter coupled multivibrator, complementary Transistor Astable multivibrator.

Unit IV Switching Characteristics of Devices: Diode and transistor as electronic switch, Breakdown mechanism in diode, Effect of temperature on diode, Charge storage phenomena, Switching times in diode and transistor, Delay time, Rise time, Storage time and fall time, Use of Schotkey diode for reducing storage time.

Unit V Linear Wave Shaping: Low pass RC Network, Response to standard waveforms circuits, Integrator High Pass RC circuits, Response to standard waveforms, Differentiator, Double differentiation, Attenuator. **Unit VI NON- Linear Wave Shaping:** Clipping circuits (diode & transistor), Diode comparators, Transistor differential comparator, Operational amplifier comparator, clamping circuits, Practical clamping circuit, clamping circuit theorem.

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

1) The students will be able to know the **applications** of clipping and clamping circuits in communication.
2) The students will be able to **design**multivibrators for various purposes.
3) The students will be able to **understand** the basic swithching concepts and their applications to pulse circuits.

Suggested Readings / Books:

- Pulse and Digital Switching Circuits by Milliman, Taub; Tata Mcgraw Hill
- Pulse and Digital Circuits by Mothiki S. Prakash Rao; Tata Mcgraw Hill
- Pulse & Digital Circuits, by Rao K, Pearson Education.
- Switching Theory & Logic Design, by Rao , Pearson Education.
- Wave Generation and Shaping by Strauss McGraw Hill.
- Pulse and Switching Circuits by Sanjeev Kumar; Dhanpat Rai & Company

BTEC406 LAB Analog Communication Systems

- Generation of DSB & DSB-SC AM signal using balanced modulator & determine modulation Index & detection of DSB using Diode detector.
- Generation of SSB AM signal & detection of SSB signal using product detector.
- To generate a FM Signal using Varactor & reactance modulation.
- Detection of FM Signal using PLL & foster seelay & resonant detector.
- To Study Super heterodyne AM receiver and measurement of receiver parameters viz. sensitivity, selectivity & fidelity.

- To study the circuit of PWM & PPM modulator & Demodulator
- Study of Frequency Division Multiplexing / Demultiplexing with sinusoidal & audio inputs Using DSBSC.
- Generation & study of Analog TDM at least 4 channels.
- Sampling Theorem & Reconstruction of Signal from its samples using Natural Sampling, Flat Top Sampling & Sample & Hold Circuits & effect of duty cycle.
- To draw & study Polar plots & polarization of Helical, Ground plane, Yagiuda & dipole Antenna & calculate Antenna gain, Antenna beam width, Element current & Front-back ratio of antenna.
- To study Antenna matching using stubline.
- To study a transmission line attenuation & frequency characteristics.

BTEC407 Electronic Measurement & Instrumentation

- Measurement of Inductance by Maxwell's Bridge.

  Measurement of small resistance by Kelvin's Bridge.
- Measurement of Capacitance by Schering Bridge.

  Measurement of Frequency by Wein Bridge.
- Measurement of medium resistance by Wheat Stone's Bridge.
- Determination of frequency & phase angle using C.R.O.
- To find the Q of a coil using LCR-Q meter.
- To determine output characteristic of a LVDT and determine its sensitivity.
- Study characteristics of temperature transducer like Thermocouple, Thermistor and RTD with implementation of small project using signal conditioning circuit.
- Study characteristics of Light transducer like Photovoltaic cell, Phototransistor and Pin Photodiode with implementation of small project using signal conditioning circuit.
- To study input- output characteristics of a potentiometer and to use two potentiometers as an error detector.

  To study transmitter- receiver characteristics of a synchro set to use the set as control component.
- To study the operation of a d-c positional servo system and to investigate the effect of damping and supply voltage on its response.

- To study the operation of an a.c. position servo-system and to obtain effects of supply voltage and system parameter on its transient response.
- To study a stepper motor and control its direction speed and number of steps with the help of a microprocessor.

BTEC408 Lab Signal & Systems Using MATLAB / MENTOR DSP

- Generation of continuous and Discrete Unit step signal.
- Generation of exponential and Ramp Signal in Continuous and Discrete Domain.

Continuous and Discrete time Convolution.

- Adding and subtracting two Given Signals (Continues as well as Discrete Signals)

To generate a random binary wave.

- To Generate a Random Sequences with arbitrary distribution, means and Variances for following:

Rayleigh Distribution

- Uniform distribution
- Gaussian distribution.
- To Plot Probability density functions. Find Mean and Variance for the above distribution

To study Power Spectrum Density

- To study Difference Equation to develop elementary signal function modules (m-files) for unit sample, unit step, exponential and unit ramp sequences.
- To develop program modules based on operation on sequences like signal shifting, signal folding, signal addition and signal multiplication.
- To develop program for discrete convolution and correlation .
- To develop program for finding response of the LTI system described by the difference equation.
- To develop program for computing inverse Z-transform.

Fifth Semester

BTCS 304 Data Structures

PART-A

1. **Dynamic Memory Management:** Understanding pointers, usage of pointers, arithmetic on pointers, memory allocation, memory management functions and operators, debugging pointers - dangling pointers, memory leaks, etc. **[2]**
2. **Introduction:** Concept of data type, definition and brief description of various data structures, data structures versus data types, operations on data structures, algorithm complexity, Big O notation. **[2]**
3. **Arrays:** Linear and multi-dimensional arrays and their representation, operations on arrays, sparse matrices and their storage. **[3]**
4. **Linked List:** Linear linked list, operations on linear linked list, doubly linked list, operations on doubly linked list, application of linked lists. **[4]**
5. **Stacks:** Sequential and linked representations, operations on stacks, application of stacks such as parenthesis checker, evaluation of postfix expressions, conversion from infix to postfix representation, implementing recursive functions. **[4]**
6. **Queues:** Sequential representation of queue, linear queue, circular queue, operations on linear and circular queue, linked representation of a queue and operations on it, deque, priority queue, applications of queues. **[4]**

PART-B

7. **Trees:** Basic terminology, sequential and linked representations of trees, traversing a binary tree using recursive and non-recursive procedures, inserting a node, deleting a node, brief introduction to threaded binary trees, AVL trees and B-trees. **[4]**
8. **Heaps:** Representing a heap in memory, operations on heaps, application of heap in implementing priority queue and heap sort algorithm. **[2]**
9. **Graphs:** Basic terminology, representation of graphs (adjacency matrix, adjacency list), traversal of a graph (breadth-first search and depth-first search), and applications of graphs. **[3]**
10. **Hashing & Hash Tables:** Comparing direct address tables with hash tables, hash functions, concept of collision and its resolution using open addressing and separate chaining, double hashing, rehashing. **[3]**

Searching & Sorting: Searching an element using linear search and binary search techniques, Sorting arrays using bubble sort, selection sort, insertion sort, quick sort, merge sort, heap sort, shell sort and radix sort, complexities of searching & sorting algorithms. **[5]**

1. Sartaj Sahni, **Data Structures, Algorithms and Applications in C++,** Tata McGraw Hill.
2. Tenenbaum, Augenstein, & Langsam, **Data Structures using C and C++**, Prentice Hall of India.
3. R. S. Salaria, **Data Structures & Algorithms Using C++,** Khanna Book Publishing Co. (P) Ltd.
4. Seymour Lipschutz, **Data Structures**, Schaum's Outline Series, Tata McGraw Hill
5. Kruse, **Data Structures & Program Design**, Prentice Hall of India.
6. R. S. Salaria, **Test Your Skills in Data Structures**

BTEC-501 DIGITAL COMMUNICATION SYSTEM

Internal Marks: 40	**L**	**T**	**P**
External Marks: 60	**3**	**1**	**0**

UNIT I: - Elements of Digital Communication System:- Block diagram of Digital Communication system, Digital representation of Analog signals, Advantages and Disadvantages of Digital Communication system, Bandwidth -S/N trade off, Hartley Shannon Law, Sampling theorem . Concept of amount of Information and entropy, Shannon Fano Source Coding, Huffman source coding and Lampel-Ziv Source coding algorithm.

UNIT-II: - Pulse Code Modulation:- Sampling, Sampling Rate, Aliasing, quantization error, Uniform and Non uniform quantization, Dynamic Range, Coding efficiency, A law & μ law companding, Bandwidth of PCM, Block diagram of PCM system, Delta Modulation, Continuously variable Slope Delta Modulator (CVSDM) or Adaptive Delta Modulation, Differential Pulse Code Modulation, Intersymbol Interference, Eye Patterns, Signal power in binary digital signals.

UNIT-III Line Coding & Multiplexing Techniques: Line Coding & its properties. NRZ & RZ types, signaling format for unipolar, Polar, bipolar (AMI) & Manchester coding and their power spectra (No derivation), HDB and B8ZS signaling, Nyquist's criterions for pulse shaping, Fundamentals of time division multiplexing, Bit versus word interleaving, Statistical TDM, Codecs & Combo Chips. Basics of TDMA, FDMA and CDMA

UNIT-IV Digital Carrier Modulation & Demodulation Techniques: Introduction, Amplitude Shift Keying (ASK), ASK Spectrum, ASK Modulator, Coherent ASK Detector, Noncoherent ASK Detector, Frequency Shift Keying (FSK), FSK Bit Rate and Baud, Bandwidth and Frequency Spectrum of FSK, FSK Transmitter, Non-coherent FSK Detector, Coherent FSK Detector, FSK Detection Using PLL, Binary Phase Shift Keying, Binary PSK Spectrum, BPSK Transmitter, Coherent PSK Detection, Quadrature Phase Shift Keying (QPSK), QPSK Demodulator, Offset QPSK, π/4 QPSK, Comparison of conventional QPSK, Offset QPSK and π/4 QPSK, M-Ary BPSK, Quadrature Amplitude Modulation (QAM); MQAM transmitters and receivers, Band Width efficiency, Carrier Recovery; Squaring Loop & Costas Loop, Differential PSK, DBPSK transmitter and receiver, Constant Envelop Modulation; Minimum Shift Keying (MSK) & Gaussian Minimum Shift Keying (GMSK), matched filter receivers, bandwidth consideration and probability of error calculations for ASK, PSK, FSK schemes.

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

1) **Analyze** the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
2) **Perform** the time and frequency domain analysis of the signals in a digital communication system.
3) **Select** the blocks in a design of digital communication system.
4) **Analyz**e Performance of spread spectrum communication system.

TEXT BOOK RECOMMENDED

1. Electronic Communication System Fundamentals through Advance Wayne Tomasi 5th 2009 Pearson Education.
2. Communication Systems, Fourth Edition, Simon Haykin, Wiley publication.

BOOKS RECOMMENDED

1. Modern Electronic Communication, (6th edition), by Gary M. Miller, published by Prentice-Hall, 1999
2. Introduction to Communication Systems, third edition, by F. G. Stremler, AddisonWesley, 1990.
3. Digital Communication, E.A. Lee and D.G. Messerschmitt, , Kluwer Academic Publishers,1994
4. Digital Communication Receivers, H. Meyr, M. Moeneclaey, S.A. Fechtel, Wiley, 1998

5. Modulation and Coding Techniques in Wireless Communications by EVGENII KROUK, SERGEI SEMENOV, WILEY, 2011

BTEC-502 **DIGITAL SIGNAL PROCESSING**

Internal Marks: 40	L T P
External Marks: 60	4 1 0
Total Marks: 100	

UNIT I

Introduction: Limitations of analog signal processing, Advantages of digital signal processing and its applications; Some elementary discrete time sequences and systems; Basic elements of digital signal processing such as convolution, correlation and autocorrelation, Concepts of stability, causality, linearity, difference equations. **DFT** and its properties; Linear Periodic and Circular convolution; Linear Filtering Methods based on DFT; Fast Fourier Transform algorithm using decimation in time and decimation frequency techniques; Goertzel algorithm.

UNIT II

The Z Transform: Introduction, Z-Transform, Region of convergence; Inverse Z Transform methods, properties of Z transform.

UNIT III

Design of Digital Filters: Structures of realization of discrete time system, direct form, Cascade form, parallel form and lattice structure of FIR and IIR systems. Linear Phase FIR filters; Design methods for FIR filters; IIR filter design by Impulse Invariance, Bilinear Transformation, Matched Z-Transformation, Analog and Digital Transformation in the Frequency Domain. Finite Precision Effects**:** Fixed point and Floating point representations, Effects of coefficient unitization, Effect of round off noise in digital filters, Limit cycles.

UNIT IV

DSP Processors: Architectures of ADSP and TMS series of processor.

1) **Apply** the concept of discrete time signals and various manipulations on them.
2) **Analyze** the Discrete time system using Z-transform and Discrete Fourier Transform
3) **Learn** and understand realizations of various forms of structures' for discrete time systems
4) **Develop** the capability to design FIR and IIR filters depending upon the specific application
5) **Analyze** the effects of finite word length on filter performance
6) D**escribe** the architecture and characteristics of digital signal processors.

RECOMMENDED TEXT BOOK

Digital Signal Processing Principles, Algorithms and Application John G Proakis, Dimtris G Manolakis 4th 2009.

Books Recommended

1. Discrete-Time Signal Processing Alan V Oppenheim, Ronald W Schafer, John R Back 2nd 2008, Prentice Hall.
2. Digital Signal Processing S. Salivahan, A Vallavaraj, Gnanpiya 1st 2008 Tata McGraw Hill.
3. Digital Signal Processing-A computer based approach S. K. Mitra 1st 2006 Tata

4. Jervis, ―Digital Signal Processing‖, Pearson Education India.
5. Introduction to Digital Signal Processing Johny R.Johnson 1st 2006, Prentice Hall.

BTEC-503 **LINEAR INTEGRATED CIRCUIT**

Internal Marks: 40 L T P

External Marks: 60 3 1 0

Total Marks: 100

UNIT I

DIFFERENTIAL AND CASCADE AMPLIFIERS: Introduction, Differential Amplifier, Differential Amplifier Circuit Configuration, Dual Input-Balanced output Differential Amplifier, Dual Input-Unbalanced output Differential Amplifier, Single Input-Balanced output Differential Amplifier, Single Input-unbalanced output Differential Amplifier with their DC and AC analysis, Differential Amplifier with swamping resistors, Constant current bias, Current Mirror, Cascaded differential Amplifier Stages, Level Translator, CE-CB configuration.

UNIT II

INTRODUCTION TO OPERATIONAL AMPLIFIERS: Block diagram of a typical Op-Amp, Schematic symbol, integrated circuits and their types, IC package types, Pin Identification and temperature range, Interpretation of data sheets, Overview of typical set of data sheets, Characteristics and performance parameters of and Op-Amp, Ideal Op-Amp, Equivalent circuit of an Op-Amp, Ideal voltage transfer curve, Open loop configurations : Differential, Inverting & Non Inverting. Practical Op-Amp: Input offset voltage, Input bias current, Input offset current, total output offset voltage, Thermal drift, Effcet of variation in power supply voltages on offset voltage, Change in Input offset voltage and Input offset current with time, Temperature and supply voltage sensitive parameters, Noise, Common Mode configuration and common mode rejection Ratio. Feedback configurations.

UNIT III

APLICATIONS OF OP-AMP: DC and AC amplifiers, Peaking Amp, Summing, Scaling and Averaging Amp, Instrumentation Amplifier, V to I and I and to V converter, Log and Antilog Amp, Integrator, Differentiator. Active filters: First order LP Butterworth filter, Second order LP Butterworth filter, First order HP Butterworth filter, Second order HP Butterworth filter, Higher order filters, Band pass filter, Band reject filters, All pass filter, Phase shift oscillator, Wein bridge oscillator, Quadrature oscillator, Square wave generator, Triangular wave generator, Sawtooth wave generator, Voltage controlled oscillator, Basic comparator, Zero crossing detector, Schmitt trigger, window detector, V to F and F to V converters, A to D and D to A converters, Peak Detector, Sample and Hold Circuit.

UNIT IV

SPECIALIZED IC APPLICATIONS: IC 555 Timer: Pin configuration, Block diagram, application of IC 555 as Monostable and Astable Multivibrator., Phase Lock Loops: Operating principles & applications of IC 565, Voltage Regulators: Fixed voltage regulators, Adjustable voltage regulators, Switching Regulators.

Course Outcomes: Upon successful completion of this course,

1) Students will be able to **understand** the basic concepts of Linear Integrated Circuits.
2) Students will be able to **apply** the knowledge of operational amplifiers and design various op-amp circuits.
3) Students will be able to able to **complete** accurate and comprehensive analysis ofLinear Integrated Circuits.
4) Students will be able to **demonstrate** the working of various circuits using 741C and 555 ICs

Recommended Text Book:

1. Op Amps & Linear Integrated circuits by Ramakant Gayakwad.

Recommended Reference Books

1. Op Amps & Linear Integrated circuits by Coughlin

2. Op Amps & Linear Integrated circuits by RaviRaj Dudeja.

BTEC-504 **MICROPROCESSORS & MICROCONTROLLERS**

Internal Marks: 40 L T P

External Marks: 60 4 1 0

Total Marks: 100

Unit I

INTRODUCTION TO 8085 MICROPROCESSOR: History and evolution of Microprocessors, 8085 Microprocessor, Memory Interfacing, Memory mapped I/O and peripheral mapped I/O 8085 Microprocessor Programming model. Introduction to 8085 instructions, programming techniques, counters and time delays, stack and subroutines, interrupts.

Unit II

8051 MICROCONTROLLER: Comparison of Microprocessor and Microcontroller, micro controller and embedded processors, Architecture and pin configuration of 8051

Unit III

8051 ASSEMBLY LANGUAGE PROGRAMMING: Introduction to 8051 Assembly programming, Data Types and directives, 8051 flag bits and PSW register. Register banks and stack. Jump loop and call instructions, I/O Port programming: Addressing modes and accessing memory using various addressing modes. Arithmetic instructions and programs, Logic instructions and programs, Single bit instructions and programming, Timer/counter programming in the 8051.

Unit IV

SERIAL COMMUNICATION: 8051 connection to RS 232, 8051 serial communication programming, interfacing of 8051microcontroller: LCD, ADC and DAC, Stepper motor.

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

1) To understand the detailed architecture of 8085-microprocessor & 8051 microcontrollers.
2) The students will be able to apply the knowledge of addressing modes and instruction sets for writing assembly language programmes for problem solving.
3) The students will be able to compare microprocessors and microcontrollers.
4) The students will be able to demonstrate the interfacing of various peripheral devices to microcontroller and design of interfacing systems.

Recommended Text Books:-

1. Microprocessor Architecture, Programming and application with 8085 by Gaonkar
2. The 8051 Microcontroller and embedded Systems by: - Ali Mazidi, Pearson Education
3. The 8051 Microcontroller by K. J. Ayala, Cengage Learning.

BTEC-505 **LAB DIGITAL SIGNAL PROCESSING**

Internal Marks: 30 L T P
External Marks: 20 0 0 2
Total Marks: 50

List Of Experiments:

Perform the following exercises using MATLAB

1. To develop elementary signal function modules (m-files) for unit sample, unit step, exponential and unit ramp sequences.
2. Write a program in MATLAB to generate standard sequences.
3. Write a program in MATLAB to compute power density spectrum of a sequence.
4. To develop program modules based on operation on sequences like signal Shifting, signal folding, signal addition and signal multiplication.
5. Write a program in MATLAB to verify linear convolution.
6. Write a program in MATLAB to verify the circular convolution.
7. To develop program for finding magnitude and phase response of LTI system Described by system function H(z).
8. To develop program for finding response of the LTI system described by the difference equation.
9. To develop program for computing inverse Z-transform.
10. To develop program for computing DFT and IDFT.
11. To develop program for conversion of direct form realization to cascade form realization.
12. To develop program for cascade realization of IIR and FIR filters.
13. To develop program for designing FIR filter.
14. To develop program for designing IIR filter.
15. To write a MATLAB program for noise reduction using correlation and autocorrelation methods.
16. To write a MATLAB programs for pole-zero plot, amplitude, phase response and impulse response from the given transfer function of a discrete-time causal system.
17. Write a program in MATLAB to find frequency response of different types of analog filters.
18. Write a program in MATLAB to design FIR filter (LP/HP) through Window technique
    a. Using rectangular window
    b. Using triangular window

BTEC-506 **LAB LINEAR INTEGRATED CIRUIT**

Internal Marks: 30 L T P
External Marks: 20

0 0 2

Total Marks: 50

List Of Experiments:

1. To study differential amplifier configurations.
2. To measure the performance parameters of an Op amp.
3. Application of Op amp as Inverting and Non Inverting amplifier.
4. To study frequency response of an Op Amp
5. To use the Op-Amp as summing, scaling & averaging amplifier.
6. To use the Op-Amp as Instrumentation amplifier
7. Design differentiator and Integrator using Op-Amp.
8. Application of Op Amp as Log and Antilog amplifier. Design Low pass, High pass and Band pass 1st order butterworth active filters using Op Amp.
9. Design Phase shift oscillator using Op-Amp.
10. Design Wein Bridge oscillator using Op-Amp.
11. Application of Op Amp as Sawtooth wave generator.
12. Application of Op Amp as Zero Crossing detector and window detector.
13. Application of Op Amp as Schmitt Trigger.
14. Design a series regulators with an error amplifier to provide an output voltage of 5 volt at a load current of 1.5 Amp. Use a 741 Op-Amp and specify the Zener voltage necessary transistor gain and the maximum power dissipation of the transistor.
15. Design a delay circuit using 555.
16. To examine the operation of a PLL and to determine the free running frequency, the capture range and the lock in range of PLL.
17. Verification of hardware results obtained using SPICE.

BTEC-507 Lab-Digital Communication System

Internal Marks: 30 L T P
External Marks: 20 0 0 2

Total Marks: 50

LIST OF EXPERIMENTS

1. Study of Time Division Multiplexing system.
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 various formats.
5. Data decoding techniques for various 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.
9. Error Detection & Correction using Hamming Code
10. Digital link simulation; error introduction & error estimation in a digital link using MATLAB (SIMULINK)/ communication simulation packages.

BTEC-508 **Lab Hardware Programme & Interfacing**

Internal Marks: 30 L T P
External Marks: 20 0 0 2

Total Marks: 50

LIST OF EXPERIMENTS

Note: Any Eight Experiments each from Part A and Part-B Part-A:
List of Experiments using 8085/8086:

1. Study of 8085 and 8086 Microprocessor Kits.
2. Write a program to add two 8-bit number using 8085.
3. Write a program to add two 16-bit number using 8085.
4. Write a program to subtract two 8-bit number using 8085.
5. Write a program to subtract two 16-bit number using 8085.
6. Write a program to multiply two 8 bit numbers by repetitive addition method using 8085.
7. Write a program to sort series using bubble sort algorithm using 8085.
8. Write a program to copy 12 bytes of data from source to destination using 8086.
9. Write a program to find maximum and minimum from series using 8086.
10. Write a program to control the operation of stepper motor using 8085/8086 microprocessors and 8255 PPI.
11. Write a program to control speed of DC motor using 8085/8086 microprocessors and 8255 PPI.

Part-B: List of Experiments using 8051:

1. Study of 8051/8031 Micro controller kits.
2. Write a program to add two numbers lying at two memory locations and display the result.
3. Write a program for multiplication of two numbers lying at memory location and display the result.
4. Write a Program to arrange 10 numbers stored in memory location in Ascending and Descending order.
5. Write a program to show the use of INT0 and INT1.
6. Write a program of Flashing LED connected to port 1 of the Micro Controller
7. Write a program to generate a Ramp waveform using DAC with micro controller.
8. Write a program to interface the ADC.
9. Write a program to control a stepper motor in direction, speed and number of steps.
10. Write a program to control the speed of DC motor.
11. Interfacing of high power devices to Micro-controller port-lines, LED, relays and LCD display.

Sixth Semester

BTCS 401 **OPERATING SYSTEMS**

Internal Marks: 40	**L**	**T**	**P**
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

PART-A

1. Introduction to Operating system, Role of Operating System as resource manager, function of kernel and shell, operating system structures, views of an operating system.

2. Process management: CPU scheduling, Scheduling Algorithms, PCB, Process synchronization, Deadlocks, Prevention, Detection and Recovery.

3. Memory Management: Overlays, Memory management policies, Fragmentation and its types, Partitioned memory managements, Paging, Segmentation, Need of Virtual memories, Page replacement Algorithms, Concept of Thrashing.

PART-B

4. Device Management: I/O system and secondary storage structure, Device management policies, Role of I/O traffic controller, scheduler.

5. File Management: File System Architecture, Layered Architecture, Physical and Logical File Systems, Protection and Security.

6. Brief study to multiprocessor and distributed operating systems.

7. Case Studies: LINUX / UNIX Operating System and Windows based operating systems.

Suggested Readings/ Books:

1. A Silberschatz and Peter B. Galvin, ―Operating System Concepts" Addison‖ W esley Publishing Company
2. Dhamdhere, ―Systems Programming & Operating Systems‖ Tata M cG raw H ill
3. Gary Nutt, ―Operating Systems Concepts‖, Pearson Education Ltd. 3rd Edition
4. Operating System by Madnick Donovan
5. Operating System by Stallings

BTEC-601 MICROWAVE AND RADAR ENGINEERING

	L	T	P
Internal Marks: 40			
External Marks: 60	**4**	**1**	**0**
Total Marks: 100			

Microwave Tubes: Limitations of conventional tubes, construction, operation and properties of Klystron Amplifier, reflex Klystron, Magnetron, Travelling Wave Tube (TWT), Backward Wave Oscillator (BWO), Crossed field amplifiers.

Microwave Solid State Devices: Limitation of conventional solid state devices at Microwaves, Transistors (Bipolar, FET), Diodes (Tunnel, Varactor, PIN), Transferred Electron Devices (Gunn diode), Avalanche transit time effect (IMPATT, TRAPATT, SBD), Microwave Amplification by Stimulated Emission of Radiation (MASER).

Microwave Components: Analysis of Microwave components using s-parameters, Junctions (E, H, Hybrid), Directional coupler, Bends and Corners, Microwave posts, S.S. tuners, Attenuators, Phase shifter, Ferrite devices (Isolator, Circulator, Gyrator), Cavity resonator, Matched termination.

Microwave Measurements: Power measurements using calorimeters and bolometers, Measurement of Standing Wave Ratio (SWR), Frequency and wavelength, Microwave bridges. **Introduction to Radar Systems:** Basic Principle: Block diagram and operation of Radar, Radar range Equation, Pulse Repetition Frequency (PRF) and Range Ambiguities, Applications of Radar. **Doppler Radars:** Doppler determination of velocity, Continuous Wave (CW) radar and its limitations, Frequency Modulated Continuous Wave (FMCW) radar, Basic principle and operation of Moving Target Indicator (MTI) radar, Delay line cancellers, Blind speeds and staggered PRFs. **Scanning and Tracking Techniques:** Various scanning techniques (Horizontal, vertical, spiral, palmer, raster, nodding), Angle tracking systems (Lobe switching, conical scan, monopulse), Range tracking systems, Doppler (velocity) tracking systems.

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

1) The students will be able to **know** the basics of Microwave Range and its advantages and disadvantages.
2) They will be able to **understand** the importance of various microwave components
3) They will be able to **measure** various microwave parameters to judge the performance of the Microwave systems.

Text books:

1. Microwave devices and circuits: Samuel Liao; PHI
2. Microwave devices and Radar Engg: M. Kulkarni; Umesh Publications
3. Introduction to radar systems: Merill I. Skolnik

4. Foundation of Microwave Engg. : R.E. Collin; McGraw Hill

BTEC-602 WIRELESS COMMUNICATION SYSTEM

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

Introduction: A basic cellular system, performance criteria, operation of cellular systems, planning a cellular system, analog & digital cellular systems. Examples of Wireless Communication Systems: Paging Systems, Cordless Telephone Systems, Cellular Telephone Systems. Blue tooth and Zig Bee.

Elements of Cellular Radio Systems Design: General description of the problem, concept of frequency reuse channels, co-channel interference reduction factor, desired C/I from a normal case in an omni directional antenna system, cell splitting, consideration of the components of cellular systems.

Digital Communication through fading multipath channels: Fading channel and their characteristics- Channel modeling, Digital signaling over a frequency non selective slowly fading channel. Concept of diversity branches and signal paths. Combining methods: Selective diversity combining, Switched combining, maximal ratio combining, Equal gain combining.

Multiple Access Techniques for Wireless Communications: Introduction, Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Spread Spectrum Multiple Access, Space Division Multiple Access, Packet Radio Protocols; Pure ALOHA, Slotted ALLOHA.

Wireless Systems & Standards: AMPS and ETACS, United states digital cellular (IS- 54 & IS 136), Global system for Mobile (GSM): Services, Features, System Architecture, and Channel Types, Frame Structure for GSM, Speech Processing in GSM, GPRS/EDGE specifications and features. 3G systems: UMTS & CDMA 2000 standards and specifications. CDMA Digital standard (IS 95): Frequency and Channel specifications, Forward CDMA Channel, Reverse CDMA Channel, Wireless Cable Television.

Future trends: 4G mobile techniques, LTE-Advance systems

Course Outcomes: Upon successful completion of this course

CO1: The students shall have the understanding of basics of Wireless communication.

CO2: The students will be able to understand the cellular concept, Co-channel Interference and frequency Reuse concept

CO3: Upon completion of the course, the students shall have the ability to understand the concept of fading and Diversity and design some model to reduce these effects.

CO4: Upon completion of the course, the students shall have the ability to understand the concept of multiple access techniques and the cellular systems which are using these techniques.

CO5: Students shall be able to understand various wireless systems and standards GSM,CDMA,UMTS,4G,LTE

Recommended Text Books:

1. T.S.Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Pearson Education Asia, 2010.
2. William C Y Lee, Mobile Cellular Telecommunications, 2nd Edition, MGH, 2004.
3. Raj Pandya, ―Mobile and Personal Communication systems and services‖, Prentice Hall of India, 2001.
4. Wireless and Digital Communications; Dr. Kamilo Feher (PHI)

BTEC-603 ENGINEERING ECONOMICS & INDUSTRIAL MANAGEMENT

External Marks: 60	**L**	**T**	**P**
Internal Marks: 40	**3**	**1**	**0**
Total Marks: 100			

Cost analysis: Break-even analysis, two and three alternatives, graphical solution. Breakeven charts, effects of changes in fixed and variable costs. Minimum cost analysis, economics order quality. Effect of risk and uncertainty on lot size.

Replacement Studies: Reasons for replacement, factors to be considered in replacement Studies, discounted cash flow analysis, economic life of a project, challenger and defender.

Economic Analysis Of Investment Alternatives : Basic economy study patterns and their comparison, decision making in selection of alternative by present worth methods, rate of return method, payout period method and uniform annual cost method, economic analysis of new projects, effect of taxation on economic studies.

Cost Estimation : Difference between cost estimation and cost accounting, qualifications of an estimator. Estimating procedure, Estimate of material cost and labour cost. Estimation of cost in various manufacturing operations.

Depreciation : Types of depreciation and their Methods.

Concepts of Industrial Management: Concept, Development, application and scope of Industrial Management **,** Functions of Management, Evolution of Management Thought : Taylor's Scientific Management, Fayol's**,**Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Mayo's Hawthorne, Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs'

Productivity : Definition, measurement, productivity index, types of production system, Industrial Ownership.

Designing Organizational Structures: Concept, Importance and characteristics of organization, Types of organization - Project, matrix and informal organization. Span of control, Delegation of authority.

Materials Management-Objectives, Inventory - functions, types, associated costs, Inventory Control Systems-Continuous review system-periodical review system. Stores Management and Stores Records. Purchase management, duties of purchase of manager, associated forms.

TEXT BOOKS

1. O.P Khanna, Industrial Engineering.
2. T.N. Bhagooiwal Economics of Labour and Industrial Relations (Sahitya BhawanAgra)
3. Engineering Economy : Thuesen Prentice Hall

1. Minappa and Personnel Managements M.S. Saiyada (Tata Mc Graw Hill)
2. C.B. Mamoria Personnel Management (Himalaya publishing house Bombay)
3. Engg. Economics Analysis Bullinger
4. Introduction to Econometrics : Kliwen Prentice Hall

BTEC-604 VLSI DESIGN

	L	T	P
Internal Marks: 40			
External Marks: 60	**4**	**1**	**0**
Total Marks: 100			

Introduction: Introduction to Computer-aided design tools for digital systems. Hardware description languages, Introduction to VHDL, Data objects, Classes and data types, Operators, Overloading, and Logical operators. Types of delays, Entity and Architecture declaration Introduction to behavioral, dataflow and structural models

VHDL Statements: Assignment statements, Sequential Statements and Process, Conditional Statements, Case Statements, Array and Loops, Resolution Functions, Packages & Libraries, Concurrent Statements.

Applications of VHDL: Combinational Circuit Design such as such as Multiplexers, Encoders, Decoders, Code Converters, Comparators, and Implementation of Boolean functions etc., Sequential Circuit Design such as Shift registers, Counters etc.

Review of MOS Devices: MOS Structure, Enhancement & Depletion Transistor, Threshold Voltage, MOS device design equations MOS Transistor Models. NMOS, PMOS, CMOS.

Basic Electrical Properties and Circuit Concepts: The NMOS Inverter and Transfer Characteristics pull up and pull down ratios of NMOS, alternative forms of pull up the CMOS Inverter and transfer characteristics. CMOS Inverter Delays. Driving large Capacitive loads, Propagation delays and effect of wiring capacitance.

Circuit Characterization and Performance Estimation: Estimation of R, C, L, Switching Characteristics-delay models. Power dissipation. Scaling of MOS circuits. Effect of device scaling on circuit performance.

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

1) To understand mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnect.
2) To create models of moderately sized CMOS circuits that realizes specified digital functions.
3) To apply CMOS technology-specific layout rules in the placement and routing of transistors and interconnect, and to verify the functionality, timing, power, and parasitic effects.

Recommended Text Books:

1. —*A VHDL Primmer* ‖ : Bhasker; Prentice Hall 1995.
2. Weste and Eshrighian, —*Principle of CMOS VLSI Design* ‖ Pearson Education, 2001.

3. Pucknell D A and Eshraghian K, ―*Basic VLSI Design*‖, Prentice Hall India, New Delhi (2003).
4. *Fundamentals of Digital Logic with VHDL Design*: Brown and Vranesic; TMH(2000)
5. S. M. Kang, Y. Lebiebici, ―*CMOS digital integrated circuits analysis & design*‖ TMH, 3rd Edition.

BTEC-605 LAB VLSI

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 2**
Total Marks: 50
List of Experiments:

Combinational Design Exercises

1. Design of basic Gates: AND, OR, NOT.

2. Design of universal gates

3. Design of 2:1 Mux using other basic gates

4. Design of 2 to 4 Decoder

5. Design of Half-Adder, Full Adder, Half Substractor, Full Substractor

6. Design of 3:8 Decoder

7. Design of 8:3 Priority Encoder

8. Design of 4 Bit Binary to Grey code Converter

9. Design of 4 Bit Binary to BCD Converter using sequential statement

10. Design an 8 Bit parity generator (with for loop and Generic statements)

11. Design of 2,s Complementary for 8-bit Binary number using Generate statements

Sequential Design Exercises

12. Design of all type of Flip-Flops using (if-then-else) Sequential Constructs

13. Design of 8-Bit Shift Register with shift Right, Rhisft Left, Load and Synchronous reset.

14. Design of Synchronous 8-bit Johnson Counter.

15. Design of Synchronous 8-Bit universal shift register (parallel-in, parallel-out) with 3-state output (IC 74299)

16. Design of 4 Bit Binary to BCD Converter using sequential statement.

17. Design counters (MOD 3, MOD 5, MOD 8, MOD 16)

18. Design a decimal up/down counter that counts up from 00 to 99 or down from 99 to 00.

19. Design 3-line to 8-line decoder with address latch

BTEC-606 LAB MICROWAVE ENGINEERING

	L	T	P
Internal Marks: 30			
External Marks: 20	**0**	**0**	**2**
Total Marks: 50			

List of Experiments:

1. Study of microwave components and instruments.
2. Measurement of crystal characteristics and proof of the square law characteristics of the diode.
3. Measurement of klystron characteristics.
4. Measurement of VSWR and standing wave ratio.
5. Measurement of Dielectric constants.
6. Measurement of Directivity and coupling coefficient of a directional coupler.
7. Measurement of Q of a cavity.
8. Calibration of the attenuation constant of an attenuator.
9. Determination of the radiation characteristics and gain of an antenna.
10. Determination of the phase-shift of a phase shifter.
11. Determination of the standing wave pattern on a transmission line and finding the length and position of the short circuited stub.

DIGITAL SYSTEM DESIGN

BTEC 904

Internal Marks: 40	**L T P**
External Marks: 60	**4 1 0**
Total Marks: 100	

Combinational Logic: Review of adders, Subtractor, Multipliers, Multiplexers, ROM, PLA, PAL and PLD.

Synchronous Sequential Logic: Flip-flops, Triggering of flip-flops, Analysis of clocked sequential circuits, State reduction and assignment, Flip-flop excitation tables, Design procedure, Design of counters,

Finite State Machines: Finite state model, Memory elements and their excitation functions, Synthesis of Synchronous sequential circuits, Capabilities and limitations of FSM, Design, Modeling and Simulation of Moore and Mealy machines.

Algorithmic State Machines: ASM chart, Timing considerations, Control implementation, Control Design with multiplexers, PLAs, etc.

Asynchronous Sequential Logic: Analysis Procedure, Circuits with latches, Design procedure, Reduction of state and flow tables, Race-free state assignment, Hazards, Design examples.

Designing with Programmable Logic Devices and Programmable Gate Arrays: Read only memories, Programmable logic arrays, Programmable array logic, Designing with FPGAs, Xilinx series FPGAs

TEXT BOOKS:

1. VHDL - 3rd Edition - Douglas Perry - TMH
2. Fundamentals of Digital Logic with VHDL design - Stephen Brown, Zvonko Vranesic - TMH.
3. Digital Design Principles - William I Fletcher.

REFERENCE BOOKS:

1. Digital System Design Using VHDL - Chales H. Roth.
2. Digital System Design - John Wakerley.
3. VHDL - Zainalabedin Navabbi.
4. VHDL - D. Smith.

BTEC-906 INTELLIGENT INSTRUMENTATION

Internal Marks: 40	**L T P**
External Marks: 60	**4 1 0**
Total Marks: 100	

INSTRUMENTATION

Introduction about Instrumentation systems, Types of Instrumentation systems, Data acquisition system (DAS) and its uses in intelligent Instrumentation system, Detailed study of each block involved in making of DAS, Signal Conditioners: as DA, IA, Signal Converters (ADC & DAC), Sample and hold, Designing of Pressure, Temperature measuring instrumentation system using DAS, Data logger.

AUTOMATION

Introduction about Automation system, Concepts of Control Schemes, Types of Controllers, Components involved in implementation of Automation system i.e., DAS, DOS, Converter (I to P) and Actuators: Pneumatic cylinder, Relay, Solenoid (Final Control Element), Computer Supervisory Control System (SCADA), Direct Digital Control's Structure and Software.

PLC

Introduction of Programmable logic controller, Principles of operation, Architecture of Programmable controllers, Programming the Programmable controller.

INTELLIGENT CONTROLLER

Introduction to Intelligent Controllers, Model based controllers, Predictive control, Artificial Intelligent Based Systems, Experts Controller, Fuzzy Logic System and Controller, Artificial Neural Networks, Neuro-Fuzzy Controller system.

Reference Text Books:

1. —Process Control Instrumentation Technology‖ 6/e, by Curtis D Johnson, Pearson Ed.

2. —Electrical and Electronics Measurement and Instrumentation‖ by A. K. Swahney.

3. —Electronics instrumentation‖ by H. S. Kalsi [TMH]

4. —Computer-Based Industrial Control‖, by Krishna Kant, PHI.

5. —Process Control Instrumentation Technology‖, by Curtis D Johnson, Pearson Ed

BTEC 907 INFORMATION THEORY & CODING

Internal Marks: 40	L T P
External Marks: 60	4 1 0
Total Marks: 100	

Basic Concepts of Information Theory : The concept of Amount of Information, Average Information, Entropy, Information rate, Shannon's Theorem, Mutual information; Channel capacity; BSC and other channels, Capacity of a Gaussian Channel, Bandwidth - S/N Trade-off, Introduction to Channel Capacity & Coding, Channel Models, Channel Capacity Theorem, Shannon Limit. Huffman source coding algorithm, Lempel Ziv source coding algorithm. **Introduction to Error Control Coding:**

Linear Block Codes: Introduction to Linear Block codes, Syndrome and Error detection, Minimum distance of block code, Hamming Code.

Cyclic Codes: Description of Cyclic codes, Generator and parity check matrices of cyclic codes, error detection decoding of cyclic codes.

BCH Codes: Description of codes, Decoding of BCH codes, Implementation of error connection.

Convolution Codes: Encoding of convolution codes, structural properties of Convolution codes, Distance Properties of convolution codes.

Automatic Repeat Request Strategies: Stop and wait, Go back and selective repeat ARQ strategies, Hybrid ARQ Schemes.

Recommended Books:

1. F.M Reza: Information Theory, Mc Graw Hill
2. ShuLin & J Costeib: Error Control Coding, PHI
3. Dass, Mullick & Chatterjee: Digital Communication, John Wiley, Ed. 1992
4. Information Theory and Reliable Communication: Robert G. Gallanger Mc Graw Hill, 1992
5. Related IEEE/IEE publications

Seventh/ Eighth Semester

BTCS-403 Computer Networks

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

UNIT 1. Introduction to Computer Networks:
Data Communication System and its components, Data Flow, Computer network and its goals, Types of computer networks: LAN, MAN, WAN, Wireless and wired networks, broadcast and point to point networks, Network topologies, Network software: concept of layers, protocols, interfaces and services, ISO-OSI reference model, TCP/IP reference model.

Unit 2. Physical Layer:
Concept of Analog & Digital Signal, Bandwidth, Transmission Impairments: Attenuation, Distortion, Noise, Data rate limits : Nyquist formula, Shannon Formula, Multiplexing : Frequency Division, Time Division, Wavelength Division, Introduction to Transmission Media : Twisted pair, Coaxial cable, Fiber optics, Wireless transmission (radio, microwave, infrared), Switching: Circuit Switching, Message Switching ,Packet Switching & their comparisons.

Unit 3. Data Link Layer:
Design issues, Framing, Error detection and correction codes: checksum, CRC, hamming code, Data link protocols for noisy and noiseless channels, Sliding Window Protocols: Stop & Wait ARQ, Go-back-N ARQ, Selective repeat ARQ, Data link protocols: HDLC and PPP.

Unit 4. Medium Access Sub-Layer:
Static and dynamic channel allocation, Random Access: ALOHA, CSMA protocols, Controlled Access: Polling, Token Passing, IEEE 802.3 frame format, Ethernet cabling, Manchester encoding, collision detection in 802.3, Binary exponential back off algorithm.

Unit 5. Network Layer:
Design issues, IPv4 classful and classless addressing, subnetting, Routing algorithms: distance vector and link state routing, Congestion control: Principles of Congestion Control, Congestion prevention policies, Leaky bucket and token bucket algorithms.

Unit6. Transport Layer:
Elements of transport protocols: addressing, connection establishment and release, flow control and buffering, multiplexing and de-multiplexing, crash recovery, introduction to TCP/UDP protocols and their comparison.

Unit 7. Application Layer:
World Wide Web (WWW), Domain Name System (DNS), E-mail, File Transfer Protocol (FTP), Introduction to Network security

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

1) Students will be able to understand basic networking concepts.
2) Students will be able to compare the data link protocols and networking layer protocols.
3) Students are able to design new protocols for data link layer and routing algorithms.

Reference Books:

1. William Stallings ―Computer Networking with Internet Protocols And Technology‖, Pearson Education.

2. Andrew S. Tanenbaum ―Computer Networks‖, PHI

BTEC-701 Embedded Systems

Internal Marks: 40	**L**	**T**	**P**
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

Unit-I: Arm Processor Architecture

Architecture, Registers, Interrupts & Vector Table, I/O Ports, ARM Processor family, JTAG, I2C bus

Unit-II: Arm Programming Instructions

Instruction Set: Data processing instructions, Addressing modes, Load Store Instructions, PSR (Program Status Register) Instructions, Conditional Instructions, Interrupt Instructions

Unit-III: C Programming

Integrated Development Environment (IDE) for C/C++ Programming, C/C++ Programs using Function Calls, Pointers, Structures, Integers & Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation, Conditional Execution & Loops

Unit-IV: Interfacing Peripherals

Interfacing: ADC & DAC, Sensors, Memory, LCD Display, Stepper Motor, DC Motor, SD-MMC Card, Biometric & RFID, ZIGBEE, GSM Interfaces, Debugging Tools

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

1) Get insight of design metrics of Embedded systems to design real time applications to match recent trends in technology.
2) Understand Real time systems concepts.
3) Apply interfacing of devices using LPC2148

References Books:

1. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield, ―ARM System Developer's Guide Designing and Optimizing System Software‖, Elsevier 2008.
2. Brooks, Cole, ―Embedded Microcontroller Systems, Real Time Interfacing‖, Thomson Learning 1999

3. Steve Furber, —ARM system on Chip Architecture‖, Addision Wesley

4. Trevor Martin, —The Insider's Guide to The Philips ARM7 - Based Microcontrollers, An Engineer's Introduction To The LPC2100 Series‖ Hitex Ltd.

5. ARM Architecture Reference Manual

6. Website www.arm.com

BTEC-702 Optical Communication

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

Unit-I Introduction

Need of Fiber Optic Communications, Evolution of Light wave Systems, Basic Concepts; Analog & Digital Signals, Channel Multiplexing, Modulation Formats, Optical Communication Systems, Light wave System Components; Optical Fibers as a Communication Channel, Optical Transmitters, Optical Receivers.

Unit-II Optical Fibers

Geometrical-Optics Description; Step-Index Fibers, Graded Index Fibers, Wave Propagation; Maxwell's Equations, Fiber Modes, Single-Mode-Fibers, Dispersion in Single-Mode Fibers; Group Velocity Dispersion, Material Dispersion, Wave guide Dispersion, Higher-order Dispersion, Polarization-Mode Dispersion, Dispersion-Induced Limitations; Basic Propagation Equation, Chirped Gaussian Pulses, Limitations on the Bit Rate, Fiber Bandwidth , Fiber Losses; Attenuation Coefficient, Material Absorption, Rayleigh Scattering, wave guide Imperfections, Nonlinear Optical effects; Stimulated Light Scattering, Nonlinear Phase Modulation, Four Wave Mixing, Fiber Manufacturing; Design Issues, Fabrication Methods, Cables and Connectors

Unit-III Optical Transmitters

Basic Concepts; Emission and Absorption Rates, p-n Junctions, Non radiative Recombination, Semi conductor Materials, Light Emitting Diodes; Power-current Characteristics, LED spectrum, Modulation Response, LED Structures, Semi Conductor Lasers; DFB Lasers, Coupled Cavity semiconductor Lasers, Tunable Semiconductor Lasers, Vertical Cavity Semiconductor Lasers, Laser Characteristics, Small & Large Signal Modulation, Spectral Line width, Source Fiber Coupling.

Unit-IV Optical Receivers

Basic concepts, p-n Photo Diodes, p-i-n Photo Diodes, Avalanche Photo Diode, MSM Photo detector, Receiver Design, Receiver Noise; Noise mechanism, Receiver sensitivity; Bit error rate, Minimum Receiver Power, Sensitivity Degradation, Receiver Performance.

Unit-V Light Wave Systems

System Architecture, Loss limited Light wave systems, Dispersion limited Light wave systems, Power Budget, Long Haul systems, Sources of Power Penalty; Model Noise, Dispersive Pulse Broadening, Mode Partition Noise, Frequency Chirping, Reflection Feedback Noise

Unit-VI Multi channel Systems

WDM Light wave systems, Optical TDM Systems, Subscriber Multiplexing, Code Division Multiplexing.

Course Outcomes:

1) The students will **learn** the need of optical communication system with basic knowledge to elements of optical fiber transmission link, fiber modes configurations and structures

2)The student will understand the different kind of losses, signal distortion in optical wave guides and other signal degradation Factors

3) The student will **become** skilled at the various optical source materials, LED & Laser structures,quantum efficiency of optical source as well as photo detector, fiber optical receivers such as PIN,APD diodes, noise performance in photo detector, receiver Operation and configuration

4)The student will **gain** knowledge of the fiber optical network components, variety of optical communication system & network aspects

Reference Books:

1. Senior J. Optical Fiber Communications, Principles & Practice, PHI.
2. Keiser G., Optical Fiber Communication Mc graw-hill.
3. Govind P. Agrawal, Fiber Optics Communication Systems John Wiley & Sons (Asia) Pvt. Ltd.
4. Djafar K. Mynbeav, ―Fiber-Optics Communications Technology‖ Pearson.

BTEC-703 Lab Wireless and Optical Systems & Networks

	L	T	P
Internal Marks: 30			
External Marks: 20	**0**	**0**	**2**
Total Marks: 50			

1. Study and measurement of attenuation and loss in optical fiber.
2. Study and measurement of bending loss in optical fiber.
3. Study and measurement of numerical aperture of optical fiber.
4. Measurement of optical power using optical power meter.
5. To Study the transmission of TDM signal through optical fiber.
6. To determine the bit rate of the optical fiber link.
7. Study of various multiplexing techniques.
8. To determine the BER of wireless system using M-ARY (BPSK,QPSK,8PSK,16PSK) technique.
9. To determine the BER of wireless system using QAM technique

BTEC-704 Embedded Systems Lab

	L	T	P
Internal Marks: 30			
External Marks: 20	**0**	**0**	**2**
Total Marks: 50			

List of Experiments

1. Study of ARM7 & ARM9 Bit Processor Architecture and Pin Diagram.
2. Study of Interrupt structure in ARM Processors
3. Write ARM Processor program to Flash LED
4. Interfacing of an LCD Display
5. Write a program to interface an ADC
6. Write a program to generate a Ramp waveform using DAC interface
7. Write a program to control a Stepper Motor
8. Write a program to control the speed of DC motor
9. Interface relays and write a program to control them
10. Interface ZIGBEE with ARM to control more external devices
11. Interfacing of Biometric information recorder
12. Interfacing RFID module with ARM Microcontroller

BTEC 910 Satellite Communication

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

Unit-I Introduction to Satellite Communication

Origin, Brief History, Current state and advantages of Satellite Communication, Active & Passive satellite, Orbital aspects of Satellite Communication, Angle of Evaluation, Propagation Delay, Orbital Spacing, System Performance

Unit-II Satellite Link Design

Link design equation, system noise temperature, C/N & G/T ratio, atmospheric & econospheric effects on link design, complete link design, interference effects on complete link design, earth station parameters, Earth space propagation effects, Frequency window, Free space loss, Atmospheric absorption, Rainfall Attenuation, Ionospheric scintillation, Telemetry, Tracking and command of satellites.

Unit-III Satellite Multiple Access System

FDMA techniques, SCPC & CSSB systems, TDMA frame structure, burst structure, frame efficiency, super-frame, frame acquisition & synchronization, TDMA vs FDMA, burst time plan, beam hopping, satellite switched, Erlang call congestion formula, DA-FDMA, DA-TDMA.

Unit-IV Satellite Services

INTELSAT, INSAT Series, VSAT, Weather forecasting, Remote sensing, LANDSAT, Satellite Navigation, Mobile satellite Service.

Unit-V Laser & Satellite Communication

Link analysis, optical satellite link Tx & Rx, Satellite, beam acquisition, tracking & pointing, cable channel frequency, head end equation, distribution of signal, n/w specifications and architecture, optical fibre CATV system.

Reference Books:

1. Trimothy Pratt, Charles W. Bostian, ―Satellite Communications‖, John Wiley & Sons, 1986.
2. Dr. D.C. Aggarwal, ―Satellite Communications‖, Khanna Publishers, 2001.
3. Dennis Roddy, ―Satellite Communications‖, McGraw Hill, 1996.

BTEC 912 Speech & Image Processing

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

Unit-I Introduction to Image Processing

Historical background, visual perception, image formation, Elements of Storage, sampling & Quantization, Relationships between pixels-neighbors of pixel, connectivity labeling of connected components, Relations, equivalence and Transitive closure, Distance measures, Arithmetic/ Logic operation, Imaging Geometry Basic and perspective transformation stereo imaging, application of image Processing.

Unit-II Image Enhancement

Spatial and frequency domain methods point processing, intensity transformation, Histogram processing image substation and Averaging spatial filtering, LP, HP and homo-morphic felling, generation of spatial marks, Color image processing.

Unit-III Image Compression

Redundancy models, error free compression, Lossy compression, Image compression standards.

Unit-IV Image Segmentation

Detection of Discontinuity, Edge detection, Boundary detection, Thresholding, Regional oriented segmentation, use of motion in segmentation.

Unit-V Speech Processing

Review of human speech and Acoustic theory, nature of sound, harmonics, resonance measurement, virtual display. Music theory, pitch, duration, intervals, rhythm. Human speech production, the vocal tract, the Larynx, the source filter. Speech signal processing-the phasor mode, Fourier transfer, DFT, FFT. The hardware use of FIR & IIR filters. Software, Elements of speech Synthesisspeech Recognition-speech in the computer-human interface.

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

1) After studying this course, the students will be able to **understand** the basics of image and speech processing
2) Students will be able to **analyze** image tools on image enhancement, segmentation and color image models.
3) Students will **conceptualize** the basics of speech production, speech synthesis, music theory and filters used for practical applications.

Reference Books:

1. Digital Image Processing - by Rafact Gonzalez and Richard E. Woods, Pearson Education Society.
2. Digital Image Processing - by Keenneth R Castleman, Pearson Education Society.
3. A. K. Jain, ―Fundamental of Digital Image Processing‖, PHI
4. Speech and Audio Processing for multimedia PC's - by Iain Murray

BTECH-916 Neural Networks And Fuzzy Logic

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

Unit-I: Introduction To Neural Networks

Human brain and Biological Neuron, Artificial Neural Network, ANN Terminology, McCulloch-Pitts Neural Model, Activation functions, Topology, Feedforward Neural Networks, ANN Learning: Supervised, Un-supervised, Competitive learning, Reinforcement learning, Knowledge representation.

Unit-II: Hopfield Neural Model

Learning Laws:- Hebb's rule, Delta rule, Widrow & Hoff LMS learning rule, Correlation learning rule, Instar and Outstar learning rules, Back-propagation Neural Networks, K-means clustering algorithm, Kohenen's feature maps, Associative Memories

Unit-III: Radial Basis Neural Networks

Function Neural Networks, Basic learning laws in RBF Nets, Recurrent Networks, Recurrent Backpropagation, Counter-Propagation Networks, CMAC Networks, ART Networks.

Unit-IV: Fuzzy Logic Sets & System

Introduction to Fuzzy Logic, Fuzzy Vs Crisp set, Linguistic variables, Membership functions, Fuzzy set operations, IF-THEN fuzzy rules, Mamdani & Sugeno inference techniques, Defuzzification techniques, Fuzzy Logic System: Block diagram, Implementation, Useful tools Fuzzy logic controller Vs PID controller, Antilock Braking System (ABS).

Reference Books:

1. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley publications.
2. Yagna Narayanan - Artificial Neural Networks
3. Bart Kosko - Neural Networks & Fuzzy logic
4. Simon Haykin - Neural Networks

BTEC 920 Wireless Sensor Network

Internal Marks: 40	L	T	P
External Marks: 60	3	1	0

Total Marks: 100

Unit-I Introduction to Wireless Sensor Networks

Constraints and Challenges of sensor networks, Emerging technologies for wireless sensor networks, Node architecture, Hardware components overview, Energy consumption of Sensor nodes, Dynamic energy and power management on System level, some examples of Sensor nodes, Optimization goals and figures of merit, QOS, Energy Efficiency, scalability, robustness Advantages of sensor networks, Sensor network applications.

Unit-II Topology Control

Location driven, Geographic Adaptive Fidelity (GAF), Geographic Random Forwarding (GeRaF), GEAR, Connectivity driven, SPAN, ASCENT.

Unit-III WSN Sensors

Physical Layer Design, Transceiver Design, MAC Protocols for WSN, Low Duty Cycle Protocols & Wakeup Concepts, S-MAC, Mediation Device Protocol, Wakeup Radio Concepts, Address & Name Management, Assignment of MAC Addresses, Routing Protocols, Energy Efficient Routing, Geographic Routing.

Unit-IV WSN Platforms & Tools

Sensor Node Hardware, Berkeley Motes, Programming Challenges, Node-level software platforms, Node level Simulators, State-centric programming.

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

CO1. Students will be introduced to sensor networks and their characteristics

CO2.Students will be introduced to some existing applications of wireless sensor networks

CO3. Students will get an overview of the various network level protocols for MAC, routing, time synchronization, aggregation, consensus and distributed tracking.

CO4. Students will learn to program sensor network platforms using TinyOS, NS2 Java and will get an opportunity to have hands on training in developing applications on wireless motes, smart phones and other embedded platforms

CO5. Students will understand what research problems sensor networks pose in disciplines such as signal processing, wireless communications and even control systems

Reference Books:

1. Holger Karl & Andreas Willig, "Protocols & Architectures for Wireless Sensor Networks", John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, ―Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
3. Waltenegus Dargie and Christian Poellabauer, ―Fundamentals of Wireless Sensor Networks - Theory and Practice‖, John Wiley and Sons, first edition, 2010.
4. Holger Karl and Andreas Willig,―Protocols and Architectures for Wireless Sensor Networks‖, JohnWiley and Sons, 2007.