REVISED CURRICULUM AND DETAILED SYLLABI

FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2010-2011 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2000 certified
Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

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Electronics and Communication Engineering

Graduating Students of BE program of ECE will be able to

1. Specify, design, prototype and test modern electronic systems that perform analog and digital processing functions.
2. Architect, partition, and select appropriate technologies for implementation of a specified communication system.
3. Design essential elements (circuits and antennas) of modern RF/Wireless communication systems.
4. Work in a team using common tools and environments to achieve project objectives

Thiagarajar College of Engineering, Madurai-625015

Department of Electronics and Communication Engineering

Scheduling of Courses

Semester	Courses						Laboratory/Project		
8th (21)	Elective 6 3:0	Elective 7 3:0	Elective 8 3:0				D84 Project 0:12		
7th (22)	D71 Accounting and Finance 3:0	D72 RF Wireless Systems 3:0	Elective 3 3:0	Elective 4 3:0	Elective 5 3:0		D77 RF and Image Processing Lab 0:1	D78 Project 0:6	
6th (21)	D61 Management Theory and Practice 3:0	D62 High Performance Communication Networks 3:0	D63 Digital Image Processing 3:0	D64 RF and Microwave Engineering 3:1	Elective 1 3:0	Elective 2 3:0	D67 Networking Lab. 0:1	D68 RF Circuits Lab. 0:1	
5th (24)	D51 Numerical Methods 4:0	D52 CMOS VLSI Systems 3:1	D53 Microcontrollers 4:0	D54 Wireless Communication Systems 3:1	D55 Antennas & Wave Propagation 3:0	D56 Data Communication Networks 3:0	D57 Digital Communication Lab. 0:1	D58 μp / μc Lab. 0:1	
4th (26)	D41 Engineering Mathematics -4 4:0	D42 Designing with PLDs and FPGAs 3:1	D43 Mixed Signal Circuits & Interfacing 3:0	D44 Digital Communication Systems 3:0	D45 Electro-magnetic Field Theory 3:1	D46 Digital Signal Processing 3:1	D47 MSCI Lab. 0:1	D48 DSP Lab. 0:1	D49 Professional Communications 1:1
3rd (23)	D31 Engineering Mathematics–3 4:0	D32 Analog Circuits and Systems 4:0	D33 Signal Processing 3:1	D34 Analog Communication Systems 3:0	D35 Data Structures 3:0	D36 Microprocessors 2:1	D37 ACS Lab. 0:1	D38 Analog Communication Lab. 0:1	
2nd (22)	D21 Engineering Mathematics–2 4:0	D22 Linear Networks 3:1	D23 Basics of Digital Systems 3:0	D24 Computers & Programming 3:0	D25 Material Science 3:0	D26 Ecology 2:0	D27 Digital Systems Lab. 0:1	D28 Programming Lab. 0:1	D29 Workshop 0:1
1st (25)	H11 Engineering Mathematics–1 4:0	H12 Physics 3:0	H13 Chemistry 3:0	H14 English 3:0	H15 Basics of M & CE 4:0	H16 Basics of EEE 4:0	H17 Physics Lab 0:1	H18 Chemistry Lab 0:1	H19 Engineering Graphics 0:2

REVISED CURRICULUM AND DETAILED SYLLABI

FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

SECOND SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2010-2011 ONWARDS

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Board of Studies meeting 03.01.2009 Approved in 37th Academic council meeting dt.24-01-2009

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Electronics and Communication) Program

SUBJECTS OF STUDY
(For the candidates admitted from 2008-2009 onwards)
SECOND SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week L	T	P	credits
THEORY						
D 21	Engineering Mathematics II	BS	4	-	-	4
D 22	Linear Networks	DC	3	1	-	4
D 23	Basics of Digital Systems	DC	3	-	-	3
D 24	Computers and Programming	ES	3	-	-	3
D 25	Materials Science	ES	3	-	-	3
D 26	Ecology	HSS	2	-	-	2
PRACTICAL						
D 27	Digital Systems Lab.	DC	-	-	2	1
D 28	Computer Programming Lab.	ES	-	-	2	1
D 29	Workshop	ES	-	-	2	1
	Total		**18**	**1**	**6**	**22**

BS : Basic Science
HSS : Humanities and Social Science
ES : Engineering Science
DC : Department core
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Electronics and Communication) Program

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2008-2009 onwards)

SECOND SEMESTER

S.No	Sub. code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	D21	Engineering Mathematics II	3	50	50	100	25	50
2	D22	Linear Networks	3	50	50	100	25	50
3	D23	Basics of Digital Systems	3	50	50	100	25	50
4	D24	Computers and Programming	3	50	50	100	25	50
5	D25	Materials Science	3	50	50	100	25	50
6	D26	Ecology	3	50	50	100	25	50
PRACTICAL								
7	D27	Digital Systems Lab.	3	50	50	100	25	50
8	D28	Computer Programming Lab.	3	50	50	100	25	50
9	D29	Workshop	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks

Sub Code	Lectures	Tutorial	Practical	Credit
D 21	4	0	-	4

D21 Engineering Mathematics II

(Common to all branches of Engineering B21, C21, D21, E21, G21, T21)

Program Outcomes addressed

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

b. An ability to identify, formulate and solve engineering problems

c. An ability to engage in life-long learning

Competencies: At the end of the course the students should be able to

1. Formulate and solve problems of engineering dynamics using different differential operators.
2. Formulate the problem of computing areas and volumes through vector integration, and determine them by applying Green, Stokes and Divergence theorems
3. Determine maxima and minima of functions of several variables using analytical and Lagrangian multipliers methods
4. Determine the values of multiple integrals directly or by changing the order of integration or by making transformation with Jacobians.
5. Determine areas and volumes of geometrical figures using multiple integrals, beta and gamma functions.
6. Analyze functions of complex variable in terms of continuity, differentiability and analyticity.
7. Apply Cauchy-Riemann equations and harmonic functions to problems of fluid mechanics, thermodynamics and electro-magnetic fields.
8. Find singularities of complex functions and determine the values of integrals using residues.
9. Geometrically interpret conformal and bilinear transformations

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End-semester examination
1	Remember	10	10	0
2	Understand	30	30	30
3	Apply	60	60	70
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Syllabus

Functions of Several Variables: Partial derivatives and Jacobians, Total differentiation and applications, Lagrangian Multiplier method, Applications to Maxima and Minima **Multiple Integrals:** Double integrals and areas, Triple integrals and volumes, Change of order of integration, Beta and Gamma functions with applications, Change of variables between Cartesian and polar with applications **Vector calculus:** Vector Differentiation with simple applications, Operators Grad, div and curl with properties, Applications to Physics, Vector Integration(three famous theorems), Applications to areas and volumes **Complex Differentiation:** Analytic functions, C-R equations and properties, Harmonic Functions and Milne-Thompson Method, Applications to flow problems, Conformal maps and bilinear transformations, Applications of the bilinear transformations **Complex Integration:** Cauchy's theorem and consequences, Evaluating integrals using Cauchy's integral formula, Taylor and Laurent expansions, Singularities, poles and Cauchy residue theorem, Contour integration using unit circle and semicircular contours

Text Book

B.S. Grewal: Higher Engineering Mathematics, 39th Edn., Khanna Publishers, New Delhi,2006

References

1. Lecture Notes by the faculty of Department of Mathematics, TCE, Madurai
2. Veerarajan T., Engineering Mathematics, 3rd Edn., Tata McGraw Hill, New Delhi, 2004
3. Venkataraman M.K., Multiple Integrals and Gamma, Beta functions, National Publishing Co., 2004
4. Kreyszig E., Advanced Engineering Mathematics, 8th Edn. John Wiley & Sons,2004
5. Thomas Phinny, Calculus,13th Edition Pearson Education, New Delhi,2005

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Functions of Several Variables**	
1.1	Partial derivatives and Jacobians	2
1.2	Total differentiation and applications	2
1.3	Lagrangian Multiplier method	2
1.4	Applications to Maxima and Minima	2
2.	**Multiple Integrals**	
2.1	Double integrals and areas	1
2.2	Triple integrals and volumes	1
2.3	Change of order of integration	2
2.4	Beta and Gamma functions with applications	2
2.5	Change of variables between Cartesian and polar with applications	2
3	**Vector calculus**	
3.1	Vector Differentiation with simple applications	1
3.2	Operators Grad, div and curl with properties	3
3.3	Applications to Physics	1
3.4	Vector Integration(three famous theorems)	4
3.5	Applications to areas and volumes	3
4	**Complex Differentiation:**	
4.1	Analytic functions, C-R equations and properties	3
4.2	Harmonic Functions and Milne-Thompson Method	2
4.3	Applications to flow problems	1
4.4	Conformal maps and bilinear transformations	2

No.	Topic	No. of Lectures
4.5	Applications of the bilinear transformations	2
5.	**Complex Integration**	
5.1	Cauchy's theorem and consequences	2
5.2	Evaluating integrals using Cauchy's integral formula	2
5.3	Taylor and Laurent expansions	2
5.4	Singularities, poles and Cauchy residue theorem	2
5.5	Contour integration using unit circle and semicircular contours	4

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
D 22	3	1	-	4

D22 Linear Networks

Preamble: A 'network' refers to any interconnected set of objects. An 'electrical network' is an interconnection of electrical elements such as resistors, inductors, capacitors, transformers, diodes, sources, controlled sources and switches. Linear electrical networks are those that are interconnections of linear electrical elements. Linear electric networks are mainly used for improving the signal-to-noise (S/N) ratio of signals and signal power. The S/N ratio was improved initially using linear networks comprising of ideal passive (loss less) capacitors and inductors between the non-ideal source and a predominantly resistive load. A variety of circuits based on capacitors and inductors, known as filters, were developed to reduce noise outside the pass band to the minimum possible value. Practical capacitors and inductors have losses and also their size increases with the power levels they are required to handle. Active components like controlled sources were introduced to reduce the size of the signal processing network and for adequate signal power delivery to the load. Active components enable separation of processing function from power amplification using DC power sources. The size, poor tolerance, non-linearities and high sensitivity to temperature variations being the dominant characteristics of passive elements in present day monolithic integrated circuits, the signal processing is done using mostly active components and symmetric circuit topologies. With no limitation on the number of active components used for signal processing the focus is shifting back to passive components, but with values a few orders of magnitude lower in comparison to passives used a few years ago. We turn to processing signals in digital form to avoid using passives. However, we need to be concerned with passives until we convert analog signals into digital form and digital signals to analog form, and when we need to send a digital signal at high speeds from one active device to another in a chip.

One of the main competencies that an electronic engineer has to acquire is to design passive and active linear networks that improve signal-to-noise ratio of signals, and deliver power at the required level to loads at different frequencies and in different contexts.

Program Outcomes addressed

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

d. An ability to identify, formulate and solve engineering problems

e. An ability to use techniques, skills, and modern engineering tools to implement and organize engineering works under given constraints

Competencies

1. Explain the nature of time domain and frequency domain behavior of ideal one-port and two-port networks
2. Determine the time-domain and frequency-domain behavior of networks in response to periodic and aperiodic signals at different frequencies
3. Synthesize high performance interconnection between two active circuits/systems /equipments, probes, coupled and resonant networks and filters
4. Analyze circuits using ideal passive elements and controlled sources
5. Synthesize signal conditioning and signal generating networks using controlled sources and passive network elements

Knowledge

- 1-port and 2-port network parameters
- Network theorems
- Frequency domain characterization of networks
- Time domain characterization of networks
- Resonance in networks
- Controlled Sources

Methods

- Differential equations
- Laplace transforms
- Matrix algebra

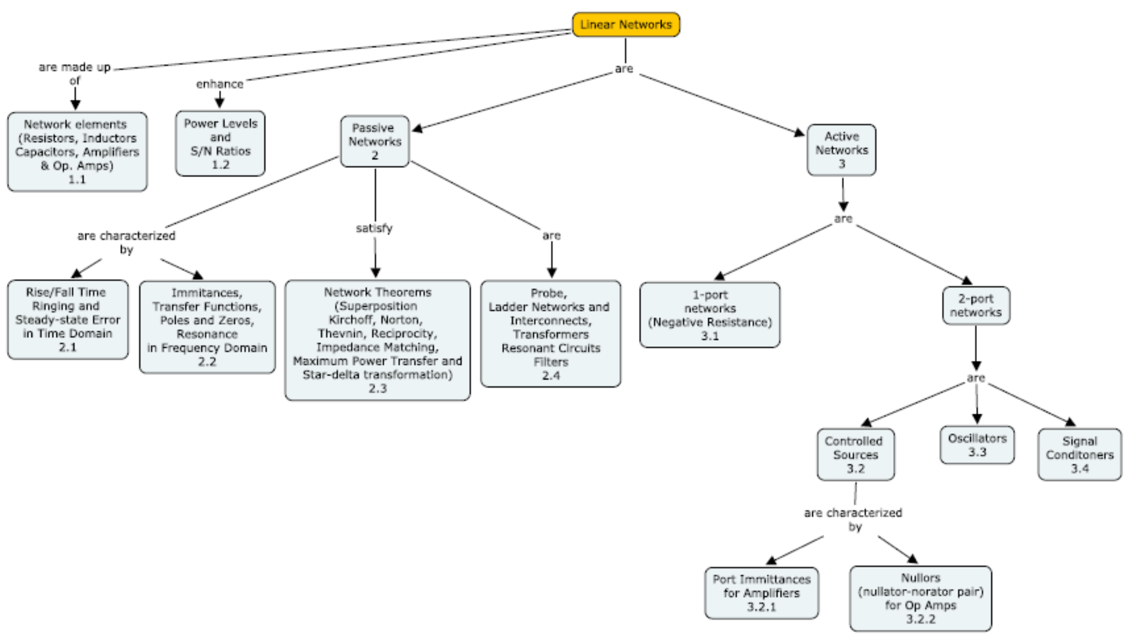
Tools

- Microcap

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	10	10	0
2	Understand	30	10	10
3	Apply	30	30	30
4	Analyze	20	20	20
5	Evaluate	10	10	10
6	Create	0	20	30

Concept Map



Syllabus

Linear Networks: Network elements (Ideal R, L, C and sources), source transformation, purpose of networks, Networks enhance power levels and signal-to-noise ratio **Passive Networks:** Time domain characterization of passive networks (Rise and fall times, ringing, Elmors delay and steady state error), Frequency domain characterization of passive networks (Poles and Zeros and Resonance), Network Theorems: Initial and Final Value, Superposition, Duality, Kirchoff's and Telegon's laws, Thevenin's and Norton's Theorems and Impedance Matching, Reciprocity Theorem, Maximum Power Transfer Theorem, Star-Delta Transformation; Examples of two-port passive networks: Probe, Ladder Networks and Interconnects, simulation of passive networks using network simulator, Transformers and Coupled Circuits, Resonant Circuits and Filters **Two-port Active Networks:** Negative Resistance, Controlled Sources: Network parameters, Port Immittances of Amplifiers, Nullors (Nullators—Norator Pairs) for Op Amps, Realization of controlled sources, Negative resistance, LC oscillators, Signal Conditioners: Realization of Adders, difference amplifiers, simulation of resistor and inductor, realization of integrator and differentiator, simulation of active networks using network simulator.

References

1. Decarlo R.A. and Pen-Min Lin: Linear Circuit Analysis, 2nd Edn., Oxford University Press, 2001
2. Mahmood Nahvi and Joseph Edminister: Electric Circuits 4th Ed, Schaum's Outlines, Tata McGraw-Hill, 2003
3. Lecture Notes

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Linear Networks**	
1.1	Network elements (Ideal R, L, C and sources), source transformation	1
1.2	Networks enhance power levels and signal-to-noise ratio	1
2	**Passive Networks**	
2.1	Time domain characterization of passive networks (Rise and fall times, ringing and steady state error) , Elmors delay	1
2.2	Frequency domain characterization of passive networks (Poles and Zeros and Resonance)	3
2.3	Network Theorems	
2.3.1	Initial and Final Value Theorem	1
2.3.2	Superposition and Duality	2
2.3.3	Kirchoff and Telegon Laws	2
2.3.4	Thevenin's and Norton's Theorems and	2

	Impedance Matching	
2.3.5	Reciprocity Theorem	2
2.3.6	Maximum Power Transfer Theorem	1
2.3.7	Star-Delta Transformation	2
2.4	Two-port Passive Networks	
2.4.1	Probe	1
2.4.2	Ladder Networks and Interconnects	2
2.4.3	Simulation of passive networks	2
2.4.4	Transformers and Coupled Circuits	1
2.4.5	Resonant Circuits	2
2.4.6	Filters	2
3.	Active Networks	
3.1	Negative Resistance	1
3.2	Controlled Sources	
3.2.1	Network parameters, Port Immittances of Amplifiers	2
3.2.2	Nullors (Nullators—Norator Pairs) for Op Amps	2
3.2.3	Realization of controlled sources	1
3.3	LC Oscillators	1
3.4	Signal Conditioners	
3.4.1	Realization of Adders, difference amplifiers,	1
3.4.2	Simulation of active networks	2
3.4.3	Simulation of resistor and inductor	1
3.4.4	Realization of integrators and differentiator	1

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 23	3	0	-	3

D23 Basics of Digital Systems

Preamble: The proposed course is offered in the second semester. It is concurrent with the course on Linear Networks which is treated as a prerequisite to other electronics courses. This course will be followed by the course Design with PLDs and FPGAs. In designing this course the following assumptions are made.

- The course aims at design of combinational and sequential functions at gate level and simulate and verify their functionality using the Hardware description Language (Verilog)
- No reference will be made to any technology or logic family.
- No hardware aspects (voltages, currents, noise margins, transients etc.) other than the delay time would be considered in designing logic functions.
- As SSIs and MSIs are not in use any more, no reference needs to be made to these ICs.
- This course will be followed by another course which will deal with technology and electrical behavior of modern logic devices, design of general digital system at RTL level, functional verification using test benches in Verilog, synthesizing into a circuit with desired functionality, mapping into a selected CPLD or FPGA, verifying the timing performance, and generating the final configuration file.

Program Outcomes addressed:

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

c. An ability to design a system or component, or process to meet stated specifications

e. An ability to use techniques, skills, and modern engineering tools to implement and organize engineering works under given constraints

Competencies:

1. Determine the functional behavior and timing performance of a given combinational circuit.

2. Determine the functional behavior and timing performance of a given sequential circuit using state diagrams, timing diagrams, and PS-NS-O tables.
3. Determine the behavior of a given digital circuit with regard to hazards, asynchronous inputs, and output races.
4. Design digital circuits to perform specified combinational and sequential functions.
5. Describe, simulate and test combinational and sequential logic, and finite state machines in Verilog through behavioral, data flow and structural models.

Methods:

- Truth-tables
- Minimization of logic expressions through algebraic and algorithmic methods
- Schematic diagrams for digital circuits
- Timing diagrams
- State diagrams
- Present-state next-state output tables
- Verilog description of digital circuits

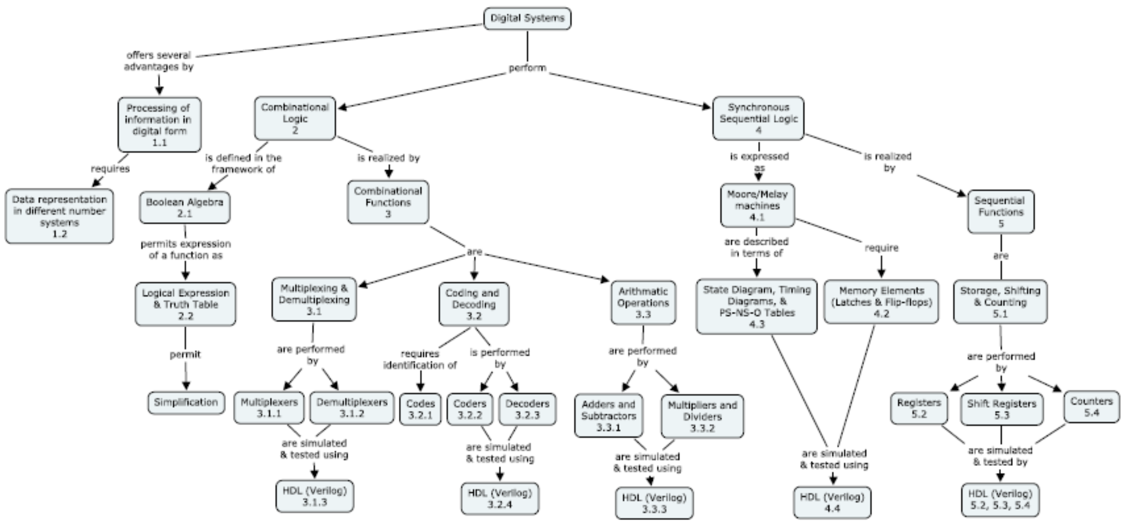
Tools

- Timing Tool
- Verilog Simulator

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/ End-semester examination
1	Remember	10	10	0
2	Understand	20	20	10
3	Apply	40	20	20
4	Analyze	30	20	20
5	Evaluate	0	10	10
6	Create	0	20	40

Concept Map



Syllabus

Digital systems process information digital form offering many advantages. **Combination Logic**: Boolean Algebra, Logic Expressions and Truth Tables, Logic Minimization. **Combinational Functions**: Multiplexing and Demultiplexing, Verilog description of Multiplexers and Demultiplexers; Encoding and Decoding: Codes and Verilog description of Encoders and Decoders; Arithmetic Operations: Adders and Subtractors, Multipliers and Dividers, and Verilog Description of Arithmetic Operators. **Synchronous Sequential Logic**: Moore and Melay Machines, Latches and Flip-Flops, State Diagrams, Timing Diagrams and PSNSO Tables, Verilog description of Synchronous Sequential Logic. **Sequential Functions**: Storing, Shifting and Counting.

Text Book:

Morris Mano: Digital Design, Third Edition, Prentice Hall, 2001

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Digital Information Processing**	
1.1	Advantages of processing information in digital form	1

No.	Topic	No. of Lectures
1.2	Number systems	1
2.	**Combinational Logic**	
2.1	Boolean Algebra	2
2.2	Logic Expressions and Truth Tables	2
2.3	Logic Minimization	2
3.	**Combinational Functions**	
3.1	**Multiplexing and Demultiplexing**	
3.1.1	Multiplexers	0.5
3.1.2	Demultiplexers	0.5
3.1.3	Introduction to Verilog and Verilog description of Multiplexers and Demultiplexers	3
3.2	**Encoding and Decoding**	
3.2.1	Codes	1
3.2.2	Encoders	1.5
3.2.3	Decoders	1.5
3.2.4	Verilog description of Encoders and Decoders	1
3.3	**Arithmetic Operations**	
3.3.1	Adders and Subtractors	2
3.3.2	Multipliers and Dividers	2
3.3.3	Verilog Description of Arithmetic Operators	2
4.	**Synchronous Sequential Logic**	
4.1	Moore and Melay Machines	1
4.2	Latches and Flip-Flops	2
4.3	State Diagrams, Timing Diagrams and PSNSO Tables	3

No.	Topic	No. of Lectures
4.4	Verilog description of Synchronous Sequential Logic	2
5.	**Sequential Function**	
5.1	Storing, Shifting and Counting	1
5.2	Registers and their Verilog description	2
5.3	Shift Registers and their Verilog description	3
5.4	Counters and their Verilog description	3

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 24	3	0	-	3

D24 Computers and Programming

(Common to all branches of Engineering B24, C24, D24, E24, G24, T24)

Program Outcomes addressed

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

c. An ability to design a system or component, or process to meet stated specifications

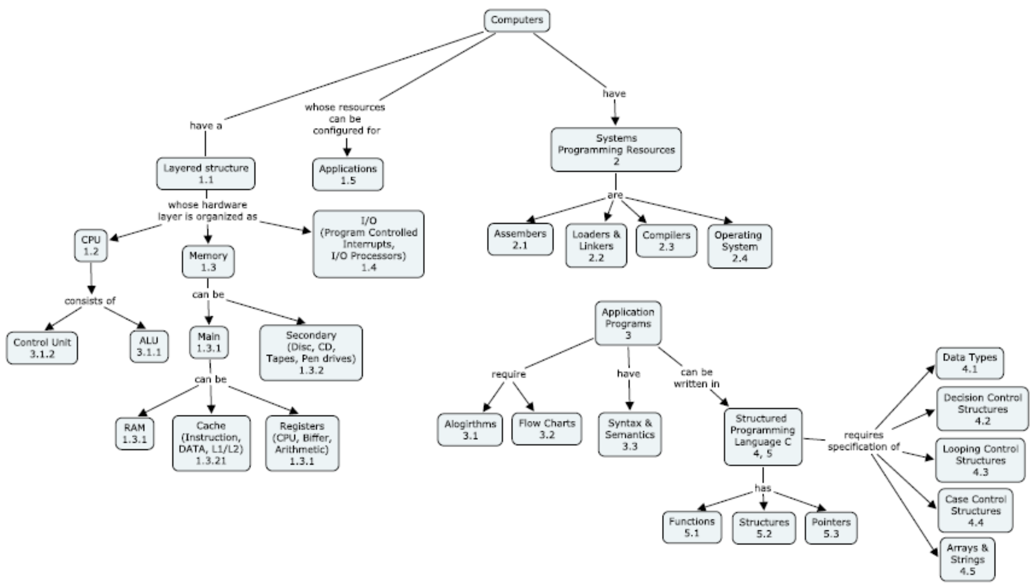
Competencies

1. Select computers for different applications.
2. Comprehend the nature of problems that a computer can solve extremely well - be able to list 5 non-trivial, interesting problems (unique in their own way) which are difficult to solve for a human being but can be solved easily by a computer.
3. Comprehend the following terms in the context of problem solving by a computer: Problem specification, input-output analysis, algorithm, flowchart, pseudo-program, programming language, assembly language, machine language, compiler, assembler, program correctness
4. Explain the difference between arrays and linked lists, and create two examples where arrays are better than linked lists and two examples where linked lists are better than arrays.
5. Explain the difference between iteration and recursion, and create two examples where iteration is better than recursion and two examples where recursion is better than iteration.
6. Design the flowchart and write efficient code for problems like
   - Recursive and iterative programs for binary search
   - Recursive and iterative programs for Fibonacci numbers
   - Recursive and iterative programs for finding the GCD of two numbers
   - Reverse a linked list while traversing it only once
7. Explain the role of pointers in implementing singly linked lists, doubly linked lists, binary trees, and general trees.
8. Explain the reason why different constructs are available for iteration, such as "for" loops, "do...while" loops.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End-semester examination
1	Remember	20	10	0
2	Understand	20	20	10
3	Apply	50	40	50
4	Analyze	10	20	20
5	Evaluate	0	10	20
6	Create	0	0	0

Concept Map:



Syllabus

Introduction to computers: Layered Structure of a computer, CPU, Memory, Input/Output, Configuring resources of computers for applications **Application Programming:** Algorithms, Flowcharts, Syntax, semantics and execution, **Structured Programming Language:** Symbols and data types, Looping control structures, Decision control structures, Case control structures, Arrays and Strings, **Functions and Pointers:** Functions, Structures, and Pointers **Systems Programming :** Assemblers, Loaders and Linkers, Compilers, Operating Systems

References

1. Leland L. Beck: System Software, Pearson Education, 3rd Edition, 2004
2. John. J Donovan: System Programming, Tata McGraw Hill Edition, 2000
3. Yashavant Kanetkar: Programming in ANSI C, 2nd Edition-BPB Publications
4. Yashavant Kanetkar: Let us C, BPB Publications 8th Edition 2007
5. Yeshavant Kanetkar: Understanding Pointers in C, 2nd Edition BPB Publications
6. Peter Norton : Introduction to computers 6th Edition.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction to computers**	
1.1	Layered Structure of a computer	1
1.2	CPU, Memory	1
1.3	Input/Output	2
1.4	Configuring resources of computers for applications	1
2	**Applications Programming**	
2.1	Algorithms	1
2.2	Flowcharts	1
2.3	Syntax, semantics and execution	1
3.	**Structured Programming Language**	
3.1	Symbols and data types	1
3.2	Looping control structures	3
3.3	Decision control structures	3
3.4	Case control structures	2
3.5	Arrays and Strings	3
4.	**Functions and Pointers**	

No.	Topic	No. of Lectures
4.1	Functions	3
4.2	Structures	3
4.3	Pointers	4
5	**Systems Programming**	
5.1	Assemblers	2
5.2	Loaders and Linkers	4
5.3	Compilers	2
5.4	Operating Systems	2

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
D 25	3	0	-	3

D25 Materials Science

Program Outcomes addressed

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

Competencies:

1. Explain the physics of thermal expansion, electrical conductivity, ferromagnetic behavior, mechanical hardness, fatigue, creep, and wear at bulk and nano particle level.
2. Explain the chemistry of corrosion and its impact on materials.
3. Choose appropriate material for windings of motors and transformers, wiring harnesses for electrical and electronic equipment, signal interconnects on wiring boards, and on-board and off-board connectors.
4. Choose a conductive coating material for a given specified performance requirement in printed wiring boards and EMI shielding.
5. Identify appropriate laminate for making a printed wiring board for given performance requirement and specified technology.
6. Select with justification suitable magnetic materials for transformers, motors, linear motors, pulse transformers, electromagnets, relays, magnetostrictive sensors and actuators, and smart antennae.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	20	20
2	Understand	30	30	30
3	Apply	30	30	30
4	Analyze	0	0	0
5	Evaluate	20	20	20
6	Create	0	0	0

Syllabus

Engineering Properties of Materials: Thermal Properties: Expansion, Heat Capacity and Conductivity, Electrical Properties: Conductivity, Dielectric Constant, Dielectric Losses, Dielectric Breakdown, and Insulation; Magnetic Properties: Permittivity, Permeability, Hysteresis, Susceptibility, Magnetic Intensity, Magnetic Saturation and Anisotropy; Mechanical Properties of Bulk Materials: Hardness, Tensile Strength, Fatigue, Creep, Wear, Mechanical Properties of Nano-particles; Corrosion **Conducting Materials:** Windings of motors and transformers, Wiring harnesses for electrical and electronic equipment, Signal interconnects on wiring boards, On-board and off-board connectors, Conductive coatings, semi-conducting materials **Semiconducting Materials:** Free carrier concentration, junction properties, FET, single electron transistor, quantum dots, quantum computations **Smart Materials:** NiTi, Ferromagnetic Shape Memory Alloys, Materials for making Transformers, motors, Electromagnets and relays, Terfenol-D, Magnetostrictive sensors and actuators, Smart antennae

References:

1. Van Vlack L.H.: Elements of Materials Science and Engineering, 6th Edition, Addison-Wesley, 1989
2. Callister W. D.: Materials Science and Engineering, John Wiley &Sons, 2007
3. O'Handley R.C.: Modern Magnetic Materials, John Wiley & Sons, 2000

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Engineering Properties of Materials**	
1.1	Thermal Properties: Expansion, Heat Capacity and Conductivity	3
1.2	Electrical Properties: Conductivity, Dielectric Constant, Dielectric Losses, Dielectric Breakdown, and Insulation	3
1.3	Magnetic Properties: Permittivity, Permeability, Hysteresis, Susceptibility, Magnetic Intensity, Magnetic Saturation and Anisotropy	3
1.4	Mechanical Properties of Bulk Materials: Hardness, Tensile Strength, Fatigue, Creep, Wear	3

No.	Topic	No. of Lectures
1.5	Mechanical Properties of Nano-particles	3
1.6	Corrosion	1
2	**Conducting Materials**	
2.1	Windings of motors and transformers	1
2.2	Wiring for electrical and electronic equipment	2
2.3	Signal interconnects on wiring boards	2
2.4	On-board and off-board connectors	2
2.5	Conductive coatings	1
3.	**Semiconducting Materials**	
3.1	Free carrier concentration	1
3.2	Junction properties	2
3.3	FET, Single Electron Transistor	2
3.4	Quantum Dots, Quantum Computations	2
4.	**Smart Materials**	
4.1	NiTi, Ferromagnetic Shape Memory Alloys	2
4.2	Materials for making transformers, motors	1
4.3	Electromagnets and relays	2
4.4	Terfenol-D, Magnetostrictive sensors and actuators	2
4.5	Smart antennae	2

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
D 26	2	0	-	2

D26 Ecology

(Common to all branches of Engineering B46, C26, D26, E26, G36, T26)

Preamble: Progress, as majority perceives it, implies increasing energy flow through the society. With exponentially increasing population and per capita consumption, single most concern of all people across the world ought to be the threat to the sustainability of life we know of. World Commission on Environment and Development issued a report in 1987 entitled “Our Common Future” which concluded that then existing trends of economic development and the accompanying environmental degradation were unsustainable. It clearly emphasized that the health of global environment is essential for the future of every one. Therefore, engineers, who through their technological activities greatly influence the health of global environment, need to be sensitive about what keeps the ecosystem sustainable for humans. This course aims to achieve this sensitization.

Programme outcomes addressed

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

d. An ability to identify, formulate and solve engineering problems

h. An ability to engage in life-long learning

i. An ability to consider social, environmental, economic and ethical impact of engineering activities in a given context.

j. An ability to consider issues from global and multilateral views.

Competencies: At the end of the course the student should be able to

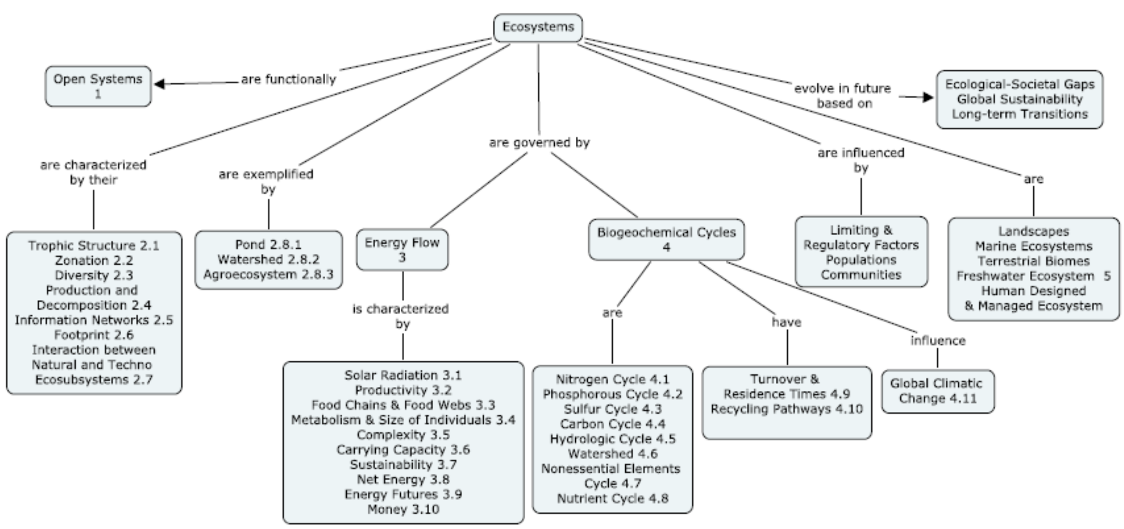
1. Explain why an ecosystem is an open system
2. Explain how an ecosystem is characterized by trophic structure, zonation, diversity, production and decomposition, information networks, footprint, interaction between natural and techno ecosubsystems.
3. Analyze specific ecosystems like a pond, watershed and agroecosystem.
4. Trace the energy flows through an ecosystem by way of solar radiation, productivity, food chains and food webs, metabolism and size of individuals, carrying capacity, complexity, sustainability, net energy, energy futures and money.

5. Trace how an ecosystem is governed by different biogeochemical cycles, including nitrogen, phosphorous, sulfur, carbon, hydrologic, non-essential elements and nutrient cycles, and watershed.
6. Analyze the biogeochemical cycles in terms of turnover and residence times and recycling pathways.
7. Explain how global climatic changes occur.
8. Analyze the fresh water ecosystem

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End-semester examination
1	Remember	30	20	10
2	Understand	50	40	40
3	Apply	10	20	20
4	Analyze	10	10	20
5	Evaluate	0	10	10
6	Create	0	0	0

Concept Map



Syllabus

Ecosystem as an Open System; Characterization of Ecosystems: Trophic structure, Zonation, Diversity, Production and Decomposition, Information Networks, Ecological Footprint, Interaction between Natural and Techno Eco-subsystems, Examples of Ecosystems: Pond, Watershed, Agro-ecosystem **Energy Flow in Ecosystem:** Solar Radiation, Productivity, Food Chains and Food Webs, Metabolism and Size of Individuals, Carrying Capacity, Complexity, Sustainability, Net energy, Energy Futures, Money **Biogeochemical Cycles:** Nitrogen Cycle, Phosphorous Cycle, Sulfur Cycle, Carbon Cycle, Hydrologic Cycle, Non-essential Elements Cycle, Nutrient Cycle, Watershed, Turnover and Residence Times, Recycling Pathways, Global Climatic Change **Fresh Water Ecosystem**

Text Book

1. Odum E.P. and Barret G. W.: Fundamentals of Ecology, 2005, Thomson Brooks/Cole

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Ecosystem as an Open System**	1
2	**Characterization of Ecosystems**	
2.1	Trophic structure and Zonation	1
2.2	Diversity and Ecological Footprint	1
2.3	Production and Decomposition	1
2.4	Information Networks	1
2.5	Interaction between Natural and Techno Ecosubsystems	1
2.6	Examples of Ecosystems	
2.6.1	Pond / Watershed / Agroecosystem	2
3	**Energy Flow in Ecosystem**	
3.1	Solar radiation , Productivity	1
3.2	Food Chains and Food Webs	1
3.3	Metabolism and Size of Individuals	1
3.4	Carrying Capacity and Complexity	1
3.5	Sustainability	1
3.6	Net Energy, Energy Future and Money	2
4.	**Biogeochemical Cycles**	

No.	Topic	No. of Lectures
4.1	Nitrogen Cycle	1
4.2	Phosphorous Cycle	1
4.3	Sulfur Cycle	1
4.4	Carbon Cycle	1
4.5	Hydrologic Cycle	1
4.6	Non-essential Elements Cycle and Nutrient Cycle	1
4.7	Watershed	1
4.8	Turnover, Residence Times and Recycling Pathways	1
4.9	Global Climatic Change	1
5.	**Fresh Water Ecosystem**	**2**

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 27	-	-	2	1

D27 Digital Systems Lab

The experiments proposed to be done in this course are directly related to the course D26: Basics of Digital Systems. All the experiments require creating a design to meet the specified functional requirements, generation of Verilog code using structural modeling, simulating the design using Xilinx Foundation Tools, generating test vectors, and verifying the design for functional correctness. The students are required to solve a minimum of three problems from the problem set given for each experiment.

List of Experiments

1. Multiplexers
2. Demultiplexers
3. Encoders
4. Decoders
5. Simulating hazards
6. Adders/Subtractors
7. Arithmetic Logic Unit
8. Multipliers
9. Dividers
10. Registers
11. Shifters
12. Counters
13. Pattern recognizers
14. PRBS generators

Sub Code	Lectures	Tutorial	Practical	Credit
D 28	-	-	2	1

D28 Computer Programming Lab

(Common to all branches of Engineering B28, C28, D28, E28, G28, T28)

Any twelve experiments to be performed

List of Experiments

1. Simple Programs
    a. Fibonacci Series
    b. Sum of set of numbers
    c. Generation of prime numbers
2. Matrix Addition, Subtraction and Multiplication
3. Sorting of Names & Numbers
4. String Manipulation
5. Bitwise Operation
6. Macro Expansion with Conditional Compilation
7. Array of Structures
8. Pointers to functions
9. Pointers to Pointers
10. File Manipulations
    a. Read the file and display the contents of the file
    b. Read the lines from the keyboard and write it into a specified file
12. Store and retrieve the structure elements in a specific file
13. Program to Illustrate int 86() function
14. Program for creating files with read and write permissions

Sub Code	Lectures	Tutorial	Practical	Credit
D 29	-	-	2	1

D29 Work Shop

(Common to all branches of Engineering B29, C29, D29, E29, G29, T29)

Objective: The students of all branches of engineering would get exposure to basic practices in a mechanical workshop. The students get trained to acquire skills at basic level in fitting, carpentry, joining, metal forming and plumbing.

List of Exercises

I Fitting

1. Fitting tools and practice
2. Joining of two different metals with adhesives
3. Preparation of single step joint
4. Preparation of 'V' joint
5. Preparation of Gauge joint
6. Preparation of Taper sep joint

II Carpentry

1. Carpentry tools and practice
2. Joining different types of wood with adhesives
3. Preparation of Half joint
4. Preparation of Dovetail joint
5. Preparation of T-brittle joint
6. Turning on wood lathe

III Demonstration on Tools and Practice

1. Welding
2. Soldering
3. Brazing
4. Foundry and Moulding practice
5. Smithy forging
6. Plumbing
7. House wiring
8. Press work

Terminal Examination: Students are tested in fitting and carpentry trades

BOARD OF STUDIES MEETING

B.E Degree (Electronics and Communication) Program

Third Semester

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2000 certified
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FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

THIRD SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2010-2011 ONWARDS

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Electronics and Communication) Program

SUBJECTS OF STUDY

(For the candidates admitted from 2008-2009 onwards)

THIRD SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week L	T	P	credits
THEORY						
D 31	Engineering Mathematics III	BS	4	-	-	4
D 32	Analog circuits and systems	DC	4	-	-	4
D 33	Signal Processing	DC	3	1	-	4
D 34	Analog Communication system	DC	3	-	-	3
D 35	Data Structures	ES	3	-	-	3
D 36	Microprocessors	DC	2	1	-	3
PRACTICAL						
D 37	Analog Circuits and Systems Lab.	DC	-	-	3	1
D 38	Analog Communication Lab	DC	-	-	3	1
	Total		**19**	**2**	**6**	**23**

BS : Basic Science
HSS : Humanities and Social Science
ES : Engineering Science
DC : Department core
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Electronics and Communication) Program

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2008-2009 onwards)

THIRD SEMESTER

S.No	Sub. code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	D 31	Engineering Mathematics III	3	50	50	100	25	50
2	D 32	Analog circuits and systems	3	50	50	100	25	50
3	D 33	Signal Processing	3	50	50	100	25	50
4	D 34	Analog Communication system	3	50	50	100	25	50
5	D 35	Data Structures	3	50	50	100	25	50
6	D 36	Microprocessors	3	50	50	100	25	50
PRACTICAL								
7	D 37	Analog Circuits and Systems Lab	3	50	50	100	25	50
8	D 38	Analog Communication Lab	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks

Sub Code	Lectures	Tutorial	Practical	Credit
D 31	4	0	-	4

D31 Engineering Mathematics III 4:0

(Common to all branches of Engineering, B31,C31,D31,E31,G31,T31)

Preamble:

An engineering student needs to have some basic mathematical tools and techniques. This emphasizes the development of rigorous logical thinking and analytical skills of the student and appraises him the complete procedure for solving different kinds of problems that occur in engineering. Based on this the course aims at giving the adequate exposure in the theory and applications of Fourier series, Fourier Transforms, PDE's and BVP

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
j. Graduate will develop confidence for self education and ability for life-long learning.

Competencies

1. Express the periodic functions arising in the study of engineering problems as Fourier series of Sines and Cosines.
2. Find the Fourier series for the typical waveforms.
3. Find the Fourier series for discrete data using Harmonic Analysis.
4. To study some of the well-known integral transforms (like Fourier, Fourier Sine and Cosine) and properties.
5. Formulate simple Engineering problems as Partial Differential Equations and state the boundary conditions.
6. Solve Partial Differential Equations, linear, nonlinear, homogeneous and non-homogeneous, by various methods.
7. Solve the standard Partial Differential Equations arising in engineering problems like Wave equation, Heat flow equation (one dimensional and two dimensional, Cartesian and polar coordinates) by Fourier series.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End semester examination
1	Remember	10	10	0
2	Understand	30	30	30
3	Apply	60	60	70
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course level Learning Objectives

Remember

1. Define Periodic function?
2. Show that f(x)= x^3 is an odd function?
3. State the Fourier Series for the function f(x) in the interval (1, 3)?
4. Identify the Kernel for Fourier Cosine and Sine Transforms?
5. State Parsevals Identity?
6. State Convolution Theorem?

Understand

1. Distinguish between Odd and Even functions?
2. Use the Fourier series expansion of $x^2 = \frac{\pi^2}{3} + 4\sum_1^\infty (-1)^n \frac{\cos nx}{n^2}$, $-\pi < x < \pi$

to predict the value of $\sum \frac{1}{n^2}$?

3. Discuss harmonic analysis?
4. Discuss Fourier Series in Complex form?
5. Interpret the result $F[f(ax)] = \frac{1}{a}F\left(\frac{s}{a}\right)$.
6. Interpret the usage of Parsevals theorem?
7. Discuss the two methods of forming partial differential equations.
8. Discuss the solution of $\frac{\partial^2 z}{\partial x \partial y} = x^2 y$ by direct integration?
9. Discuss the working rule of solving the Lagrange's linear equation?
10. Discuss the working rule of solving f(p,q)=0?
11. cuss the working rule of solving f(z,p,q)=0?

Apply

1. Find the Fourier transform of $e^{-a^2x^2}$. Hence prove that $e^{-\frac{x^2}{2}}$ is self reciprocal with respect to Fourier transforms and (i) Find the Fourier Cosine transform of e^{-x^2}?
2. Solve the equation $z^2(p^2 + q^2 + 1) = c^2$ where c is a constant?
3. Obtain the first three harmonics in the Fourier series expansion in (0,12) for the function y=f(x) defined by the table given below:

X:	0	1	2	3	4	5	6	7	8	9	10	11
Y:	1.8	1.1	0.3	0.1	0.5	1.5	2.16	1.88	1.25	1.30	1.76	2

4. Find the Fourier transform of f(x), if $f(x) = \{1 - |x|, for|x| < 1 and 0, for|x| > 1\}$.

Syllabus

Fourier Series: Dirichlet's conditions, General Fourier Series, Half range Sine and Cosine series, Parseval's Identity, Harmonic Analysis, Complex form of Fourier Series. **Fourier Transformation:** Fourier Integral Theorem, Fourier Transform, Fourier Sine and Cosine Transforms, Convolution Theorem, properties, Parseval's Identity, Discrete Fourier Transform, Discrete Time Fourier Transform, Demonstration of Fourier transforms and its properties using MATLAB (Tutorial).**Partial Differential Equations**: Formation, Solution of standard types of first order equations, Lagrange's linear equation, Linear partial differential equations of second and higher order with constant coefficient. **Boundary Value Problem**: Classification of Second Order linear partial differential equations, One-dimensional Wave equation, One dimensional heat equation, Solution by Fourier Series, Steady State Solution of two dimensional heat equation in Cartesian Co-ordinates, Laplace equation in Polar Co-ordinates, Solution by Fourier Series method.

Text Book

B.S. Grewal: Higher Engineering Mathematics, 39th Edn. , Khanna Publishers, New Delhi, 2007.

References

1. Lecture Notes by the faculty of Department of Mathematics, TCE ,Madurai.
2. Veerarajan .T: Engineering Mathematics, 3rd Edition. , Tata McGraw Hill, NewDelhi, 2004
3. Kreyszig,E., "Advanced Engineering Mathematics", John wiley and sons,(Asia)Pte Ltd., Singapore.2006.

Course contents and Lecture Schedule

No.	Topic	No. Of Lectures
1.	**Fourier Series**	
1.1	Dirichlet's conditions, General Fourier Series	3
1.2	Half range Sine and Cosine series	3
1.3	ParseVal's Identity	1
1.4	Harmonic Analysis	2
1.5	Complex form of Fourier Series	2
2.	**Fourier Transformation**	

2.1	Fourier Integral Theorem, Fourier Transform	2
2.2	Fourier Sine and Cosine Transforms	2
2.3	Convolution Theorem	1
2.4	Properties, Parseval's Identity	2
2.5	Discrete Fourier Transform, Discrete time Fourier Transform	2
3	**Partial Differential Equations**	
3.1	Formation	2
3.2	Solution of standard types of first order equations	3
3.3	Lagrange's linear equation	2
3.4	Linear partial differential equations of second and higher order with constant coefficient	3
4	**Boundary Value Problems**	
4.1	Classification of Second Order linear partial differential equations	1
4.2	One-dimensional Wave equation, Solution by Fourier Series	4
4.3	One dimensional heat equation, Solution by Fourier Series	4
4.4	Steady State Solution of two dimensional heat equation in Cartesian Co-ordinates, Solution by Fourier Series	4
4.5	Laplace equation in Polar Co-ordinates, Solution by Fourier Series	4

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 32	4	0	-	4

D32 Analog Circuits and Systems 4:0

Preamble: Signals contain information about a variety of things and activities in our physical world. An observer, be it a human or a machine, invariably needs to condition and process the signals in some predetermined manner to extract the required information. This signal conditioning/processing is usually most conveniently performed by electronic systems. For this to be possible, however, the signal must first be converted into an electrical signal, that is, a voltage or current. This process is accomplished by devices known as transducers, which can be considered as non-ideal voltage or current sources. The signals from the transducers have to be conditioned and processed as per the requirements of the application. These could involve amplification, filtering, modulation demodulation, mixing, frequency synthesizing etc. Complex analog computations can be performed on the signals if analog integrators and adders are available. Many of these processes would require availability signal sources like LC and crystal oscillators as signal carriers and clock generators. In many applications the power level of the processed signal has to be increased significantly using a power amplifier to operate an actuator. While the circuits that performed these functions were designed until a few years ago using discrete active and passive components, they are now increasingly made available in integrated circuit form. However, a small percentage of these circuits have to be still designed using discrete components. Therefore, an electronic designer should acquire the competency of designing the discrete as well as integrated version of these signal conditioning and processing circuits. Initially these circuits were realized vacuum tubes, and since 1960s with bipolar transistors, and now with the mastering of CMOS technology all circuits both discrete and integrated versions are at present mainly designed using MOSFETS.

This course 'D32: Analog Circuits and Systems' is preceded by a two credit course 'Basics of Electrical and Electronic Engineering' offered in the first semester which presents an over view of the entire field of electronic engineering, and D23: Linear Networks. This course is followed by courses 'Mixed Signal Circuits and Systems' and 'Power Electronics'. This course, therefore, is mainly concerned with discrete analog amplifiers and signal generators, and signal conditioning and processing of signals using operational amplifiers. In view of the present day technologies the discrete circuits addressed are MOSFET based.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

1. Design signal conditioning and processing circuits including differential, current and coscode amplifiers, filters, and multipliers/multiplexers – modulators, demodulators, phase detectors, and frequency synthesizers using discrete MOSFETs and operational amplifiers

2. Design signal sources for signal conditioning circuits and testing including LC and crystal oscillators, VCOs, and clock generators

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End semester Examination
1	Remember	20	20	0
2	Understand	20	20	20
3	Apply	40	40	40
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	20	20	40

Course Level Learning Objectives:

Remember

1. Write the expression of current in a diode?
2. What is meant by cut-in voltage or barrier potential in a diode?
3. How temperature affects the reverse saturation current and forward voltage across a diode?
4. What is the expression for I_C in terms of I_B and I_{CBO} in a BJT?
5. Write the relation between α and β in a BJT?
6. Show the three different regions in which a BJT can operate?

7. How do you compute the power dissipated in BJT in CE configuration?
8. Draw the low frequency hybrid model of BJT in CE configuration and define the various hybrid parameters in it?
9. What is meant by pinch off voltage in MOSFET?
10. What are the advantages of MOSFET over BJT?
11. When is induced channel formed in an enhancement MOSFET?
12. Write the expression for I_D in terms of V_{GS} in an enhancement MOSFET?
13. Name the three different regions of operation in a MOSFET and show them?
14. What are the different MOSFET parameters and write the relation between them?
15. Draw the small signal model of MOSFET?
16. Write the characteristics of an ideal op-amp?
17. Write the expression for gain in an inverting and non-inverting amplifier?
18. What is a precision rectifier?
19. What are the characteristics of an Instrumentation amplifier?
20. Define CMRR and slew rate in an op-amp?
21. Define input offset voltage and input offset current in an op-amp.
22. State the Barkaushen criteria for production of sustained oscillation in an oscillator?
23. What is meant by active filter? Mention its advantages over passive filter?
24. Write the main components in PLL?
25. Mention few applications of PLL?
26. List some applications of multiplier?

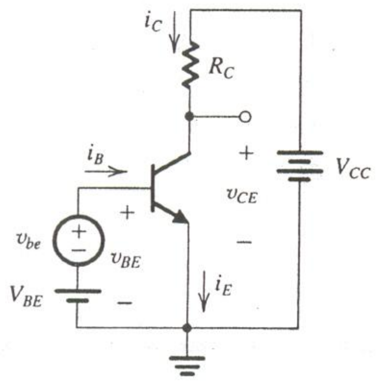
Understand

1. How a MOSFET can be used as voltage controlled resistor?
2. Why is biasing needed for a transistor?
3. Why is the base current very low in a BJT?
4. Why is FET called voltage controlled device?
5. What is the difference between static and dynamic resistance of a diode?
6. What is the value of volt equivalent of temperature at 250 K and 350 K?
7. In a negative feedback amplifier using op-amp, if the voltage at the non-inverting terminal is 2 V, find the voltage at the inverting terminal?
8. Why CMRR must be very high in op-amp used in noisy environment?
9. How does the frequency of the input signal affect the performance of integrator and differentiator?
10. Why is crystal oscillator mostly preferred?
11. Why an op-amp in open loop is not used for most of the applications?
12. Why VCO is called voltage to frequency converter?

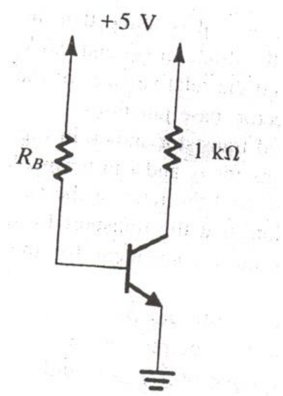
13. Compare the frequency response characteristics of Chebyshev and Butterworth filters?
14. How does the slew rate affect the behavior of op-amp in high frequency circuits?

Apply

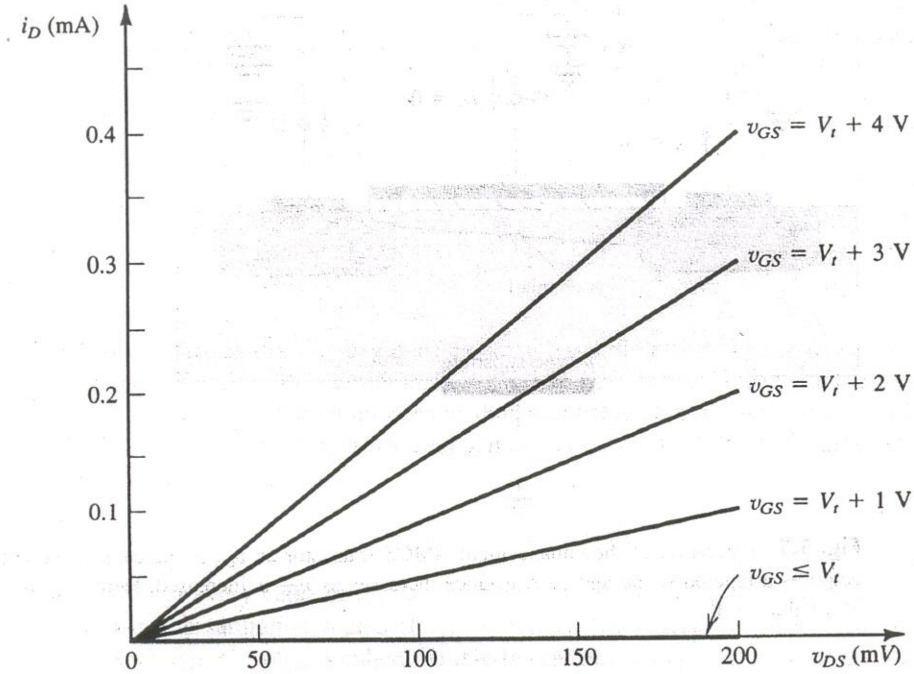
1. Measurement of an *npn* BJT in a particular circuit shows the base current to be 14.46 μA, the emitter current to be 1.460 mA, and the base-emitter voltage to be 0.7V. Calculate α, β and I_s for these conditions?
2. In the circuit shown in the figure V_{BE} is adjusted to yield a dc collector current of 1 mA. Let V_{CC} = 15 V, R_C = 10 kΩ, and β = 100. Find the voltage gain V_c/B_{be}? If V_{be} = 0.005 sin ωt volts, find v_C (t) and i_B (t)?



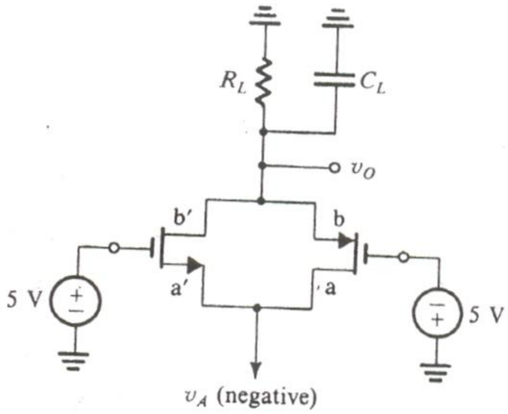
3. For the circuit shown in the figure (in Fig. P4.97) select a value for R_B so that the transistor saturates with an overdrive factor of 10. The BJT is specified to have a minimum β of 30 and V_{CEsat} = 0.2 V. What is the value of forced β achieved?



4. Find the constant of proportionality for the device whose characteristics are shown below. Also give the range of drain-source resistance corresponding to Vgs = 2 V to 5 V. Also find the largest value that R_D can have while the MOSFET remains in saturation.

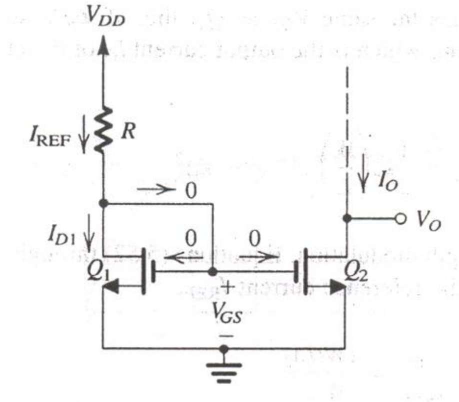


5. Consider the CMOS transmission gate and its equivalent circuit shown in the figure (Fig. 5.65(b)) let the two devices have $| V_t | = 2$ V and $k' (W/L) = 100$ $\mu A/V^2$, and let $R_L = 50$ kΩ. For (a) $V_A = -5$ V, (b) $V_A = -2$ V, and (c) $V_A = 0$ V, calculate V_O and the total resistance of the switch?

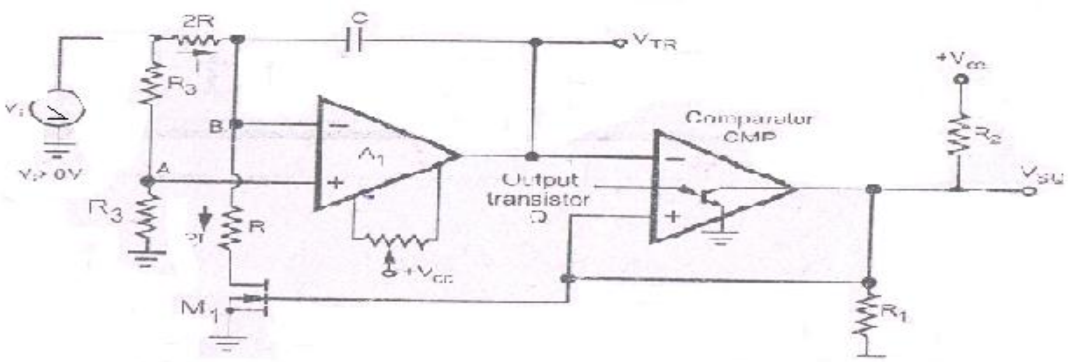


6. Consider an *n*-channel MOSFET with $t_{ox} = 20$ nm, $V_t = 0.8$ V, and $W/L = 10$. Find the drain current in the following cases:
   a. $v_{GS} = 5$ V and $v_{DS} = 1$ V.
   b. $v_{GS} = 2$ V and $v_{DS} = 1.2$ V.
   c. $v_{GS} = 5$ V and $v_{DS} = 0.2$ V.
   d. $v_{GS} = v_{DS} = 5$ V.
7. Given $V_{DD} = 5$ V and using $I_{REF} = 100$ µA, it is required to design the circuit of Fig. 5.40 to obtain an output current whose nominal value is 100 µA. Find R if Q_1 and Q_2 are matched, have channel lengths of 10 µm and channel widths of 100 µm, $V_t = 1$ V and $k'_n = 20$ $\mu A/V^2$? What is the lowest possible value of

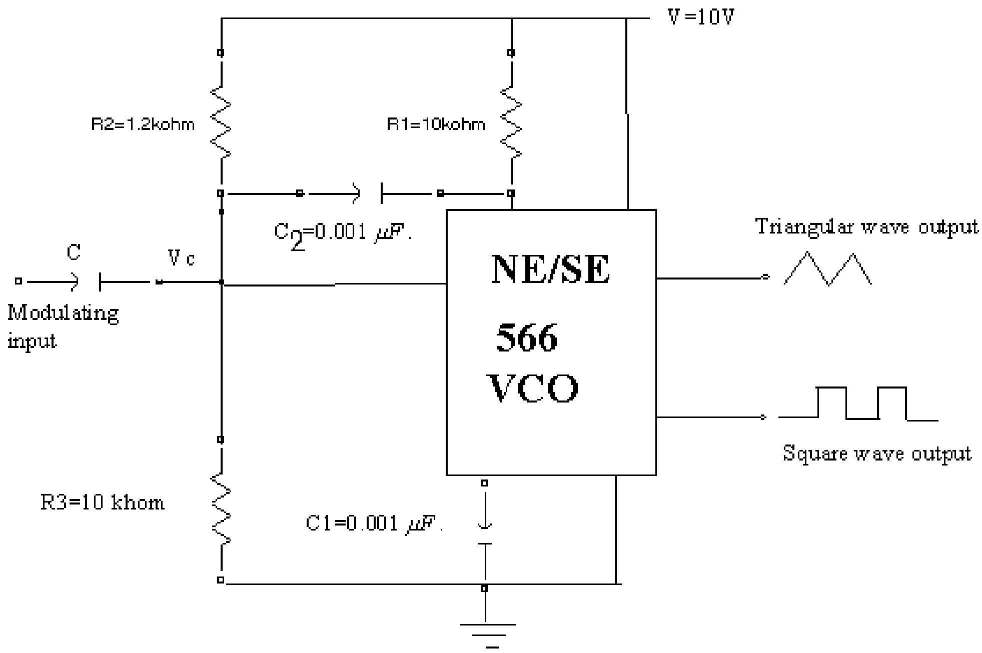
V_O? Assuming that the fabrication technology results in an Early voltage that can be expressed as V_A = 10 L, where L is in microns and V_A in volts, find the output resistance of the current source. Also find the change in output current resulting from a 3-V change in V_O?



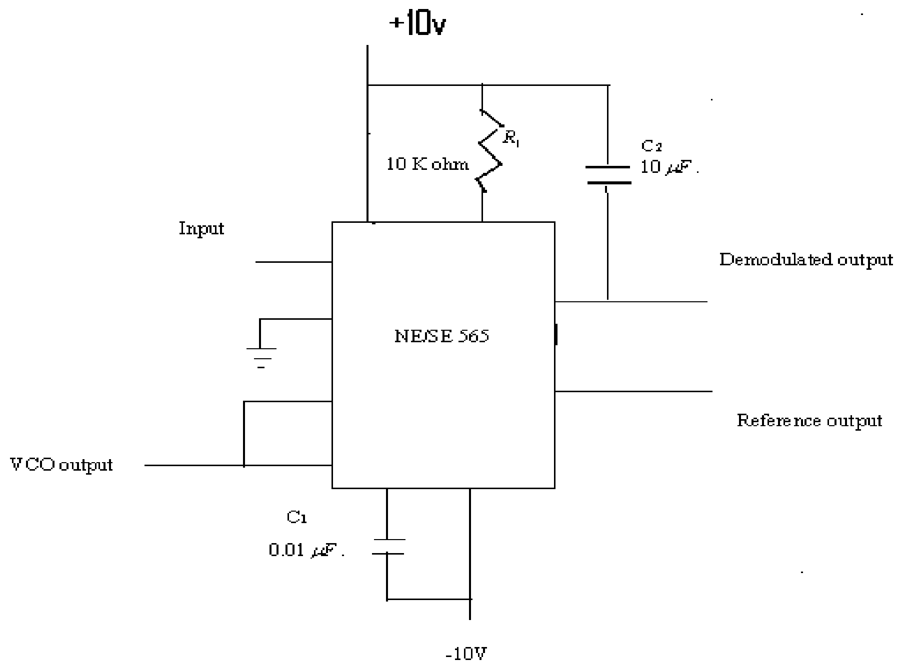
8. A MOS differential amplifier utilizes a bias current I = 25 μA. The devices have V_t = 1 V, W = 120 μm, L = 6μm, and ($\mu_n C_{ox}$) for this technology is 20 μA/V^2. Find V_{GS}, g_m, and the value v_{id} for full current switching?
9. A 2-MHz quartz crystal is specified to have L = 0.52 H, C_s = 0.012 pF, C_p = 4 pF, and r = 120 Ω. Find f_s, f_p, and Q?
10. In the VCO circuit shown in the figure, the various parameters are R=10 k ohm, C=1.25 nF, $V_{UT} = 10V$ and $V_{LT} = 0V$. If the input is changed from 10 mV to 10 V calculate the range over which the output frequency can be varied?



11. For a 566 VCO shown in the figure V=10V, R2=1.2 kohm and R1=R3=100 kilo ohm with C1=0.001 μF .
    e. Calculate the frequency of output?
    f. Calculate the variation in fo if Vc is varied between7.7 V and 9.5 V?
    g. Draw the square wave output if the modulating input is sine wave?



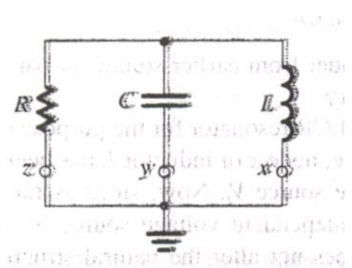
12. Find R_1 and R_f in the lossy integrator so that the peak gain is 20 dB and the r is 3 dB down from its peak when ω = 10000 rad/sec? Use $C_f = 0.01\mu F$?
13. For the non-inverting operational amplifier with input resistance 100 k ohm and feedback resistance 900 k ohm. Find the effect on output voltage due to common mode voltage when input voltage changes by 1V? Assume CMRR as 70 dB?
14. If the magnitude of pass band transmission is to remain constant to within ± 5%, and if the stop band transmission is to be no greater than 1% of the pass band transmission, find A_{max} and $A_{min.}$?
15. Give the transfer function of a second-order band pass filter with center frequency of 10^5 rad/s, a center-frequency gain of 10, and a 3-dB bandwidth of 10^3 rad/s?
16. For the circuit shown in the figure calculate free running frequency, lock range and capture range?



17. A PLL has the free running frequency of 500 kHz and bandwidth of the low pass filter is 10 kHz. Will the loop acquire lock for an input signal of 600 kHz? Justify your answer. Assume that the phase detector produces sum and different frequency components.
18. Free running frequency of 100 kHz. Supply voltage is $\pm 6V$ .Demodulation capacitor is 1 μF . Find out Lock and capture frequencies and range of the PLL employing LM 565.Design the components of this PLL for given free running frequency?
19. Show that the lock-in range of a PLL is given by $\nabla f_L = \pm 7.8 f_o$/V where the symbols used have the usual meaning.

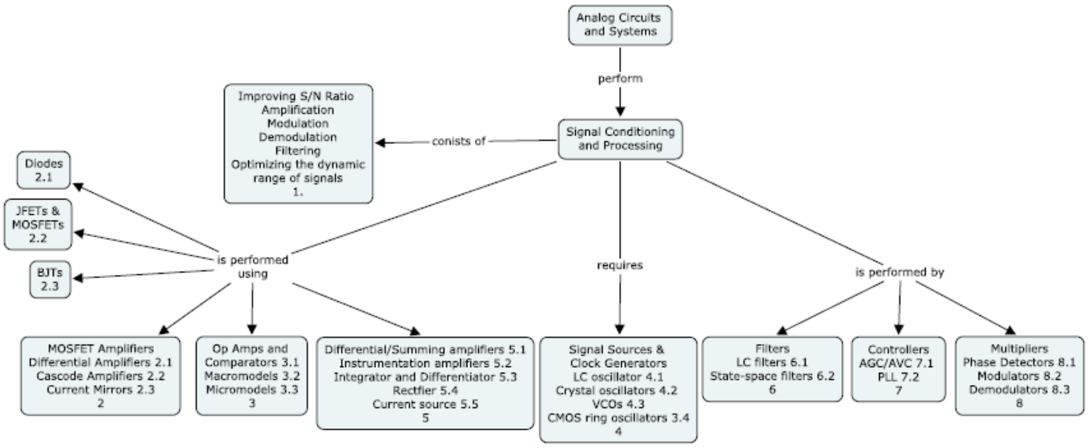
Create

1. Design an Instrumentation amplifier whose gain can be varied over the range 1≤A≤1000. Use 100 k ohm potentiometer?
2. Design the LCR resonator of figure to obtain natural modes with ω_0 = 10^4 rad/s and Q = 2. Use R = 10 kΩ.



3. Design a practical differentiator circuit that will differentiate an input signal with the $f_{max} = 150$ Hz.
4. Design a MOS differential amplifier to operate at V_{GS} - V_t = 0.2 V and to provide a trans-conductance g_m of 1mA/V. Specify the W/L ratios and the bias current. The technology available provides V_t = 0.8 V and $\mu_n C_{ox}$ = 90 μA/V^2.
5. Design a fifth order butterworth low pass filter with 3 db bandwidth of 5kHz and a DC gain of unity using the cascade connection of two sallen-and-key circuits and a first order section. Use 10 kilo ohm value for all resistors

Concept Map



Syllabus:

Devices for Signal Conditioning Circuits: Signal Conditioning and processing functions-Diodes (Signal, power and photo)- BJTs – JFETs - MOSFETs **MOSFET Amplifiers**: Differential Amplifiers- Cascode Amplifiers-Current Mirrors. **Op Amps and Comparators**: Macro-models of Op Amps and comparators-Micro-models of Op Amps and comparators. **Signal Sources and Clock Generators**: LC/RC Oscillators-Crystal Oscillators-Voltage Controlled Oscillator-CMOS Ring Oscillators. **Signal Conditioning and processing using Op Amps**: Differential and Summing Amplifiers-Instrumentation Amplifiers-Integrators and Differentiators-Rectifiers-Current Sources. **Filters**: LC Filters-State-space Filters. **Controllers**: AVC/AGC-Phase Locked Loops. **Multipliers**: Phase Detectors-Modulators-Demodulators

Reference Books:

1. Sedra and Smith, "Microelectronic Circuits", 5th Edition, Oxford university Press, 2004.
2. Behzad Razavi "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2007.

Course Contents and Lecture schedule

No.	Topic	No. of Lectures
1	**Devices for Signal Conditioning Circuits**	
1.1	Signal conditioning and processing functions	2
1.2	Diodes (signal, power and photo)	2
1.2	JFETs and MOSFETs	4
1.4	BJTs	2
2.	**MOSFET Amplifiers**	
2.1	Differential Amplifiers	3
2.2	Coscode Amplifiers	2
2.3	Current Mirrors	2
3.	**Op Amps and Comparators**	
3.1	Op Amps and Comparators : Introduction	1
3.2	Macromodels of Op Amps and Comparators	1
3.3	Micromodels of Op Amps and Comparators	2
4.	**Signal Sources and Clock Generators**	
4.1	LC/RC Oscillators	2
4.2	Crystal Oscillators	1
4.3	Voltage Controlled Oscillators	2
4.4	CMOS Ring Oscillators	2
5.	**Signal Conditioning and Processing using Op Amps**	
5.1	Differential and Summing Amplifiers	1
5.2	Instrumentation Amplifiers	1
5.3	Integrators and Differentiators	1
5.4	Rectifiers	1
5.5	Current Sources	1
6	**Filters**	
6.1	LC Filters	3

6.2	State-space Filters	2
7.	**Controllers**	
7.1	AVC/AGC	3
7.2	Phase Locked Loops	3
8.	**Multipliers**	
8.1	Phase Detectors	1
8.2	Modulators	2
8.3	Demodulators	1

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 33	3	1	-	4

D33 Signal Processing 3:1

Preamble:

Signal Processing (SP) is the best starting point for the study of Electrical/ECE and Computer engineering. It introduces the students to the use of mathematics as a language for thinking about engineering problems; it creates useful ground work for subsequent courses; it makes a strong connection to digital computation as a means for implementing systems; and it offers the possibility of interesting applications to motivate engineer students to do the hard work of connecting mathematics and computation to problem solving.

Hands on experience with real signals are crucial. This can be provided by assignments based on MATLAB/Silab provided on PCs. Sound and image signals are the most familiar signals to students of

first year. In assignments, students gain direct reinforcement from hearing and seeing the effects of filtering operations that they have implemented on sound and image signals. They synthesize music from sinusoids, and they see that those same sinusoids are the basis for the data modems that are used routinely to access internet.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

1. To plot sinusoids from equations, explain how rotating phasors of different frequencies produce complicated waveforms, determine the basic parameters of a given sinusoid, and determine the results of simple operations on complex numbers.
2. To express complex continuous time signals (beat notes, amplitude modulated signals, periodic waveforms and synthetic vowels) as sums of sinusoids and Fourier series.
3. To convert analog signals into digital signals through sampling and reconstruct analog signals from digital signals.

4. To characterize linear time invariant discrete-time systems, that have finite impulse response (FIR filters), in time domain, frequency domain and z-domain.
5. To characterize linear time invariant discrete-time systems, that have infinite impulse response (IIR filters), in time domain, frequency domain and z-domain.
6. To characterize linear time invariant continuous-time systems, samplers, modulators and filters, in time domain and frequency domain.
7. To perform well-informed interpretation of data by computing the spectrum of signals.

Knowledge

- Mathematical Representations of signals
- Parameters of analog and digital signals
- Concept of sampling
- Fourier analysis of periodic signals
- Implementation and Responses of FIR filters
- Implementation and Responses of IIR filters
- Analysis of Filters using z-Transforms
- Time and Frequency domain response of continuous time signals
- Frequency domain representation for analog and digital signals

Methods

1. Difference equations
2. Fourier series
3. Fourier Transforms
4. Discrete Fourier Transforms
5. z-Transforms

Tools

1. Matlab
2. LabView

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End semester Examination
1	Remember	10	10	0
2	Understand	20	20	20
3	Apply	40	30	30
4	Analyze	30	30	30
5	Evaluate	0	10	20
6	Create	0	0	0

Course level learning Objectives

Remember

1. Define the following
   a. unit impulse function
   b. unit step function
2. State shannon sampling theorem
3. Define aliasing.
4. List the basic blocks for implementing FIR filter.
5. Define the linearity and time invariance property of LTI system.
6. What is the relationship between z-transform and Discrete Time Fourier Transform.

Understand

1. What is the difference between radian frequency and cyclic frequency?
2. Is the signal $7\cos(9.6\pi n + 0.2\pi)$ is an alias of the signal $7\cos(0.4\pi n - 0.2\pi)$?
3. Is the time flip system $y(n) = x(-n)$ linear system?
4. Distinguish between continuous time signal and discrete time signal.
5. Relate DFT with CTFT.

Apply

1. Let

$$x(t) = 5\cos(\omega t + (3/2)\pi) + 4\cos(\omega t + (2/3)\pi) + 4\cos(\omega t + (1/3)\pi)$$

   a) Express x(t) in the form x(t) = A cos(ωt+Φ) by finding the numerical values of A and Φ.

   b) Plot the phasors used to solve the problem in (a) in the complex plane.

2. Find the spectrum of a square wave which has 50% duty cycle and a fundamental frequency 25 Hz.
3. Compute the output $y(n)$ for the length-4 filter whose coefficients are $\{b_k\}=\{3, -1, 2, 1\}$ where $x(n)=\{2,4,6,4,2\}$.
4. An LTI system is described the following equation

   $$y(n)=x(n)+2x(n-1)+x(n-2)$$

   a) Obtain an expression for the frequency response of this system.

   b) Sketch the magnitude and phase response as a function of frequency.

   c) Determine the output when the input is $x(n)=10+4\cos(0.5\pi n+\pi/4)$

   d) Determine the output when the input is unit impulse sequence.

   e) Determine the output when the input is unit step sequence.
5. An LTI system is described by the following equation

   $$y(n)=1/4\{x(n)+x(n-1)+x(n-2)+x(n-3)\}$$

   $$= 1/4\sum_{k=0}^{3}x(n-k)$$

   a) what is h(n) , the impulse response of the system?

   b) Determine the system function H(z) for this system.

   c) Plot the poles and zeros of H(z) in the complex z-plane.

   d) From H(z) , obtain an expression for the frequency response $H(e^{j\omega})$ of this system.
6. For the z-transform of the following feedback filter

   $$y(n)=0.5y(n-1)-x(n)+3x(n-1)$$

   Determine the locations of poles and zeros.
7. A LTI system has impulse response

   $h(t) = \delta(t) - 3e^{-3t}u(t)$

   Use convolution to find the output y(t) when the input is

   $x(t) = u(-t)$
8. Determine 10-point DFT of the following

   a) $x(n) = 1 \quad n=0$

   $\qquad\quad 0 \quad n=1,2...9$

   b) $x(n) = 1$ for $n= 0,1,2....9$

   c) $x(n) = 1 \quad n=4$

   $\qquad = 0 \quad n\neq4$

   d) $x(n)=e^{j\pi n/5}$ for $n=0,1,2....9$
9. A LTI system has impulse response

   $$h(n)=3\delta(n)-2\delta(n-1)+4\delta(n-2)+\delta(n-4)$$

Synthesize a system as a block diagram in direct form.

10. Design an IIR filter that will synthesize the following y(n)
$$y(n) = (0.99)^n \cos(2\pi(0.123)n + \phi)$$
11. Synthesize a square wave and triangular wave using sinusoidal signals(use of Fourier series)

Analyze

1. Suppose that x(t) is a periodic signal with half-wave symmetry and is defined over half a period by

   x(t) = t for 0 <= t < To/2

   where To is the period of the signal.

   a) Prove that the DC coefficient a_o is zero for any periodic signal having half-wave symmetry.

   b) Prove that all the even indexed Fourier series coefficients are zero for a signal with half-wave symmetry ; i.e $a_k = 0$ if k is an even integer.

2. Suppose that S is a linear time-invariant system whose exact form is unknown. It has been tested by observing the output signals corresponding to several different test inputs. Suppose that the following input-output pairs were the result of the tests:

Input: x(n)	**Output: y(n)**
$\delta(n)$	$\delta(n)$ - $\delta(n-3)$
$\cos(2\pi n/3)$	0
$\cos(\pi n/3 + \pi/3)$	$2\cos(\pi n/3 + \pi/3)$

   Is the following statement true or false? Explain.
$$H(e^{j\pi/2}) = 0$$

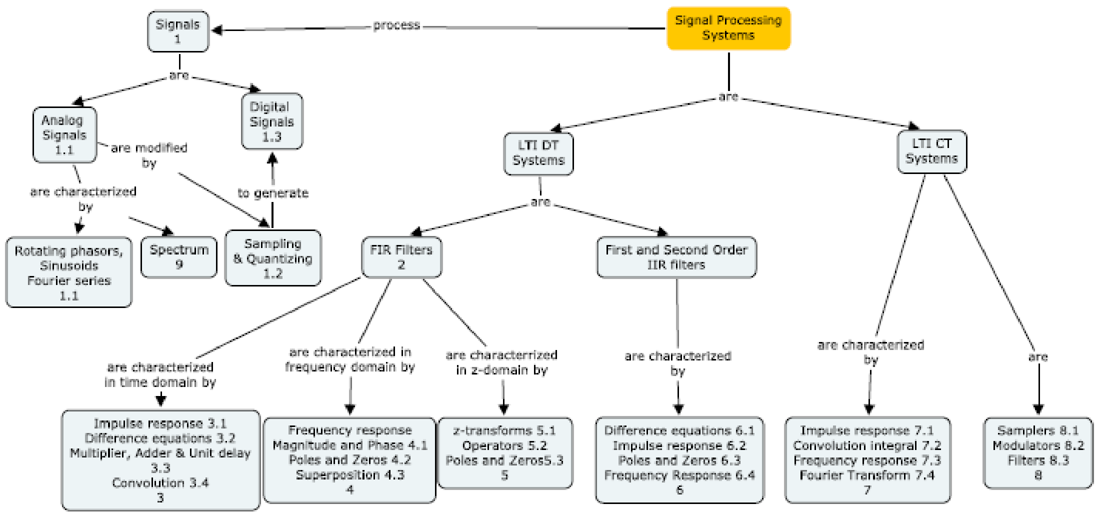
3. State whether the system described by the following equation is stable or Not
$$H(z) = (2 + 2z^{-1})/(1 - 1.25z^{-1})$$

4. Determine the frequency response and impulse response of an ideal high pass filter with delay t_d

Evaluate

1. Compare the different interpolation techniques.
2. Evaluate the convolution of two identical pulses defined by
$$x(t) = u(t + (1/2)T) - u(t - (1/2)T)$$

Concept Map



Syllabus:

Signals Analog Signals, Sampling and Quantizing, Digital Signals **FIR Filters** Discrete Time Systems, The General FIR Filter **Time Domain Characterization of FIR Filter** Impulse Response, Difference Equations, Implementation of FIR Filter, Convolution **Frequency Domain Characterization of FIR Filter** Frequency Response-magnitude and phase response, Superposition **z-Domain Characterization of FIR Filter** Z-Transforms, Z-Transform as an Operator, Poles and Zeros **IIR Filter** Difference Equations, Impulse Response, Poles and zeros, Frequency Response **Characterization of continuous Time Systems** Impulse Response, Convolution Integral, Frequency Response, Fourier Transform **LTI Continuous systems** samplers, Modulators, Filters **Spectrum of Digital Signal** Discrete Time Fourier Transform, Discrete Fourier Transform

Reference books:

1. James H.McClellen, Ronald W.Schafer, Mark A.Yoder ,"Signal Processing First", Pearson Education,2003
2. Rodger E.Ziemer, William H.Tranter and D.Ronald Fannain " Signals & Systems Continuous and Discrete", Pearson Education, 2002.
3. Simon Haykin, Barry Van Veen," Signals and Systems" ,Wiely,2nd Edition, 2002.
4. Sophocles J.Orfanidis " Introduction to Signal Processing", Prentice Hall, 1996.

Course Contents and Lecture schedule

No.	Topic	No. of Lectures
1	**Signals**	
1.1	Analog Signals	3
1.2	Sampling and Quantizing	1
1.3	Digital Signals	1
2.	**FIR Filters**	
2.1	Discrete Time Systems	1
2.2	The General FIR Filter	1
3.	**Time Domain Characterization of FIR Filter**	
3.1	Impulse Response	1
3.2	Difference Equations	1
3.3	Implementation of FIR Filter	1
3.4	Convolution	2
4.	**Frequency Domain Characterization of FIR Filter**	
4.1	Frequency Response-magnitude and phase response	3
4.2	Superposition	1
5.	**z- Domain Characterization of FIR Filter**	
5.1	Z-Transforms	2
5.2	Z-Transform as an Operator	1
5.3	Poles and Zeros	2
6	**IIR Filter**	
6.1	Difference Equations	1
6.2	Impulse Response	2
6.3	Poles and zeros	1
6.4	Frequency Response	1

7.	**Characterization of continuous Time Systems**	
7.1	Impulse Response	2
7.2	Convolution Integral	2
7.3	Frequency Response	1
7.4	Fourier Transform	2
8.	**LTI Continuous systems**	
8.1	samplers	2
8.2	Modulators	1
8.3	Filters	2
9.	**Spectrum of Digital Signal**	
9.1	Discrete Time Fourier Transform	1
9.2	Discrete Fourier Transform	1

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 34	3	0	-	3

D34 Analog Communication Systems 3:0

Preamble: The course "D34: Analog Communication Systems" is offered in the third semester concurrent with the course on "Signal Processing" and "Engineering Mathematics 3". Both these courses deal with the topic of Fourier transforms, and hence this course will not deal with it in depth. This course will be followed by the course on "Digital Communication Systems" and "Wireless Communication Systems". This course aims at designing analog communication systems for a given channel and performance specifications choosing from the available modulation and demodulation schemes.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

1. Characterize analog signals in time domain as random processes, and in frequency domain using Fourier and Hilbert transforms.
2. Characterize and determine the behavior of analog modulation schemes in time and frequency domains
3. Describe and determine the performance of different schemes of generation and detection of modulated analog signals
4. Characterize the influence of channel on different analog modulated signals
5. Determine the performance of different analog communication systems
6. Design analog communication systems as per given specifications

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/ End semester Examination
1	Remember	10	10	0
2	Understand	20	20	20
3	Apply	40	30	30
4	Analyze	30	30	30
5	Evaluate	0	10	20
6	Create	0	20	0

Course level Learning Objectives

Remember:

1. Define modulation.
2. List the various types of analog modulation schemes.
3. What is coherent detector?
4. What is Quadrature carrier multiplexing?
5. What is Quadrature null effect in DSBSC coherent detection?
6. What is narrowband noise?
7. What is the Nyquist rate of the signal $g(t) = \sin c(200t)$
8. What is aliasing?
9. State Low pass sampling theorem.
10. What is capture effect in FM demodulation?

Understand:

1. How will you differentiate VSB modulation scheme from DSBSC and SSB?
2. Distinguish the features of wideband and narrowband FM.
3. Discuss the effect of pre-emphasis and de-emphasis in FM system.
4. A DSBSC modulated signal is demodulated by applying it to a coherent detector. Discuss the effect of a frequency error Δf in the local carrier frequency of the detector, measured with respect to the carrier frequency of the incoming DSBSC signal
5. What are the needs for modulation?

Apply:

1. A 400watts carrier waveform is modulated to a depth of 75%. Calculate the total power in DSBSC and SSBSC modulation schemes.
2. Calculate the transmission bandwidth of FM system if the modulation frequency is 15kHz and the frequency deviation is 75kHz.
3. Compute the bandwidth of the FM signal using Carson rule, assuming that the frequency deviation is 20kHz and the message frequency is 1kHz.

4. A transmitter radiates 9KW when the carrier is unmodulated and 10.125 kW when the carrier is sinusoidal modulated. Calculate the modulation index. If another sine wave corresponding to 40% modulation is transmitted simultaneously, determine the total radiated power.
5. Using the message signal $m(t) = \frac{1}{1+t^2}$, determine and sketch the modulated waves for the following methods of modulation
   a. Amplitude modulation with 50% modulation
   b. Double sideband suppressed carrier modulation
   c. Single sideband modulation with only the upper sideband is transmitted
6. An FM signal with the modulation index $\beta = 1$ is transmitted through an ideal bandpass filter with mid-band frequency f_c and bandwidth $5f_m$, where f_c is the carrier frequency and f_m is the frequency of the sinusoidal modulating wave. Determine the amplitude spectrum of the filter output.
7. An FM signal with a frequency deviation of 10kHz at a modulation frequency of 5kHz is applied to two frequency multipliers connected in cascade. The first multiplier doubles the frequency and the second multiplier triples the frequency.
   a. Determine the frequency deviation and the modulation index of the FM signal obtained at the second multiplier output.
   b. What is the frequency separation of the adjacent side frequencies of this FM signal?

Analyze

1. Compare the merits and demerits of AM and FM.
2. Explain how a PLL is used to demodulate FM signal.
3. The expression for a modulated wave is given as $s(t) = 10\cos(10^{10}\pi t + 5\sin 10^4 \pi t)$.
   a. Which type of modulation is this?
   b. What is carrier and modulating frequency?
   c. Evaluate modulation index and frequency deviation.
   d. Estimate the power dissipated in $1k\Omega$ resistance by the above wave.

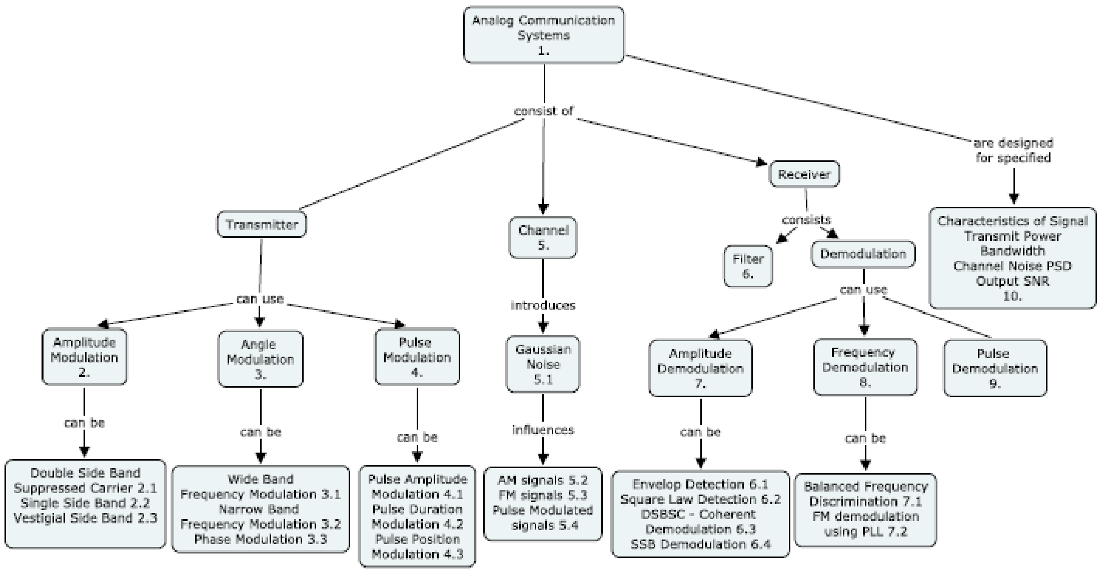
Evaluate

1. Let a message signal m(t) be transmitted using single sideband modulation. The power spectral density of m(t) is $S_M(f) = \frac{a|f|}{W} \quad |f| \le W$,

where a and W are constants. White Gaussian noise of zero mean and power spectral density $N_0/2$ is added to the SSB modulated wave at the receiver input. Derive an expression for the output signal-to-noise ratio of the receiver.

2. Evaluate the output signal-to-noise ratio of a vestigial sideband system, the receiver of which uses coherent detection. The additive noise at the detector input is narrow band.
3. Evaluate the autocorrelation functions and cross correlation functions of the in-phase and quadrature components of the narrowband noise at the coherent detector input for
    a. DSBSC System
    b. SSB system using the lower sideband
    c. SSB system using the upper sideband

Concept Map



Syllabus

Analog Communication Systems: Transmitter, Channel-Gaussian noise, Receiver-Superhetrodyne Receiver-Introduction of Design Parameters - ***Amplitude modulation Systems:*** Amplitude Modulation – Transmission, AM demodulator - Envelope Detection and Square law detection, AM – AWGN Analysis, Double Sideband suppressed carrier Modulation, DSBSC Coherent Demodulation, DSBSC- AWGN Analysis , Single side band Modulation, Single side band Modulation, SSB Coherent Demodulation, SSB-AWGN Analysis, Vestigial Side band Modulation, Vestigial Side band Demodulation , VSB-AWGN Analysis- ***Angle Modulation Systems:*** Wideband Frequency Modulation, Narrowband

Frequency Modulation ,Phase Modulation, Balanced Frequency Discrimination, FM Demodulation using PLL, Pre-Emphasis and De-emphasis, FM – AWGN Analysis- ***Pulse Modulation Systems*** : Introduction, Pulse Amplitude Modulation, Pulse Duration Modulation, Pulse Position Modulation, Pulse Modulation Systems – AWGN Analysis-***Analog Communication System Design****:* Analog Communication System Design

Reference Books

- Simon Haykin, "Communication Systems" third Edition, John Wiley and Sons, 1995
- Leon W. Couch II, " Digital and Analog Communication Systems", Prentice Hall, 1997
- Sam Shanmugam, "Digital and Analog Communication Systems", 2^{nd} ed, John Wiley, 1992.
- B. Carlson, "Introduction to Communication systems", 3^{rd} Edition, McGraw Hill, 1989.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Analog Communication Systems**	
1.1	Transmitter	1
1.2	Channel	1
1.3	Receiver	1
1.4	Introduction of Design Parameters	1
2.	**Amplitude Modulation:**	
2.1	Double Sideband Suppressed Carrier (DSBSC)	2
2.2	Single Sideband (SSB)	2
2.3	Vestigial Sideband	1
3	**Angle Modulation:**	
3.1	Wideband Frequency Modulation	2
3.2	Narrowband Frequency Modulation	2
3.3	Phase Modulation	1
4	**Pulse Modulation:**	
4.1	Pulse Amplitude Modulation	2

No.	Topic	No. of Lectures
4.2	Pulse Duration Modulation	1
4.3	Pulse Position Modulation	1
5.	**Channel**	
5.1	Gaussian Noise	3
5.2	AM Signal at the receiver front end	2
5.3	FM Signal at the receiver front end	2
5.4	Pulse Modulated Signal at the receiver front end	2
6	**Receiver**	
6.1	Filter	1
6.2	Demodulation	1
6.2.1	Amplitude Modulation	
6.2.1.1	Envelope Detection	1
6.2.1.2	Square Law Detection	1
6.2.1.3	DSBSC Coherent Demodulation	1
6.2.1.4	SSB coherent demodulation	1
6.2.2	Frequency Modulation	
6.2.2.1	Balanced Frequency Discrimination	2
6.2.2.2	FM demodulation using PLL	2
6.2.3	Pulse modulation	1
7	**Analog Communication System Design**	**2**

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 35	3	0	-	3

D35 Data Structures **3:0**

(Common to all branches of Engineering : C25,T25,B35,D35,E35,G35)

Program Outcomes addressed

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

c. An ability to design a system or component, or process to meet stated specifications

d. An ability to identify, formulate and solve engineering problems

Competencies

1. Ability to identify and implement appropriate data structure for a given application
2. Comprehend the terms "data abstraction", "abstract data type", and "data structures", and how data structures and algorithms have to be blended carefully to obtain efficient implementations.
3. Explain the notion of time complexity and the asymptotic notions of "Big Oh" with non-trivial examples.
4. Explain the difference between worst case complexity and best case complexity. Justify with an example algorithm for each of the complexities: O(n), O(n*2), O(n*3), O(2**n), O(n log n), O(n*2 log n),O(log n), O(log log n), O(sqrt(n)).
5. Identify all the trade-offs involved in choosing static versus dynamic data structures
6. In the context of searching, identify the trade-offs involved in selecting the most efficient data structure.
7. In the context of sorting, identify the trade-offs involved in selecting: (a) bubble-sort (b) insertion sort (c) selection sort (d) quick sort (e) merge sort (f) heap sort.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End semester Examination
1	Remember	30	20	10
2	Understand	30	20	10
3	Apply	20	30	30
4	Analyze	10	20	20
5	Evaluate	10	10	30
6	Create	0	0	0

Course Level Learning Objectives:

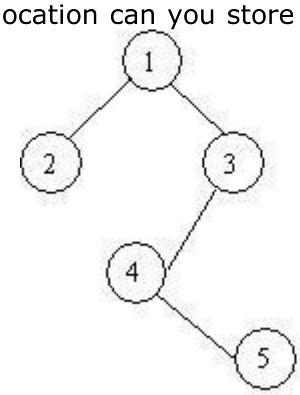
Remember

1. What is data structure?
2. List out the areas in which data structures are applied extensively?
3. What are the major data structures used in the following areas: RDBMS, Network data model and Hierarchical data model?
4. What are the notations used in Evaluation of Arithmetic Expressions using prefix and postfix forms?
5. List out few of the applications of tree data-structure?
6. List out few of the applications that make use of Multilinked Structures?
7. What is the bucket size, when the overlapping and collision occur at same time?
8. What are the Collision Resolution Techniques and the methods used in each of the type?
9. Draw a hash table with open addressing and a size of 9. Use the hash function "k%9". Insert the keys: 5, 29, 20, 0, 27 and 18 into your table (in that order).
10. Suppose that an open-address hash table has a capacity of 811 and it contains 81 elements. What is the table's load factor? (An appoximation is fine.)

Understand

1. If you are using C language to implement the heterogeneous linked list, what pointer type will you use?
2. What is the minimum number of queues needed to implement the priority queue?

3. How many null branches are there in a binary tree with 20 nodes?
4. How many different trees are possible with 10 nodes?
5. What is the condition for balancing to be done in an AVL tree?
6. How do you traverse a given tree using Inorder, Preorder and Postorder traversals.
7. What is the suitable efficient data structure for constructing a tree?
8. There are 8, 15, 13, 14 nodes were there in 4 different trees. Which of them could have formed a full binary tree?
9. At what location can you store the node 4 in a given binary tree using array?



10. Sort the given values using Quick Sort?

65	70	75	80	85	60	55	50	45

11. Classify the Hashing Functions based on the methods by which the key value is found.
12. What are the steps to inserting a new item at the head of a linked list? Use one short English sentence for each step.
13. Suppose that p is a reference to an IntNode in a linked list, and it is not the tail node. What are the steps to removing the node after p? Use one short English sentence for each step.
14. Write a class definition that could be used to define a node in a doubly linked list. Include only the instance variables, not the methods. Also write one sentence to describe a situation when a doubly linked list is appropriate.
15. Describe a situation where storing items in an array is clearly better than storing items on a linked list.
16. Describe why it is a bad idea to implement a linked list version a queue which uses the head of the list as the rear of the queue.

Apply

1. Convert the expression ((A + B) * C - (D - E) ^ (F + G)) to equivalent Prefix and Postfix notations.
2. Draw the B-tree of order 3 created by inserting the following data arriving in sequence - 92 24 6 7 11 8 22 4 5 16 19 20 78
3. Draw a binary Tree for the expression : A * B - (C + D) * (P / Q)
4. Is a Linked List a linear or non-linear data structure?
5. Suppose we are using the usual IntNode class (with instance variables called data and link). Your program is using an IntNode variable called head to refer to the first node of a linked list (or head is null for the empty list). Write a few lines of C++ code that will print all the double numbers on the list?
6. Suppose we are using the usual IntNode class (with instance variables called data and link), and that locate is referring to a node in a linked list. Write an assignment statement that will make locate refer to the next node in the list (if there is one). If there is no next node, then your assignment statement should set locate to null.
7. Suppose that p, q, and r are all references to nodes in a linked list with 15 nodes. The variable p refers to the first node, q refers to the 8th node, and r refers to the last node. Write a few lines of code that will make a new copy of the list. Your code should set THREE new variables called x, y, and z so that: x refers to the first node of the copy, y refers to the 8th node of the copy, and z refers to the last node of the copy. Your code may NOT contain any loops, but it can use the other IntNode methods.

Analyze

1. Why is the order of an algorithm generally more important than the speed of the processor?
2. Convert each time formula to the best possible big-O notation. Do not include any spurious constants in your big-O answer.

Time Formula	**Big-O**
10n	.
$2n^2$	.
3 times log (base 2) of n	.
$2n^2 + 10n$	.

3. Which of these is the correct big-O expression for 1+2+3+...+n?

    A. O(log n)

B. O(n)
C. O(n log n)
D. $O(n^2)$

4. Which of the following formulas in big-O notation best represent the expression $n^2+35n+6$?

A. $O(n^3)$
B. $O(n^2)$
C. O(n)
D. O(42)

5. Answer true or false for this statement: For all possible inputs, a linear algorithm to solve a problem must perform faster than a quadratic algorithm to solve the same problem.

- TRUE
- FALSE

6. Answer true or false for this statement: True or false: An algorithm with worst case time behavior of 3n takes at least 30 operations for every input of size n=10.

- TRUE
- FALSE

7. What term is used to describe an O(n) algorithm.

A. Constant
B. Linear
C. Logarithmic
D. Quadratic

8. Here is some code for an *integer* variable n:

```
while (n > 0)
{
   n = n/10; // Use integer division
}
```

What is the worst-case time analysis for the above loop?

A. O(1)
B. O(log n)
C. O(n)
D. $O(n^2)$

9. Express the formula (n - 2)*(n - 4) using big-O notation:

A. O(1)
B. O(8)
C. O(log n)
D. O(n)
E. None of the above

10. Fill in the following table for the times to sort an array of n items. Use only big-O notation, and do not have any extraneous constants in your expressions.

	Worst Case	**Average Case**
Binary search of a sorted array	.	.
Insertion sort	.	.
Merge sort	.	.
Quick sort without "median of three" pivot selection	.	.
Quick sort with "median of three" pivot selection	.	.
Selection sort	.	.
Heap sort	.	.

Evaluate

1. Compare the worst-case big-O time analysis for these two methods: The add method for the Bag that is implemented using an array, and the add method for the Bag that is implemented using a linked list.
2. Compare the worst-case big-O time analysis for these two methods: The remove method for the Bag that is implemented using a fixed-sized array, and the remove method for the Bag that is implemented using a linked list.
3. Compare the worst-case big-O time analysis for these two methods: The addBefore method for the Sequence that is implemented using an array, and the addBefore method for the Sequence that is implemented using a linked list.
4. Compare the worst-case big-O time analysis for these two methods: The remove method for the Sequence that is implemented using an array, and the remove method for the Sequence that is implemented using a linked list.
5. I am going to execute this code with THREE pushes and ONE pop:

```
IntStack s = new IntStack( );
s.push(1);
s.push(2);
s.push(3);
System.out.println(s.pop( ));
```

Suppose that s is represented by a linked list. Draw the state of the private member variables of s after the above code:

```
        __________
head |       |       |
     |_ __|___ |
```

6. Implement the following method. You may use the IntStack class and the Stack operations of push, pop, peek, isEmpty, and size. The parameter, in, is an EasyReader from Appendix B of the text and it is already attached to some kind of input. You may use the methods:

   `in.isEOLN()` -- returns true when the end of line is reached.
   `in.peek()` -- returns the next input character without actually reading it.
   `in.ignore()` -- reads and throws away the next input character.
   `in.intInput()` -- reads and returns an integer value from the EasyReader.

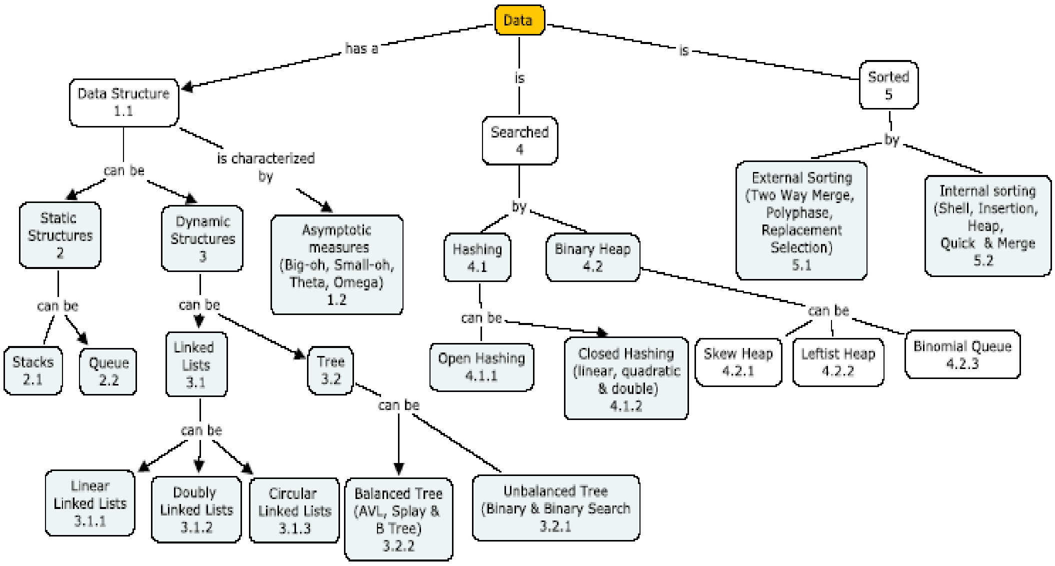
   This should be used only if you know that the next input characters form a valid integer value.

   The method specification is:

   public static int evaluatePostfix(EasyReader in)
   Precondition (Which is not checked): The next input line of in is a properly formed postfix expression consisting of integers, the binary operations + and -, and spaces.
   Postcondition: The method has read the next input line (including the newline) and returned the value of the postfix expression.

7. Consider the usual algorithm to convert an infix expression to a postfix expression. Suppose that you have read 10 input characters during a conversion and that the stack now contains these symbols: +(top), (, *(bottom)Now, suppose that you read and process the 11th symbol of the input. Draw the stack for the case where the 11th symbol is:
   - A number:
   - A left parenthesis:
   - A right parenthesis:
   - A minus sign:
   - A division sign:

Concept Map



Syllabus

Data: Data Structure, Asymptotic Measures **Static Data Structures:** Stacks, Queues **Dynamic Data Structures:** Linked Lists: Linear Linked Lists, Doubly Linked Lists and Circular Linked Lists, Trees: Unbalanced and Balanced Trees, **Data Search:** Hashing: Open Hashing and Closed Hashing; Heap: Skew Heap, Leftist Heap, Binomial Queue **Data Sorting:** Internal Sorting: Insertion sorting, Shell sorting, Quick sorting, Merge sorting and Heap sorting; External Sorting

Textbook

1. Richard F. Gilberg , Behrouz A. Forouzan: Data Structures: A Pseudocode Approach With C, 2nd Edition, Thomson Learning, 2003

Reference

1. Mark Allen Weiss: Data Structures and Algorithms in C, Addison-Wesley, 1997

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Data**	
1.1	Data Structure	0.5
1.2	Asymptotic Measures	1
2	**Static Data Structures**	
2.1	Stacks	3
2.2	Queues	2
3	**Dynamic Data Structures**	

3.1	Linked Lists	0.5
3.1.1	Linear Linked Lists	2
3.1.2	Doubly Linked Lists	1.5
3.1.3	Circular Linked Lists	1.5
3.2	Trees	1
3.2.1	Unbalanced Trees	3
3.2.2	Balanced Trees	6
4	**Data Search**	
4.1	Hashing	0.5
4.1.1	Open Hashing	1
4.1.2	Closed Hashing	2.5
4.2	Heap	2
4.2.1	Skew Heap	1.5
4.2.2	Leftist Heap	1.5
4.2.3	Binomial Queue	1
5	**Data Sorting**	
5.1	Internal Sorting	
5.1.1	Insertion sorting	1
5.1.2	Shell sorting	1
5.1.3	Quick sorting	1
5.1.4	Merge sorting	1
5.1.5	Heap sorting	2
5.2	External Sorting	2

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
D 36	2	1	-	3

D36 Microprocessors **2:1**

Preamble: This course attempts to make the students familiar with the architecture and instruction set of a range of CISC and RISC microprocessors. Even though 8085 is not available in the market anymore, a brief introduction to it was included in view of its architectural simplicity. Similarly 8086 is considered for more detailed treatment of 16 bit processors and assembly language programming as they serve as entry levels of understanding for processors used in PCs. ColdFire processor core and its different variants which are currently popular are considered in detail.

Program outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

1. Explain the architecture and instruction set of CISC (8085 and X86)
2. Explain the architecture and instruction set of Extended ISA RISC (ColdFire) microprocessors.
3. Understand the difference between embedded processor and processors used in PCs.

4. Generate efficient assembly language programs for performing different computing functions on X86
5. Generate efficient C programs using CodeWarrior for managing the peripherals of ColdFire microprocessors
6. Handle responses to interrupts and exceptions in X86 and ColdFire microprocessors

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/ End semester Examination
1	Remember	20	20	10
2	Understand	40	30	40
3	Apply	40	40	50
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1, What do you mean by addressing mode?

2, What are assembler directives and macros?

Understand

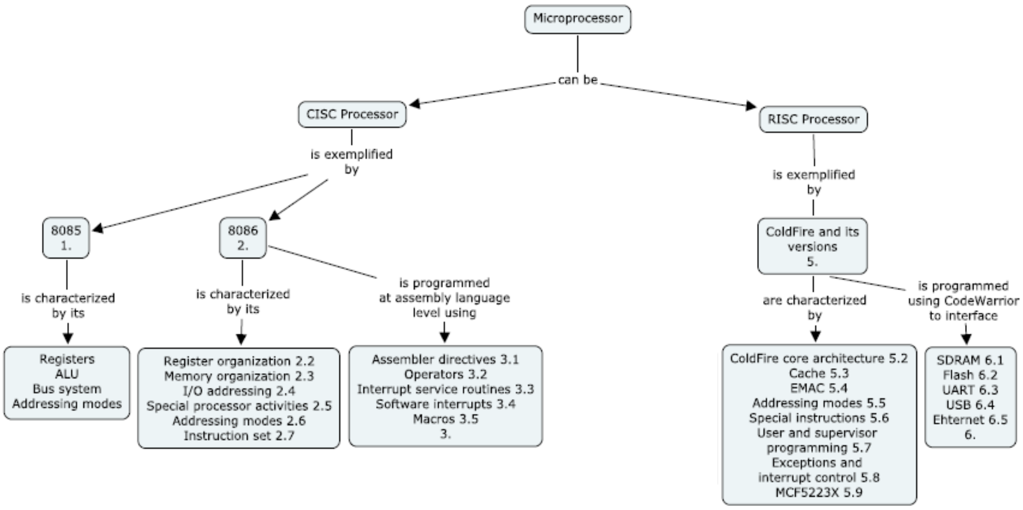
1. Differentiate between minimum mode and maximum mode of 8086 processor.
2. Differentiate between CISC and RISC

Apply

1. Develop an assembly level program in 8086 for computing Fibonacci function with less memory usage.
2. Develop a C program for cold fire processor for accessing an I/O using polling method and interrupt driven method.
3. Why an interrupt is missed, when a processor is running in Polling method ?
4. Describe the effect on accessing an interrupt with level triggered and edge triggered.
5. Compute the execution time for a 32 bit multiplication program in 8085 and 8086 processor.
6. Develop a solution for executing a function without using stack in cold fire processor.

7. Generate efficient codes for accessing an interrupt in different ways.

Concept Map



Syllabus

8085 Microprocessor: Functional block diagram – Registers, ALU, bus system, addressing modes **8086 Microprocessor:** Register organization, memory organization, I/O addressing, special processor activities, addressing modes, stack structure, interrupt cycle, non-maskable interrupt, maskable interrupt, instruction set. **Programming 8086 with an assembler**: Assembler directives, operators, interrupt service routines, software interrupts and MACROS **ColdFire 32 bit Processor:** Structure of ColdFire Core; addressing modes, special instructions, user and supervisor programming, exceptions and interrupt control, cache, EMAC **MCF5223X** with SDRAM controller, DMA controller, UART, QSPI, I2C, ADC, Fast Ethernet controller, USB, and Timers **Programming ColdFire using CodeWarrior**: Interfacing SDRAM, Flash, UART, USB and Ethernet

Textbooks

1. K. Ray, K. M. Bhurchandi – Advanced Microprocessors and Peripherals – Architecture, Programming and Interface – Tata McGraw Hill – 2000-sixteenth reprint
2. "ColdFire Microprocessors & Microcontrollers" – Munir Bannoura, Rudan Bettelheim and Richard Soja, AMT Publishing.

References

1. Gaonkar R. S.: Microprocessor Architecture: Programming and Applications with the 8085/8086A, New Age International (P) Ltd., 1995

2. Douglas V. Hall: Microprocessors and Interfacing Programming and Hardware", Tata McGraw Hill, 1995.
3. Daniel Tabak: Advanced Microprocessors, McGraw Hill, 1995
4. David A. Patterson, John. L. Hennessey: Computer organization and design-the hardware/software Interface, Elsevier-Morgan Kaufmann Publishers-2005-Third Edition. Unit IV and V
5. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: Computer organization-McGraw Hill International student Edition-2002-Fifth edition.
6. Reference Manuals from Freescale Semiconductors
7. Munir Bannoura, Margaret Frances: eTPU Programming Made Easy

Course contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Brief overview of 8085**(Functional block diagram registers, ALU, bus system and addressing modes	3
2.	**8086**	
2.1	Introduction to 16 bit processor	1
2.2	Register organization	1
2.3	Memory organization	1
2.4	I/O addressing	1
2.5	Special processor activities	1
2.6	Addressing modes	1
2.7	Instruction set	2
3	**Programming 8086 in Assembly Language**	
3.1	Assembler directives	1
3.2	Operators	1
3.3	Internet service routines	1

3.4	Software interrupts	1
3.4	Macros	1
4.	**ColdFire Processors**	
4.1	Overview of ColdFire processor family	1
4.2	ColdFire core architecture	1
4.3	Cache	1
4.4	EMAC	2
4.5	Addressing modes	2
4.6	Special instructions	2
4.7	User and supervisor programming	2
4.8	Exceptions and interrupt control	2
4.9	MCF5223X	2
5.	**Programming ColdFire with CodeWarrior**	
5.1	SDRAM interface	1
5.2	Flash interfacing	1
5.3	UART interfacing	2
5.4	USB interfacing	2
5.5	Ethernet interfacing	2

Course Designer :

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Sub Code	Lectures	Tutorial	Practical	Credit
D 37	-	-	1	1

D37 Analog Circuits and Systems Lab. 0 :1

Objective : The goals are to supplement the theory course(D32 Analog circuits and systems) to assist the students in obtaining a better understanding of the operation of electronic circuits and to provide experience in analysing and test of electronic circuits using simulation software as well as lab instruments

List of Experiments :

1. Device behaviour (Diode, BJT, and MOSFET)
2. Cascode Amplifiers
3. Differential Amplifiers
4. Current Mirrors
5. Macro models and Micro models of Op Amp
6. RC Oscillators
7. LC Oscillators
8. Voltage Controlled Oscillators
9. Crystal Oscillators
10. Differential and Summing Amplifiers
11. Integrators ,Differentiators, and Rectifiers
12. LC filters
13. Automatic Gain Control
14. Phase Locked Loop

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3. V. Vinoth Thiagarajan vvkece@tce.edu

Sub Code	Lectures	Tutorial	Practical	Credit
D 38	-	-	1	1

D38 Analog Communication Lab **0 :1**

Objective : The goals are to supplément the theory course(D34 Analog communication system) to assist the students in obtaining a better understanding of the operation of analog modulation schemes and to provide experience in analysing and test of analog communication systems using simulation software as well as lab instruments

List of Experiments :

1. Amplitude modulation & Detection.
2. Frequency modulation & Detection.
3. DSB-SC Generation & Detection
4. SSB Generation & Detection
5. Automatic Gain Control.
6. Voltage controlled oscillator
7. Narrow Band Noise Generation
8. Pulse Analog modulation (PAM,PWM and PDM)
9. Study of PLL characteristics
10. Frequency Response of equalizer
11. Digital Phase detector.
12. Simulation using MATLAB

Course Designers

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BOARD OF STUDIES MEETING

B.E Degree (Electronics and Communication) Program

Fourth Semester

THIAGARAJAR COLLEGE OF ENGINEERING
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REVISED CURRICULUM AND DETAILED SYLLABI

FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

FOURTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2010-2011 ONWARDS

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Electronics and Communication) Program

SUBJECTS OF STUDY
(For the candidates admitted from 2008-2009 onwards)

FOURTH SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
D 41	Engineering Mathematics -4	BS	4	-	-	4
D 42	Designing with PLDs and FPGAs	DC	3	1	-	4
D 43	Mixed Signal Circuits and Interfacing	DC	3	-	-	3
D 44	Digital Communication Systems	DC	3	-	-	3
D 45	Electromagnetic Field Theory	DC	3	1	-	4
PRACTICAL						
D 47	Mixed Signal Circuits and Interfacing Lab	DC	0	-	3	1
D 48	Digital Communication Lab	DC	0	-	3	1
D49	Professional Communications	HSS	1	0	2	2
Total			**17**	**2**	**8**	**22**

BS : Basic Science
HSS : Humanities and Social Science
ES : Engineering Science
DC : Department core
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Electronics and Communication) Program

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2008-2009 onwards)

THIRD SEMESTER

S.No	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	D 41	Engineering Mathematics -4	3	50	50	100	25	50
2	D 42	Designing with PLDs and FPGAs	3	50	50	100	25	50
3	D 43	Mixed Signal Circuits and Interfacing	3	50	50	100	25	50
4	D 44	Digital Communication Systems	3	50	50	100	25	50
5	D 45	Electromagnetic Field Theory	3	50	50	100	25	50
PRACTICAL								
6	D 47	Mixed Signal Circuits and Interfacing Lab	3	50	50	100	25	50
7	D 48	Digital Communication Lab	3	50	50	100	25	50
8	D49	Professional Communication	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks

Sub code	Lectures	Tutorial	Practical	Credit
D41	4	0	-	4

D41 Engineering Mathematics-4 4:0

Preamble: An engineering student needs to have some basic mathematical tools and techniques. This course emphasizes the development of rigorous logical thinking and analytical skills of the student, and appraises him the complete procedure for solving different kinds of problems that occur in engineering. Based on this, the course aims at giving adequate exposure in Operations Research, Linear Algebra and its applications.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of Mathematics, Science and Engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

c. Graduates will develop confidence for self education and ability for life-long learning.

Competencies

At the end of the course the student should be able to:

1. Apply linear programming techniques to optimization problems arising in communications engineering.
2. Understand the scheduling problems in computer networks.
3. Apply the basic concepts of Linear Algebra to problems in Communication Engineering and DSP.

Assessment Pattern

	Bloom's category	Test 1	Test 2	Test 3 / End Semester Examinations
1	Remember	10	10	0
2	Understand	30	30	30
3	Apply	60	60	70
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course content and lecture schedule

S.No.	Topic	No. of Lectures
1.	**Vector Spaces**	
1.1	Definition and Examples	1
1.2	Subspaces	2
1.3	Linear Independence	2
1.4	Basis and Dimensions	3
1.5	Row space and Column space	2
1.6	Linear Transformation-Definition and examples	2
1.7	Matrix representation of Linear Transformation	3
2.	**Orthogonality**	
2.1	The scalar product in R^n	1
2.2	Orthogonal subspaces	2
2.3	Inner product spaces	2
2.4	Least square problems	2
2.5	Orthonormal sets	2
2.6	Gram Schmidt Orthogonalization process	3
3.	**Linear Programming**	
3.1	Graphical Solution	2
3.2	Formulation	1
3.3	Slack and Surplus Variables	1
3.4	Basic feasible solutions	1
3.5	Simplex Method	3
3.6	Big-M Method	3
3.7	Duality	2
4.	**Network Models(CPM & PERT)**	
4.1	Network Representation	2

4.2	Critical Path (CPM) computations	2
4.3	Construction of the time schedule	2
4.4	Linear Programming Formulation of CPM	2
4.5	PERT Networks`	2

Syllabus

Vector Spaces: Definition and Examples, Subspaces, Linear Independence, Basis and Dimensions, Row space and Column space, Linear Transformation –Definition and Examples, Matrix Representation of Linear transformation.

Orthogonality: The scalar product in R^{n}, Orthogonal subspaces, Inner product spaces, Least square problems, Orthonormal sets, Gram Schmidt orthogonalization process.

Linear Programming: Graphical Solution, Formulation, Slack and Surplus Variables, Basic feasible solutions, Simplex Method, Big-M Method, Duality.

Network Models (CPM & PERT): Network Representation, Critical Path (CPM) computations, Construction of the time schedule, Linear Programming Formulation of CPM, PERT Networks

Text Books:

1. Steven J. Leon, "Linear Algebra With Applications", Prentice-Hall of India Private Ltd, New Delhi.(2002)

2. Hamady A.Taha, "Operations Research: An Introduction ",Prentice-Hall of India Private Ltd, New Delhi.(2005)

Course Designers:

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Sub code	Lectures	Tutorial	Practical	Credit
D42	3	1	-	4

D42: Designing with PLDs and FPGAs 3:1

Preamble: The proposed course is offered in the fourth semester. This course 'D42: Designing with PLDs and FPGAs is preceded by a three credit course 'D23 – Basics of Digital Systems' offered in second semester. This course will be followed by the course: CMOS VLSI Design. In designing this course the following assumptions are made.

- The course aims at understanding the architectures of PLDs and FPGA and its design flow, verification and testing.
- This course also aims at synthesizing the digital logic into a circuit with desired functionality, mapping into a selected PLD and FPGA, verifying the timing performance, and generating the final configuration file.

Program Outcomes addressed:

a. An ability to apply knowledge of engineering, information technology, mathematics, and science

c. An ability to design a system or component, or process to meet stated specifications

e. An ability to use techniques, skills, and modern engineering tools to implement and organize engineering works under given constraints

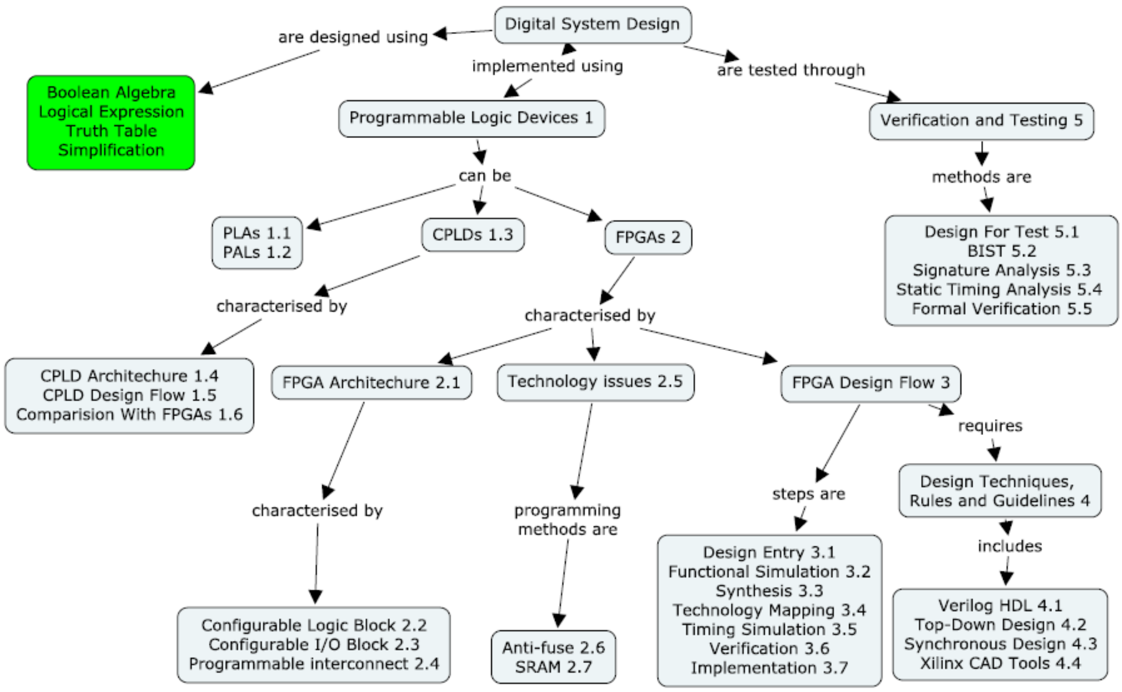
Competencies:

1. Explain the technologies of programmable devices (PLDs and FPGAs).
2. Understand the internal architecture of PLDs and FPGAs
3. Design digital systems using UDM and UDM-PD (Universal Design Methodology for programmable devices) methods.
4. Express a digital system design in Verilog
5. Use Xilinx CAD tools and techniques to implement all the stages of digital system design.
6. Design digital systems for testability

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	10	0
2	Understand	30	30	20
3	Apply	40	40	40
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	10	20	40

Concept Map:



Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Programmable Logic to ASICs**	
1.1	Programmable Logic Arrays (PLAs) .	1
1.2	Programmable Array Logic (PALs)	1
1.3	CPLDs	1
1.4	CPLD Architectures	1
1.5	CPLD Design Flow	1
1.6	Comparison with FPGAs	1
2	**Field Programmable Gate Arrays (FPGAs)**	
2.1	FPGA Architectures	1
2.2	Configurable Logic Blocks	2
2.3	Configurable I/O Blocks	2
2.4	Programmable Interconnect	2
2.5	Technology Issues	1
2.6	Antifuse	1
2.7	SRAM	1
3.	**FPGA Design Flow**	
3.1	Design Entry Design Entry	1
3.2	Functional Simulation	1
3.3	Technology Mapping	2
3.4	Synthesis	2
3.5	Timing Simulation	1
3.6	Verification	1
3.7	Implementation.	2
4	**Design Techniques, Rules, and Guidelines**	
4.1	Verilog - Hardware Description Languages	1
4.2	Top-Down Design	1
4.3	Synchronous Design	2
4.4	Xilinx CAD Tools	2
5	**Verification and Testing**	
5.1	Design For Test (DFT)	2
5.2	Built-In Self-Test (BIST)	2
5.3	Signature Analysis	1
5.4	Static Timing Analysis	1
5.5	Formal Verification	1

Syllabus

Programmable Logic Devices: Programmable Logic Arrays (PLAs), Programmable Array Logic (PALs). CPLDs, CPLD Architectures, CPLD Design Flow, Comparison with FPGA. **Field Programmable Gate Arrays (FPGAs):** FPGA Architectures, Configurable Logic Blocks , Configurable I/O Blocks, Programmable Interconnect , Technology Issues , Antifuse Programming, SRAM. **FPGA Design Flow:** Design Entry Design Entry, Functional Simulation, Synthesis, Technology Mapping, Timing Simulation, Verification, Implementation. **Design Techniques, Rules, and Guidelines:** Verilog Hardware Description Languages, Top-Down Design, Synchronous Design, Xilinx CAD Tools. **Verification and Testing:** Design For Test (DFT), Built-In Self-Test (BIST), Signature Analysis, Static Timing Analysis, Formal Verification.

Text Book:

1. Bob Zeidman, "Designing with FPGAs and CPLDs", Elsevier, CMP Books, 2002.

Reference:

1. Ion Grout," Digital Systems Design With FPGAs And CPLDs", Elsevier, 2008.
2. Samir Palnitkar, "Verilog HDL", Pearson Education, 2nd Edition, 2004.
3. Michael John Sebastian Smith, " Application Specific Integrated Circuits", Addison Wesley, Ninth Indian Reprint, 2004
4. Michael L. Bushnell and Vishwani D. Agarwal," Essentials of Electronic Testing for digital, memory and mixed signal VLSI Circuits", Springer, 2000
5. Kwang-ting Cheng, Vishwani D. Agarwal and Cheng kwang ting Cheng, "Unified Methods for VLSI Simulation and Test generation" Springer, 1989

Course Designers

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3. V.R.Venkatasubramani venthiru@tce.edu

Sub code	Lectures	Tutorial	Practical	Credit
D43	3	0	-	3

D43 Mixed Signal Circuits and Interfacing 3:0

Preamble: This course 'D43 Mixed Signal Circuits and Interfacing', a departmental core course, is preceded by courses 'D32: Analog Circuits and Systems', a two credit course 'Basics of Electrical and Electronic Engineering' offered in the first semester which presents an over view of the entire field of electronic engineering, and D23: Linear Electrical Networks. This course is followed by course 'Power Electronics'. Another course 'D42: Designing with PLDs and FPGAs' runs in the same semester as this course.

The course mainly presents state-of-the-art digital-to-analog converters, a range of analog-to-digital converters, and the design of Class A, B, C, D and E power amplifiers

Program Outcomes addressed

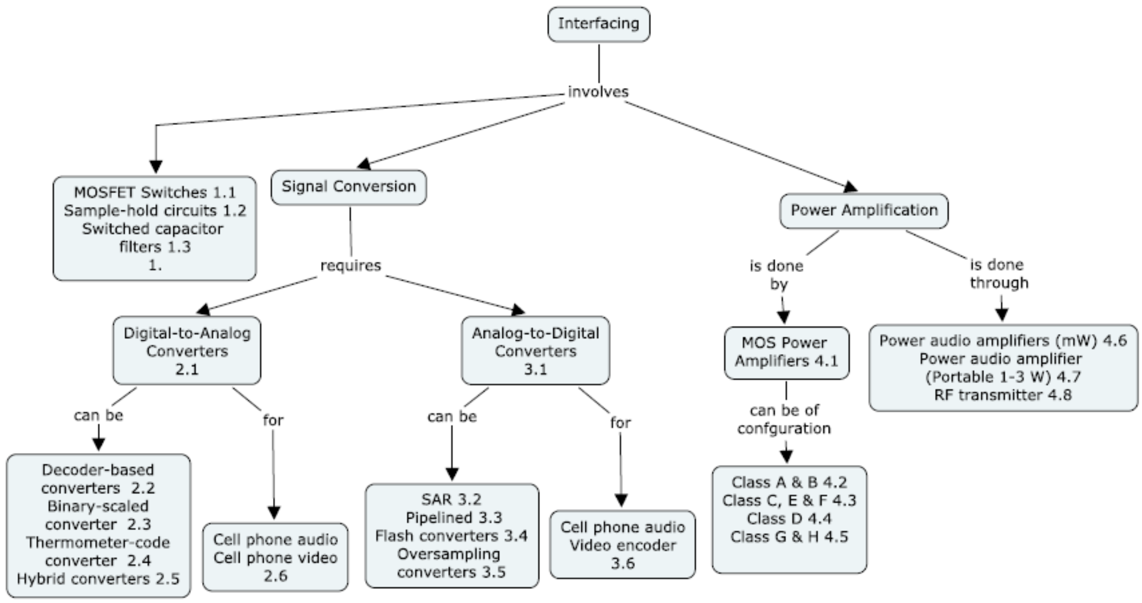
Competencies

1. Determine the performance (error/accuracy, noise, and speed) of analog-to-digital conversion and digital-to-analog conversion systems
2. Design switches, switched-capacitor networks, pre filters, post filters, off-set/error compensating networks, and sample and hold circuits using MOSFETs and op amps/comparators
3. Design feedback, flash, and over-sampling ADCs
4. Design DACs using R-2R or C-2C networks
5. Design Class A, B, C and D power amplifiers

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/ End-semester examination
1	Remembering	10	10	0
2	Understanding	20	20	20
3	Applying	40	40	40
4	Analyzing	0	0	0
5	Evaluating	0	0	0
6	Creating	30	30	40

Concept Map



Course contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Switching Circuits for Data conversion**	7
1.1	MOSFET Switches	2
1.2	Sample-hold Circuits	2
1.3	Switched Capacitor Filters	3
2.	**Digital to Analog converter**	7
2.1	DAC architecture and characteristics	1
2.2	Decoder-based DACs	1
2.3	Binary Scaled Converters	1
2.4	Thermometer-code Converter	1
2.5	Hybrid Converters	1
2.6	Cell phone Audio and Video Converters	2
3	**Analog to Digital converter**	11
3.1	ADC architecture and characteristics	1
3.2	Successive Approximation ADC	1

3.3	Pipelined ADC	1
3.4	Flash Converters	2
3.5	Over sampling-first order and second order Sigma delta ADCs**.**	3
3.6	Cell Phone Audio and Video Encoders	3
4	**Power amplifiers**	15
4.1	MOSFET Power Amplifier: Characteristics	1
4.2	MOSFET based Class A, B, AB amplifiers	1
4.3	Class C, E and F MOSFET power amplifiers	2
4.4	Class D MOSFET Power Amplifier	2
4.5	Class E and H MOSFET Power Amplifier	1
4.6	Power Audio Amplifier (mW)	2
4.7	Power Audio Amplifiers (Portable Devices)	2
4.8	RF Transmitter	2

Syllabus

Switching Circuits for Data conversion: MOSFET Switches, Sample-hold Circuits, Switched Capacitor Filters **Digital to Analog converter:** DAC architecture and characteristics, Decoder-based DACs, Binary Scaled Converters, Thermometer-code Converter, Hybrid Converters, Cell phone Audio and Video Converters **Analog to Digital converter:** ADC architecture and characteristics, Successive Approximation ADC, Pipelined ADC, Flash Converters, Over sampling-first order and second order Sigma delta ADCs**,** Cell Phone Audio and Video Encoders **Power amplifiers:** MOSFET Power Amplifier: Characteristics, MOSFET based Class A, B, AB amplifiers, Class C, E and F MOSFET power amplifiers, Class D MOSFET Power Amplifier, Class E and H MOSFET Power Amplifier, Power Audio Amplifier (mW), Power Audio Amplifiers (Portable Devices), RF Transmitter

Reference books

1. David A. Johns and Ken Martin: Analog Integrated Circuit Design, Wiley India, 1997
2. R. Jacop Baker, CMOS Design, layout, simulation. Wiley Interscience, 2nd ed., 2005.
3. R. J Baker, CMOS Mixed signal circuit Design. Wiley Interscience, 2nd ed., 2009.
4. Sundaram Natarajan: Microelectronics Analysis& design, McGraw-Hill 2006.
5. Razavi, Design of Analog CMOS Integrated Circuits. Electrical Engineering, McGraw-Hill International, 2001.
6. Sorin Alexander Huss: Model Engineering in Mixed-Signal Circuit Design, Springer, 2001.

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D44	3	0	-	3

D44 Digital Communication Systems 3:0

Preamble:

The course "D44: Digital Communication Systems" is offered in the fourth semester in continuation with the course on "D34: Analog Communication Systems". The course will be followed by the course on "Wireless Communication Systems". This course aims at designing digital communication systems for a given channel and performance specifications choosing from the available modulation and demodulation schemes.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

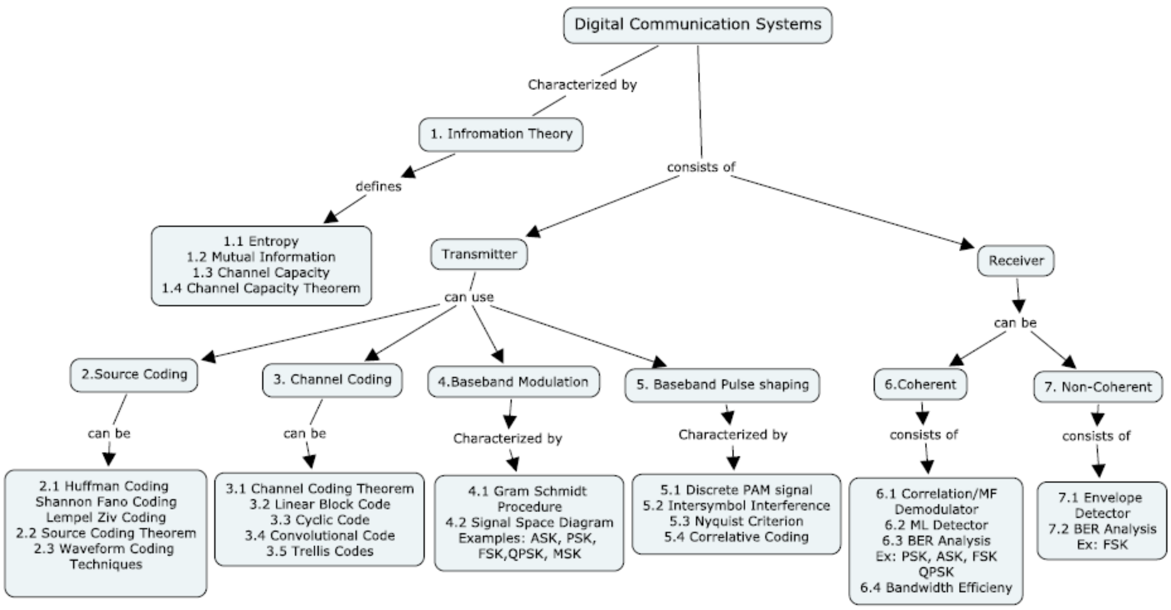
Competencies

1. Determine the minimum number of bits per symbol required to represent the source and the maximum rate at which reliable communication can take place over the channel.
2. Describe and determine the performance of different waveform coding techniques for the generation of a digital representation of the signal.
3. Describe and determine the performance of different error control coding. schemes for the reliable transmission of digital information over the channel.
4. Describe a mathematical model of digital communication system, to provide a frame work for the bit error rate (BER) analysis.
5. Characterize the influence of channel, in terms of BER on different digital modulated signals
6. Determine the performance of different digital communication systems
7. Design digital communication systems as per given specifications

Assessment Pattern

S.No	Bloom's Category	Test 1	Test 2	Test 3 /End-semester examination
1	Remember	10	0	0
2	Understand	30	20	20
3	Apply	60	60	60
4	Analyze	0	10	10
5	Evaluate	0	10	10
6	Create	0	0	0

Concept Map:



Syllabus

Fundamentals of Information Theory: Information, self Information, Entropy- Mutual Information, Differential Mutual Information – Channel Capacity - Channel Capacity Theorem, Source Coding **-** Huffman Coding, Shannon Fano Coding, Lempel Ziv Coding, Source Coding Theorem, **Waveform Coding Techniques:** Pulse Code Modulation - Sampling, Quantizing, Encoding - Quantization noise and robust quantization - Differential Pulse Code Modulation, Delta Modulation, **Error Control Coding**: Channel Coding Theorem, Linear Block Codes, Cyclic Codes, Convolutional Codes, Trellis codes, **Baseband Modulation:** Gram-Schmidt Orthogonalization Procedure, Geometric Interpretation of Signals – Signal Space Diagram –Examples: ASK,PSK,FSK,QPSK,MSK – **Baseband Pulse Shaping** - Discrete PAM signals - Power Spectra of Discrete PAM signals - Intersymbol Interference, Nyquist Criterion for Distortionless baseband binary transmission -

Correlative Coding - Eye Pattern. **Coherent Receiver:** Correlation demodulator, Matched Filter Demodulator – Maximum Likelihood Detector - BER Analysis for PSK, ASK, FSK, QPSK, - Comparison of Binary and Quarternary Modulation - M-ary Modulation Techniques - Bit Vs Symbol Error Probabilities - Bandwidth Efficiency – **Non-Coherent Receiver**: Envelope Detector – BER Analysis for Non-coherent FSK system – **Application**: Direct Sequence Spread Spectrum System.

Text Book

1. Simon Haykin: Digital Communications", John Wiley & Sons Pvt. Ltd., 2001

Reference Books

1. John G. Proakis: "Digital Communications", McGraw Hill International Edition, Fourth Edition, 2001.
2. Simon Haykin: "Communication Systems" 3rd Edition, PHI, 1996.
3. Bernard Sklar: "Digital Communications: Fundamentals and Applications", 2nd Edition, Prentice Hall, 2001
4. John R Barry, Edward Lee and David G. Messerschmitt: "Digital Communication", 3rd Edition. Springer, 2003.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Fundamentals of Information Theory**	
1.1	Information, self Information, Entropy	1
1.2	Mutual Information, Differential Mutual Information	1
1.3	Channel Capacity	1
1.4	Channel Capacity Theorem	1
2.	**Source Coding**	
2.1	Huffman Coding, Shannon Fano Coding, Lempel Ziv Coding	1
2.2	Source Coding Theorem	1
2.3	Waveform Coding Techniques	
2.3.1	Pulse Code Modulation	
2.3.1.1	Sampling, Quantizing, Encoding	1
2.3.1.2	Quantization noise and robust quantization	1

No.	Topic	No. of Lectures
2.3.2	Differential Pulse Code Modulation, Delta Modulation	1
3	**Error Control Coding**	
3.1	Channel Coding Theorem	1
3.2	Linear Block Code	1
3.3	Cyclic Codes	1
3.4	Convolutional Codes	1
3.5	Trellis Codes	1
4	**Baseband Modulation**	
4.1	Gram-Schmidt Orthogonalization Procedure, Geometric Interpretation of Signals	
4.2	Signal Space Diagram	1
4.2.1	Binary Digital Modulation Techniques: PSK, ASK, FSK	1
4.2.2	M'ary Digital Modulation Techniques:QPSK, M'ary FSK	1
4.2.3	Minimum Shift Keying	1
5	**Baseband Pulse Shaping for finite bandwidth system**	
5.1	Discrete PAM signals	1
5.1.1	Power Spectra of Discrete PAM signals	1
5.2	Intersymbol Interference, Nyquist Criterion for Distortionless baseband binary transmission	1
5.2.1	Eye Pattern	1
5.3	Correlative Coding	1
6	**Coherent Receiver**	
6.1.1	Correlation Demodulator	1
6.1.2	Matched Filter Demodulator	1
6.2	ML Detector	1
6.3	BER Analysis : PSK,ASK, FSK, QPSK	1
6.3.1	Comparison of Binary and Quarternary Modulation Techniques	1

No.	Topic	No. of Lectures
6.3.2	Bit Vs Symbol Error Probabilities	1
6.4	Bandwidth Efficiency	1
7	**Noncoherent Receiver**	
7.1	Envelope Detector	1
7.2	BER Analysis; FSK	1
8.	Application	
8.1	Direct Sequence Spread Spectrum System	1

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D 45	3	1	-	4

D45 Electromagnetic Field Theory 3:1

Preamble: The purpose of this course is to provide students with an introduction to the fundamentals of electrostatics, magnetostatics, and electromagnetics. The bridge between electric circuits and electromagnetics is done through the study of transmission lines and their lumped-element model, transmission line input impedance, and power flow on lossless transmission line. This course also emphasizes the physical understanding and practical applications of electromagnetics in electronics and bio medical systems.

Program Outcomes addressed

- An ability to apply knowledge of engineering, mathematics and science to electromagnetic fields.
- An ability to identify, formulate and solve engineering electromagnetic problems

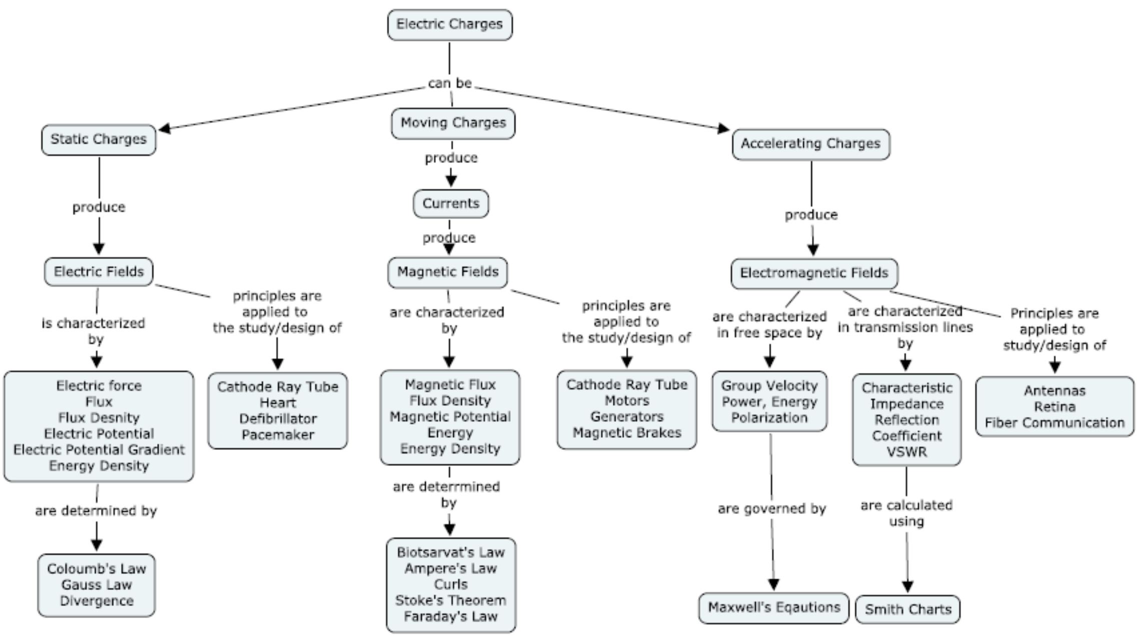
Competencies: At the end of the course the student should be able to

1. Understand the fundamental nature of static electric fields, potential, flux, charge densities, static magnetic fields, steady current, resistance, capacitance, inductance, stored energy, materials, and boundary conditions.
2. Understand Faraday’s law of induction, electromagnetic fields, Maxwell’s equations, boundary conditions, wave equations and Poynting theorem.
3. Determine the characteristics of lossless transmission lines using Smith charts
4. Understand the concepts of traveling waves, standing waves, characteristic impedance, intrinsic impedance and wave impedance.
5. Understand concepts such as wavelength, phase velocity, attenuation, plane waves, reflection, and refraction for waves in various media.
6. Determine the behavior of cathode ray tube, generator, motor, magnetic brake using electrostatic and magneto static principles
7. Determine the behavior of retina, heart, defibrillator and pacemaker using electromagnetic principles
8. Understand electromagnetic effects on desk top PC and circuit boards.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	40	40	20
2	Understand	40	40	40
3	Apply	20	20	40
4	Analysis	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Concept Map



Syllabus

Electrostatics: Introduction to Coordinate systems, Electric charge, Force, Coulomb's law, Electric field, Electric potential, Gradient, Equipotential contours, Line charges, Electric flux, Electric flux density, Gauss's law, Surface charge, Volume charge, Divergence, Poisson's and Laplace's Equations, Boundary conditions, dielectric capacitors and capacitance, capacitor energy, Energy density, Electric currents, Electric Current density, ohms law at a point, Power, Dielectrics, semiconductors and conductors.

Magnetostatics: Magnetic fields of electric currents, Magnetic flux, Magnetic flux density, Gauss's law, Lorentz force, Inductance and inductors, Energy and Energy density, Changing magnetic fields, induction and Faraday's law, Coupling, cross talk and mutual inductance, Curl, Maxwell's equations.

Transmission lines: Circuit theory, Field theory, Transmission line impendence, Energy, Power and Poynting vector, Terminated uniform transmission line and VSWR, smith chart, Bandwidth, Pulses and transients, Quarter wave transformer

Wave Propagation: Waves in space, Traveling waves and standing waves, Conducting media and lossy lines, Plane waves at interfaces, Relative phase velocity, Index of refraction, Group velocity, Power and energy relations, Linear, Elliptical and Circular polarization, Oblique incidence-Reflection and refraction for perpendicular and parallel cases.

Applications: Electrodynamics: Cathode ray tube, Electric and magnetic deflection, Generator, Linear motor, Magnetic brake. **Bio Electro magnetics:** Retinal optic fiber, Heart dipole field, Defibrillators and Pacemakers, Electromagnetic hazards and the environment **Electromagnetic effects in High Speed Digital Systems:** Lumped versus Distributed systems, Electromagnetic effects in Desktop PC, circuit boards, Cross talk, Electromagnetic interference

Text Book:

1. Kraus and Fleisch: Electromagnetics with applications, TMH Publishing Co. Ltd., 5th Edition 1999.

Reference Books:

1. D. K. Cheng, *Field and Wave Electromagnetics*, Addison-Wesley, 1992
2. N. N. Rao, *Elements of Engineering Electromagnetics*, Prentice-Hall, 2004.
3. W. Hayt and J. Buck, *Engineering Electromagnetics*, McGraw-Hill, 2006
4. J. Edminister, Schaum's Outline of Electromagnetics, McGraw-Hill.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Electrostatics**	
1.1	Introduction to Coordinate Systems	2
1.2	Electric Charge , force	1
1.3	Electric field, potential, gradient	1
1.4	Electric Flux, flux density and Gauss Law	2
1.5	Divergence, Laplace and Poisson Equations, Boundary Conditions	2
1.6	Capacitance and Energy Density	2

No.	Topic	No. of Lectures
1.7	Ohm's Law at a point	1
1.8	Dielectrics, semiconductors and Conductors	1
1.9	Tutorials	2
2.	**Magneto Statics**	
2.1	Electric Current, Biot Savart's law, magnetic flux, magnetic flux density, Ampere's Law	1
2.2	Gauss's law, Lorentz force	2
2.3	Inductance, Energy, energy density, Changing Magnetic Fields, Induction, Induction Coupling	3
2.4	Mutual inductance, cross talk, Curl, Maxwell's equations.	3
2.5	Tutorial	2
3	**Transmission Lines**	
3.1	Circuit Theory, Field Theory, Microstrip Line, Characteristic impedance, energy, power and Poynting Vector	2
3.2	Terminated Uniform transmission line, VSWR, Smith Chart, Pulses and Transients	3
3.3	Quarter wave transformer	1
3.4	Tutorial	2
4	**Wave propagation**	
4.1	Wave propagation in space, traveling Waves and Standing Waves, Conducting Medias, Lossy Lines	2
4.2	Plane Waves at Interfaces, Phase Velocity, index of Refraction, Group Velocity	2
4.3	Power and Energy Relations	2
4.4	Polarizations	1
4.5	Oblique Incidence, Reflection, Refraction	2
4.6	Tutorial	2
5	**Applications**	
5.1	Cathode ray tube, Electric and Magnetic Deflection	2

No.	Topic	No. of Lectures
5.2	Generator, Linear Motor, Magnetic Brakes	1
5.3	Defibrillator, Pace maker	1
5.4	Electromagnetic Hazards and Environment	1
5.5	Electromagnetic effects in High Speed Digital Systems – Lumped Vs Distributed Systems	1
5.6	Electromagnetic effects in Desktop PC, Circuit Boards, Cross Talk, Electromagnetic Interference,	1

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D47	0	0	-	1

D47 Mixed Signal Circuits and Interfacing Lab 0:1

Objective: The goals are to supplement the theory course (D42 Mixed Signal Circuits and Interfacing) to assist the students in obtaining a better understanding of the operation of mixed signal systems with interfacing and to provide experience in analysing and test of mixed signal circuits using simulation software as well as lab instruments

List of Experiments:

1. Design, simulation and construction of MOSFET based Sample and Hold Circuits.
2. Design and Simulation of Switched Capacitor filters using Modern engineering tools (SPICE).
3. Design, simulation and construction of Decoder based DAC.
4. Design, simulation and Construction of R-2R ladder Digital to Analog Converter.
5. Design, simulation and construction of Thermo-meter based DAC.
6. Design and simulation of Resistor-Capacitor Hybrid 8-bit DAC.
7. Interfacing of Successive approximation ADC with microprocessor Kit.
8. Static error measurement of ADC.
9. Design and simulation of class A, B and AB MOSFET power amplifiers using SPICE.
10. Design, simulation and construction of class D power amplifier (PWM) circuit.

Course Designers:

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Sub code	Lectures	Tutorial	Practical	Credit
D48	4	0	-	4

D48 Digital Communication Lab **0:1**

Objective: The goals are to supplement the theory course (D44 Digital Communication systems) to assist the students in obtaining a better understanding of the operation of digital modulation schemes and to provide experience in analyzing and test of digital communication systems using simulation software as well as lab instruments

List of Experiments:

1. Design and Implementation of Uniform Quantizer
2. Design and Implementation of Scrambler and Descrambler
3. Design and Implementation of Convolutional Coders
4. Design and Implementation of Cyclic code Encoder and its corresponding Syndrome Calculator
5. Binary Digital Modulation Techniques
    a. Design and implementation of ASK Generator and Detector
    b. Design and implementation of PSK Generator and Detector
    c. Design and implementation of FSK Generator and Detector
6. Quadrature Phase Shift Keying modulation & Detection.
7. Differential Phase Shift Keying
8. BER Analysis of binary digital Modulation Schemes (ASK, PSK and FSK) in the presence of Additive White Gaussian Noise
9. Generation of PN Sequence and Gold Sequences
10. BER Analysis of Direct Sequence Spread Spectrum Communication system in the presence of AWGN and interference.

Course Designer

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Sub code	Lectures	Tutorial	Practical	Credit
D49	1	0	1	2

PROFESSIONAL COMMUNICATION

(Common to ALL branches of B.E & B. Tech.)

Subject codes: B49, C49, D49, E49, G49, IT49 **1: 1**

Preamble: Professional communication aims to develop Listening, Speaking, Reading and Writing skills in Engineering students' professional development contexts such as projects, competitive exams, organizational communication and soft skills.

Competencies: At the end of the course the students should be able to

Listening:

1. Listen and understand the project presentations, competitive exam exercises, organizational communication activities
2. Listen to the lectures on soft skills for practice.

Speaking:

1. Present project reports, self introduction
2. Participate in GD and interview in work context.

Reading:

1. Read and collect information for project report writing.
2. Read and understand the comprehension passages given in competitive examinations.
3. Read and understand the company profile

Writing:

1. Write a project report adhering to proper format
2. Create a paragraph and essay using their own ideas
3. Write circulars, minutes of the meetings, and curriculum vitae

Assessment Pattern:

	Internal (50)	**External (100)**
1. Recall	10	10
2. Understanding	10	20
3. Application	10	20
4. Analysis	10	30
5. Evaluation	5	10
6. Creation	5	10

Course Content:

1. Listening:

1.1 Attention, understanding and responding

1.2 Project report writing, competitive exam exercises, organizational communication and soft skills practice

2. Speaking:

2.1 Planning, preparation and presentation

2.2 Project report, self introduction, GD and interview

3. Reading:

3.1 Rapid reading and reference skills

3.2 Project reports, competitive exam exercises and company profiles

4. Writing:

4.1. Structure

4. 1.1 Sentence structure

4.1.2 Abstract writing

4.1.3. CV writing

4.1.4. Project report writing

4.2 Organizational Communication

4.2.1 Circulars

4.2.2 Minutes of the meeting

Syllabus:

Listening: Listening to Project presentation: Asking Questions, Listening test as conducted in TOEFL and BEC, Listening in the context of Organizational communication and Soft skill practice.

Speaking: Project presentation skill, Speaking in the context of Group Discussion, Interview, TOEFL and BEC Exam Spoken Test, Speaking in the work Contexts : Self introduction, Mini Presentation

Reading: Reference Skills for Project Report Writing: Topic selection, Data Collection. Rapid Reading, Reading comprehension tests conducted in CAT, TOEFL, GRE and BEC, Reading skills in work situation: Company Profile

Writing: Project Report Writing : Format, Abstract, Bibliography, Structure : Sentence structure, CV Writing, Writing in Work context : Circulars, Minutes of the meeting

References

1. Tony Lynch: Study Listening. Cambridge, Cambridge University Press, 2007
2. Sangeeta Sharma and Binod Mishra: Communication Skills for Engineers and Scientists. New Delhi, PHI Learning Pvt. Ltd. 2009.

3. Hari Mohan Prasad and Uma Rani Sinha: Objective English for Competitive Examination. New Delhi, Tata McGraw – Hill, 2005
4. Bob Dignen, Steeve Flinders et. al.: Work and Life: English 365. Students Book 1,2 & 3. New Delhi, Cambridge, 2004.

List of Lecture sessions:

Listening:

1. Effective listening skills
2. Nature of listening tests in competitive examinations
3. Introduction of soft skills

Speaking:

1. Introduction of Presentation skills
2. Suggestions for speaking tests in competitive exams
3. How to participate in GD
4. Interview techniques

Reading:

1. Rapid reading techniques
2. Reference skills
3. Suggestions for reading tests in competitive exams

Writing:

1. Format of project report
2. Abstract of the project
3. Sentence structure
4. Organizational communication like sending circulars, writing minutes of the meetings
5. CV writing

List of Practice Sessions:

Listening:

1 Messages, descriptions, conversations and lectures

Speaking:

1. Self Introduction
2. Mini Presentation
3. GD
4. Interview

Reading:

1. Rapid reading practices
2. Comprehension exercises
3. Topic selection and data collection for project report

Writing:

1. Sentence structure
2. Abstract writing
3. Project Report Writing
4. Circulars
5. Minutes of the meeting
6. Model test

Course Designers

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REVISED CURRICULUM AND DETAILED SYLLABI

FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

FIFTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2010-2011 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2000 certified
Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E Degree (Electronics and Communication) Program
SUBJECTS OF STUDY
(For the candidates admitted from 2010-2011 onwards)

FIFTH SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
D51	Numerical Methods	BS	4	-	-	4
D52	CMOS VLSI Systems	DC	3	1	-	4
D53	Microcontrollers	DC	4	-	-	4
D54	Wireless Communication Systems	DC	3	1	-	4
D55	Antennas and Wave Propagation	DC	3	-	-	3
D56	Data Communication Networks	DC	3	0	-	3
PRACTICAL						
D57	Digital Communication Lab	DC	0	-	3	1
D58	Microprocessors/Microcontrollers Lab	DC	0	-	3	1
Total			**20**	**2**	**6**	**24**

BS : Basic Science
HSS : Humanities and Social Science
ES : Engineering Science
DC : Department core
L : Lecture
T : Tutorial
P : Practical

Note:
1 Hour Lecture/Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

Elective Subjects:
DCA Statistical Signal Processing
DCB Advanced Digital Systems
DCC Digital Signal Processor
DCD Optical Communication and Networking
DCE ASIC Design
DCF Antenna for Wireless Communications
DCG Design of Power Supplies
DCH Embedded Systems
DCJ MIMO Wireless Communication Systems
DCK Communication Network Security
DCL Real Time Operating Systems
DCM Low Power VLSI Systems
DCN DSP with FPGA
DCO Data Compression
DCP Microelectronics
DCQ Digital Video Systems
DCR Satellite Image Analysis
DCS Optimum Signal Processing
DCT Radio Frequency Integrated Circuits

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Electronics and Communication) Program

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2010-2011 onwards)

FIFTH SEMESTER

S. No	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	D51	Numerical Methods	3	50	50	100	25	50
2	D52	CMOS VLSI Systems	3	50	50	100	25	50
3	D53	Microcontrollers	3	50	50	100	25	50
4	D54	Wireless Communication Systems	3	50	50	100	25	50
5	D55	Antennas and Wave Propagation	3	50	50	100	25	50
6	D56	Data Communication Networks	3	50	50	100	25	50
PRACTICAL								
7	D57	Digital Communication Lab	3	50	50	100	25	50
8	D58	Microprocessors/ Microcontrollers Lab	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks

Sub code	Lectures	Tutorial	Practical	Credit
D51	4	-	-	4

D51 Numerical Methods 4:0

(Common to E51, B51, G51)

Preamble: An engineering student needs to know some basic mathematical tools and techniques. This emphasizes the development of rigorous logical thinking and analytical skills of the student and appraises him the complete procedure for solving different kinds of problems that occur in engineering. Based on this, the course aims at giving adequate exposure in the numerical solutions in the field of polynomial and transcendental equations, simultaneous equations, interpolation, differentiation and integration, ordinary and partial differential equations.

Program Outcomes addressed

a. Graduate will demonstrate an ability to apply knowledge of Engineering and Information Technology in mathematics and Science.
b. Graduate will demonstrate an ability to identify, formulate and solve engineering problems.
c. Graduate will develop confidence for self education and ability to engage in life-long learning.

Competencies

At the end of the course the student should be able to

1. Differentiate between the analytical and numerical / approximate solutions for the problems in engineering and technology.
2. Apply the concept of solutions of algebraic and transcendental equations in engineering problems by formulating such equations.
3. Apply the different techniques for getting the solution of a system of simultaneous equations using direct and iterative methods.
4. Identify the importance of Eigen values for a matrix and calculate those using different techniques.
5. Interpolate and extrapolate the given data using different methods of interpolation with the help of various operators.
6. Apply the process of Numerical Integration to related problems of engineering and technology for getting approximate values of the given integral .
7. Formulate and Give Numerical solutions using various techniques for ODEs modeled in engineering and technology.
8. Formulate and Give Numerical solutions using various techniques for PDEs modeled in engineering and technology.

Assessment Pattern

	Bloom's category	Test 1	Test 2	Test 3 / End Semester Examination
1	Remember	10	10	0
2	Understand	30	30	30
3	Apply	60	60	70
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning objectives

Understand

1. Compare the exact solution and approximate solution of equations
2. Discuss the various techniques for the approximate solution of Algebraic and transcendental equations.
3. List the various methods for obtaining the approximate solution of system of simultaneous equations stating the basic principles used.
4. Discuss the various methods to interpolate and extrapolate the given data using various methods of interpolation.
5. Interpret the importance and significance of the process of numerical integration.

Apply

1. Solve the following system of equations by Gauss Jacobi method

   $8x + y + z = 8$; $2x + 4y + z = 4$; $x + 3y + 3z = 5.$

2. Using Newton's method find the root of $x^3 - 4x^2 + x + 6 = 0$; $x_0 = 5$ correct to 4 decimal places

3. Using Lagrange's formula for interpolation find $y(9.5)$ given:

x	:	7	8	9	10
y	:	3	1	1	9

4. The following data gives the velocity of the particle for 2 seconds at an interval of 5 seconds. Find the acceleration at 5 seconds

Time	:	0	5	10	15	20
Velocity	:	0	3	14	69	228

5. Compute $\int_0^6 \frac{dx}{1+x}$, using Simpson's $\frac{1}{3}rd$ and $\frac{3}{8}th$ rule.

6. Find the value of $y(0.2)$ *and* $y(0.4)$ using Runge-Kutta method of fourth order with h=0.2 given that $\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2}$; $y(0) = 1$.

7. Solve : $u_t = u_{xx}$ given $u(0,t) = 0$; $u(x,0) = x(1-x)$; $u(1,t) = 0$; assume h=0.1 and choose suitable k so that u(i,j) is found out for i=0,0.1…1 and j=k,2k,3k.

Course contents and lecture schedule

No	Topic	No. of Lectures
1	**Solution of transcendental and polynomial equations**	
1.1	Bisection , Regulafalsi , Newton- Raphson method	3
1.2	Iterative method	2
1.3	Horner's method	3
1.4	Graffe's root squaring method	2
2	**Solution to system of equations**	
2.1	Gauss elimination and Gauss Jordan methods	2
2.2	Crout's method	2
2.3	Gauss Jacobi and Gauss siedal methods.	2
2.4	Inversion by Gauss Jordan and Crout's methods.	2
2.5	Power method and Jacobi method for finding eigen values	2
3	**Interpolation, Differentiation and integration**	
3.1	Newton Gregory's forward and backward difference interpolation formulae	2
3.2	Gauss's and Lagrange's interpolation formulae	2
3.3	Newton's forward formulae for derivatives	2
3.4	Trapezoidal, Simpson's 1/3rd & 3/8th Rules	2
3.5	Gauss quadrature ,1 point , 2 point and 3 point formulae	2
4	**Ordinary Differential equations**	
4.1	Introduction – Initial value problems	2
4.2	Runge- Kutta Methods-second and fourth order	2
4.3	Predictor corrector methods-Milne and Adams	2
4.4	Boundary value problems Finite difference method.	2
4.5	Numerov's method	2
5	**Partial Differential equations**	
5.1	Introduction, Classification of PDEs.	2
5.2	Solution of parabolic equations-Implicit and explicitmethods,	3

	Bender Schmidt method, Crank Nicholson Method	
5.3	Solution of hyperbolic equations by explicit scheme.	3
5.4	Solution of elliptic equations - Leibmann's process	2
	Total	**50**

Note: Students are required to submit one assignment in application oriented problems using MATLAB

Syllabus

Solution of Transcendental and Polynomial Equations: Bisection, Regula falsi, Newton-Raphson, Iterative Methods, Horner's Method, Giraeffes Root Squaring Method.

Solution to System of Equations: Gauss Elimination, Gauss Jordan, Crouts, Gauss Seidel, Gauss Jacobi, Inversion by Gauss Jordan and Crout's Method.

Eigen Values: Power method, Jacobi Method.

Interpolation and Differentiation: Newton's forward difference interpolation and differentiation formula and backward difference interpolation and differentiation formula, Gauss's Forward difference interpolation and differentiation formula and backward difference interpolation formula, Lagrange's Interpolation formula. Newton's formulae for derivatives.

Integration:

Trapezoidal, Simpson's $1/3$ rd , $3/8$ th rules, Gauss quadrature 1point, 2point, 3point formula

Ordinary Differential Equations:
Initial value Problem - Runge-Kutta Method, Predictor-Corrector Methods -Milne's, Adams -Boundary Value Problem - Finite difference Method- Numerov's method

Partial Differential Equations:
Classification: Parabolic (Schmidt)-Hyperbolic- Elliptic- Implicit and Explicit methods, Crank Nicholson method.

Text Book:
Jain.M.K., Iyengar.S.R.K., JainR.K., "Numerical Methods for Scientific and Engineering Computation"-Fifth edition, New Age International Publishers, New Delhi-2009.

Reference Books:

1. Robert.J Schilling, Sandra L.Harris "Applied Numerical Methods for Engineers using Matlab and C" Thomson Books/cole,1999
2. Sastry S.S "Introductory Methods of Numerical Analysis" Prentice Hall of India -2006

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D52	3	1	-	4

D52 CMOS VLSI Systems 4:0

Preamble: The proposed course is offered in the fifth semester. This course 'D52: CMOS VLSI Systems' , a departmental core course, is preceded by a three credit course 'D23 – Basics of Digital Systems' offered in second semester and four credit courses 'D32: Analog Circuits and Systems' offered in third semester, and 'D42: Designing with PLDs and FPGAs' offered in fourth semester. This course will be followed by a elective course: ASIC Design. The course aims at understanding the basic concepts of Digital CMOS VLSI circuit design by studying logic design, physical structure and fabrication of semiconductor devices and how they are combined to build systems for efficient data processing.

Program Outcomes addressed:

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.
k. Graduate who can participate and succeed in competitive examinations.

Competencies:

1. Understand the design flow of digital VLSI circuits
2. Explain the CMOS logic circuit elements used in designing digital VLSI circuits
3. Understand the electrical characteristics of CMOS logic circuit elements.
4. Demonstrate and understanding of the fabrication of and layout design rules for CMOS VLSI circuits
5. Design VLSI system components including multiplexers, decoders, latches, flip-flops and registers.
6. Design VLSI arithmetic circuits including adders and multipliers
7. Design clocking mechanisms to meet the system performance requirements

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	10	0
2	Understand	30	30	20
3	Apply	40	40	40
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	10	20	40

Course Level Learning Objectives

Remember

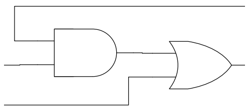
1. Draw schematic of CMOS Transmission gate.
2. Define fall time.
3. Write the formula for Inductance of CMOS transistors.
4. Define Crosstalk.
5. Explain the fabrication process of n-well Process.
6. With an example, explain the operation of Static CMOS Logic Circuit.
7. In the context of Low power design explain in detail about the sources of Power Dissipation.
8. Explain in detail about different types of Floor planning methods.
9. Explain the principle of operation of Clock distribution circuits.
10. Draw the schematic for Enhancement and depletion mode transistors.
11. Define epitaxy.
12. List any two CMOS design rules.
13. Define fall time.
14. Write the formula for Resistance of CMOS transistors.
15. Draw the schematic of Pseudo-nmos CMOS inverter.

Understand

1. What is the difference between Enhancement and depletion mode transistors?
2. What do you mean by body effect?
3. What do you understand by Transient analysis?
4. What is meant by one hot encoding?
5. Discuss in detail about any three second order effects.
6. Discuss about Path Sensitization Technique and D algorithm.
7. What is the concept of charge sharing? Explain with suitable diagram.

Apply

1. An AND-OR logic is described by the schematic.
    a. Construct the nFET array using the logic diagram.



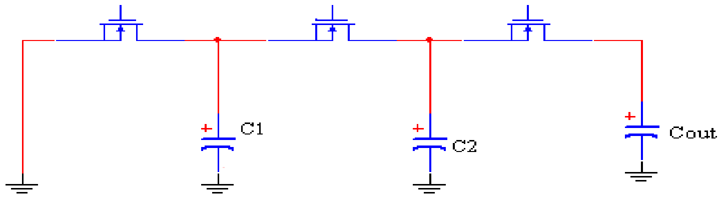
2. Construct the RC switch Model for the FET layout specifications. Assume a power supply voltage of 3 V.
    a. L'= 0.5 um　　　　Lo = 0.05 um
    b. Vton = 0.6 v　　　　k'n = 150 uA/V^2
    c. Cox = 2.70 x 10^{-15} F/um^2　　　　Cj = 0.86 x 10^{-15} F/um^2
    d. Cjsw = 0.24 x 10^{-15} F/um^2　　　　X= 2 microns, W= 6 microns

3. An inverter uses FETs with bn = 2.1 ma/v^2 and bp = 1.8 ma/v^2.The threshold voltages are given as Vtn = 0.6 V and Vtp = -0.7 V and the power supply has a value of 5V.The parasitic capacitance at the output node is C_{out} = 74 x 10^{-15} F.
    i) Find the mid point Voltage Vm
    ii) Find the values of Rn and Rp.
    iii) Calculate the rise time and fall time when C_L = 0
    iv) Calculate the rise time and fall time when C_L = 115 x 10^{-15} F
    v) Plot tr and tf as functions of C_L

4. A interconnect has the geometry with Tox = 0.9 um, w = 0.35 um and t = 1.10 um. The interconnect line has a sheet resistance of Rs = 0.04 ohms.
    - Find the value of 'c' predicted by the empirical expression that includes fringing.
    - Find the values of R_{line} and C_{line} if the line is 48um long.
    - Construct an m=7 RC ladder equivalent for the line, then use the model to determine time constant.

5. Draw the small signal model for a MOS Transistor and derive the expression for g_m,g_{ds}.
6. Derive the expression for Rise time of CMOS Inverter
7. Derive the Basic DC Equations for the three modes of operations of CMOS inverter.
8. Derive the expression for Mid point voltage for CMOS inverter using DC Characteristics.
9. Derive the expression for CMOS Capacitance.

10. Consider an nFET chain shown in figure below. This represents the portion NAND3 gate. The output capacitance has a value of C_{out} = 130 fF while the internal values are C1 = C2 = 36fF. The transistors are indentical with β_n = 2.0 mA/v^2 in a process where V_{DD}=3.3V and V_{Tn} = 0.70V.
    a. Find the discharge time constant for C_{out}=130fF using Elmore formula for LADDER RC network.
    b. Find the time constant if ignore C1 and C2.what is the percentage error introduced if we do not include the internal capacitors.



Create

1. Design a NAND3 gate using an 8:1 MUX.
2. Design a NOR3 gate using an 8:1 MUX as a basis.
3. Design a CMOS logic gate circuit the implements the function F = (a+b.c+a.b.c)′ using series-parallel logic. The objective is to minimize the transistor count.
4. Design a 4:1 MUX using three 2:1 TG multiplexors.
5. Using transmission gates, design a 2:1 MUX circuit.
6. Consider the OAI Logic Function g = (a+b).(c+d).e. Design the CMOS Logic gate and then construct a basic layout for the circuit.
7. Consider the logic function g= (a.b.c + d)′. Design a CMOS logic gate for this function.
8. Draw the Pseudo-nmos circuit for the functions

   i) F= (a+(c.[x+(y.z)]))′ ii) h=((a+b+c).x + y.z)′
9. a) Design a 4:1 mux using transmission gates (TG).

   b) Use the verilog CMOS primitive to write a structural description of your circuit.

   c) Construct a RC equivalent circuit for the mux assuming that the resistance of the TG is R and each side of the switch has the capacitance C. Then use the Elmore formula to find the delay time constant of the worst case path through the multiplexor.

10. Construct a verilog module listing for a 16:1 mux that is based on the assign statement. Use a four bit select word $S_3S_2S_1S_0$ to map the selected input P_i(i=0 to 15) to the output . Consider a 8:1 multiplexer that is constructed using smaller muxes as primitives.
11. a) Construct an 8:1 multiplexer using 4:1 and 2:1 mux units.

    b) Select a logic circuit to implement the design.

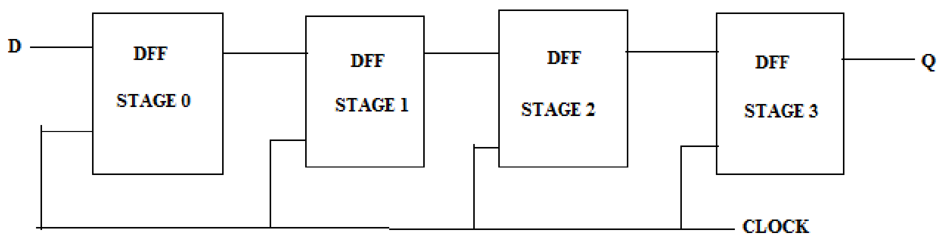
    c) Assume that the gates are built using static CMOS circuits. Apply the technique of the logical effort to design the gates if the output of the 8:1 mux is to drive a capacitor C_{out} that is 10 C_{inv} is the capacitance of the unit inverter.
12. Design a 2/4 active high decoder using only transmission gates in the main logic paths. Then construct the verilog description of your network with CMOS primitive.
13. Design a 2/4 active low decoder using NOR gates. Then

    a) Construct the verilog structural listing

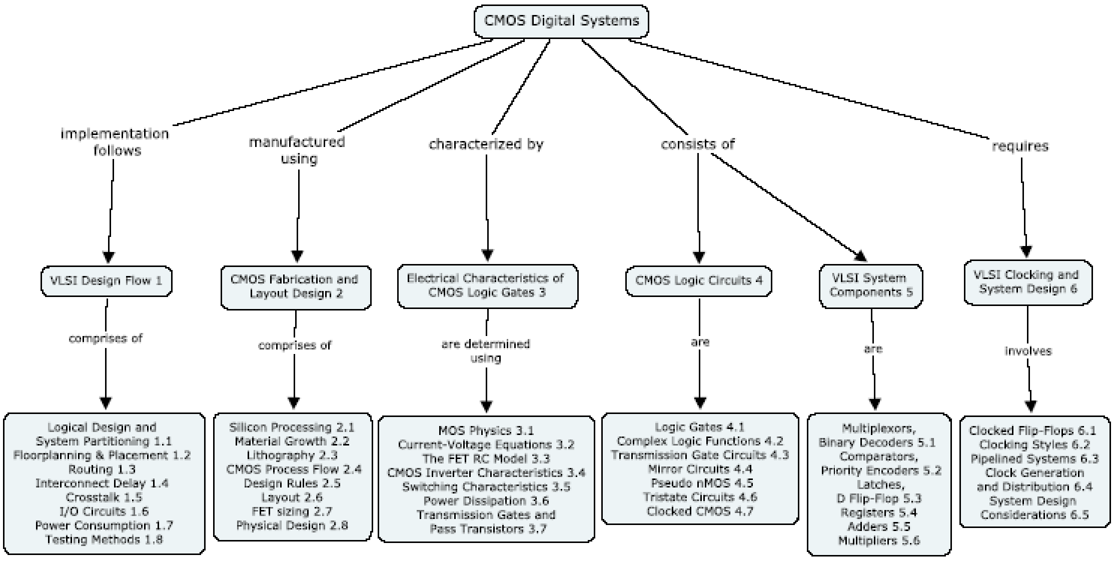
    b) Modify your verilog code to include an input enable to build a new circuit
14. Design a 4:1 mux using standard dynamic or domino CMOS logic.
15. Design a 4 bit left or right notation unit that specifies the number of bits in the rotation by a 2 bit word $OR_{0-}n$, and the direction of rotation by a single bit R/L such that R/L=1 denotes a right rotation and R/L=0 is a left rotation.
16. Construct a verilog module for an 8 bit register that loads words on rising clock edges if the control bit E_n=1, you may use any level of description.
17. a) Write a verilog description of the shift register using DFF modules as primitives.

    b) Select a CMOS design technique for the DFF and use it to construct the circuit.

    c) Now write a verilog description of the shift register using nmos and pmos primitives.



Concept Map



Syllabus

VLSI Design flow: Logical Design and System Partitioning, Floorplanning and Placement, Global and Detailed Routing, Interconnect Delay Modeling, Crosstalk and Interconnect Scaling, Input and Output Circuits, Power Distribution and Consumption, Testing and Test Generation Methods. **CMOS Fabrication and Layout Design:** Overview of Silicon Processing, Material Growth and Deposition, Lithography, The CMOS Process Flow, Stick Diagram and Layout Design Rules, Layout of Basic Structures, FET sizing and the Unit Transistor, Physical Design of Logic Gates. **Electrical Characteristics of CMOS Logic Gates:** MOS Physics, nFET Current-Voltage Equations, The FET RC Model, DC Characteristics of the CMOS Inverter, Inverter Switching Characteristics, Power Dissipation, Transmission Gates and Pass Transistors. **CMOS Logic Circuits:** Logic Gates in CMOS, Complex logic functions in CMOS, Transmission Gate Circuits, Mirror Circuits, Pseudo nMOS, Tristate Circuits, Clocked CMOS. **VLSI System Components:** Multiplexors, Binary Decoders, Comparators, Priority Encoders, Latches, D Flip-Flop, Registers, Arithmetic Circuits – Adders, Arithmetic Circuits – Multipliers. **VLSI Clocking and System Design:** Clocked Flip-Flops, CMOS Clocking Styles, Pipelined Systems, Clock Generation and Distribution, System Design Considerations.

Text Book:

1. Uyemura, John P, "Introduction to VLSI Circuits and Systems". Wiley & Sons, 2001.

Reference Books:

1. N. Weste and K. Eshraghian, "Principles of CMOS VLSI Design", Second Edition, Addison-Wesley, 1993.
2. Weste Neil, David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 3rd Edition, Addison Wesley, 2004.
3. R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation", Wiley-IEEE, Revised Second Edition, 2008.
4. Pucknell, "Basic VLSI Design", Prentice Hall, 1995.
5. Wayne Wolf, "Modern VLSI Design: System On Chip", Pearson Education, 2002.
6. Jan M. Rabaey, "Digital Integrated Circuits: A Design Perspective", Prentice Hall, Second Edition, 2006.

Lecture Plan:

No.	Topic	No. of Lectures
1	**VLSI Design flow**	
1.1	Logical Design and System Partitioning	1
1.2	Floorplanning and Placement	1
1.3	Global and Detailed Routing	1
1.4	Interconnect Delay Modeling	1
1.5	Crosstalk and Interconnect Scaling	1
1.6	Input and Output Circuits	1
1.7	Power Distribution and Consumption	1
1.8	Testing and Test Generation methods	1
2	**CMOS Fabrication and Layout Design**	
2.1	Overview of Silicon Processing	1
2.2	Material Growth and Deposition	1
2.3	Lithography	1
2.4	The CMOS Process Flow	1
2.5	Stick Diagram and Layout Design Rules	1
2.6	Layout of Basic Structures	2
2.7	FET sizing and the Unit Transistor	1
2.8	Physical Design of Logic Gates	2

3.	**Electrical Characteristics of CMOS Logic Gates**	
3.1	MOS Physics	2
3.2	nFET Current-Voltage Equations	1
3.3	The FET RC Model	1
3.4	DC Characteristics of the CMOS Inverter	2
3.5	Inverter Switching Characteristics	2
3.6	Power Dissipation	1
3.7	Transmission Gates and Pass Transistors	2
4	**CMOS Logic Circuits**	
4.1	Logic Gates in CMOS	1
4.2	Complex logic functions in CMOS	2
4.3	Transmission Gate Circuits	1
4.4	Mirror Circuits	1
4.5	Pseudo nMOS	1
4.6	Tristate Circuits	1
4.7	Clocked CMOS	1
5	**VLSI System Components**	
5.1	Multiplexors, Binary Decoders	1
5.2	Comparators, Priority Encoders	1
5.3	Latches, D Flip-Flop	1
5.4	Registers	1
5.5	Arithmetic Circuits – Adders	2
5.6	Arithmetic Circuits – Multipliers	2
6	**VLSI Clocking and System Design**	
6.1	Clocked Flip-Flops	1
6.2	CMOS Clocking Styles	1
6.3	Pipelined Systems	1
6.4	Clock Generation and Distribution	1
6.5	System Design Considerations	1

Course Designers:

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Sub code	Lectures	Tutorial	Practical	Credit
D53	4	-	-	4

D53 Microcontrollers 4:0

Preamble: This course attempts to make the students familiar with the architecture and instruction set of a range of 8 bit and 16 bit micro controllers. A brief introduction on Intel 8051 micro controller is included in view of its architectural simplicity. Free scale S12 microcontroller is considered for more detailed treatment of 16 bit architecture and assembly language programming as they serve as any application development in microcontrollers used in embedded system. Free scale microcontroller core and its different variants which are currently popular are considered in detail. Programming and Interfacing with S12 architecture is covered in detailed manner.

Program outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

f. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

1. Understand the difference between Microprocessor and controller used in PCs and embedded system.
2. Explain the architecture and instruction set of Intel 8 bit microcontroller.
3. Explain the architecture and instruction set of Free scale 16 bit micro controller
4. Generate assembly language programs for performing single and multi precision functions on 8051 and comparing with free scale controller.
5. Generate C programs using CodeWarrior for accessing the peripherals of 8051 and S12 micro controller.
6. Handling responses to interrupts and exceptions in 8051 and S12 controller.
7. Design of 8051 and HCS12 based tiny embedded system for industrial and domestic use.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	20	0
2	Understand	40	30	30
3	Apply	40	40	30
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	40

Course Level Learning Objectives

Remember

1. What do you mean by addressing mode?
2. What are assembler directives and macros?
3. List the level triggered and edge triggered interrupts in S12 controller.
4. Write the Programming model of S12 coldfire controller
5. What is an inherent and extended addressing modes in S12?
6. List S12 debug utility subroutines.
7. What is a security byte in S12?
8. Given the two binary values 10000001B and11011101B in a memory location and accumulator B respectively, what will be the content of the result flags after the execution of the ORAB?

Understand

1. Differentiate Von-Neuman and Harvard architecture.
2. Differentiate between a CISC and RISC architecture.
3. How do you clear I bit of the CCR without changing other CCR bits?
4. What would be difference of replacing ANDA instruction with the BITA instruction?
5. Distinguish between a non-maskable and maskable interrupts.
6. Differentiate Capture compare and enhanced capture timers.

Apply

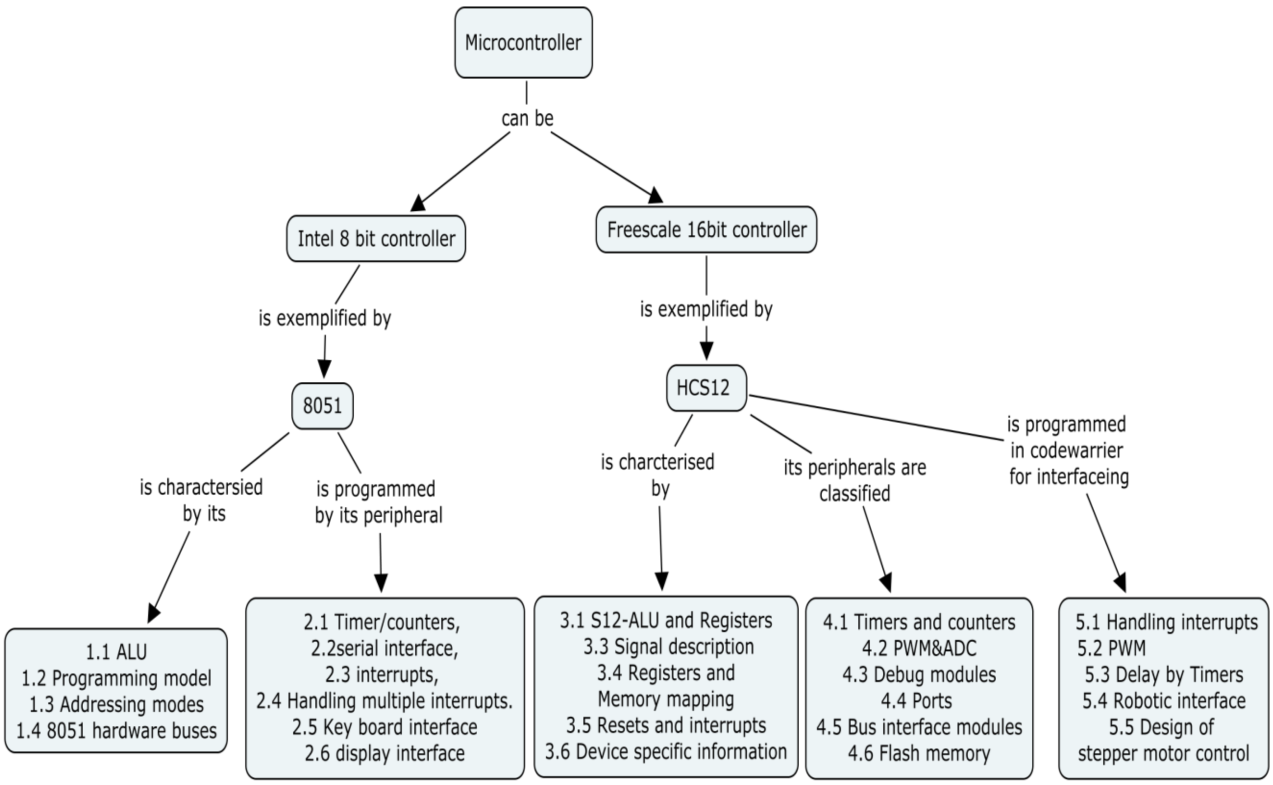
1. Develop a fuzzy logic controller to control the inside temperature of your house.
2. Develop an assembly level program for computing Fibonacci function with less memory usage.
3. Develop a C program for S12 controller for accessing an IO using polling method and interrupt driven method.

4. Develop an assembly program for single and multi precision MAC operation in S12.
5. Develop a C program to access a SPI of and external RTC.
6. Develop an embedded instruments for Temperature Data logger

Create

1. Design a system which can compute reaction time of key stroke entry.
2. Design a digital clock using internal timer of 8051.
3. Design a system to assist electronic door security.
4. Design and develop an electronic system to control DC motor.
5. Interface a mobile robot and to make forward and reverse motion.
6. Design a data acquisition system for temperature and pressure monitoring.

Concept Map



Syllabus

8051 Microcontroller: Introduction to microcontrollers and peripherals. Architectures and programming model, Instructions sets and 8051 Hardware. **8051 Peripherals:** Timer/counters, serial interface, interrupts, and handling multiple interrupts. Programming on 8051: Key board interface and display interface. **Cold fire S12 micro controller introduction:** S2-Architecture and signal description, Memory mapping, registers, Modes of operation, Resets and interrupts. Free scale device specific information. **S12 Peripherals:** Timers/counters, ADC, Debug modules, Ports, Memory interface modules and Flash memory. **S12 programming with codewarrier:** Instructions set, addressing modes, Assembler directives, and basic programming. Programming for Flash memory, Programming for serial communication, Programming for interrupts, handling interrupts, PWM and timers. A case study on Fuzzy logic implementation.

Text books:

1. Kennath J.Ayala, "The 8051 Microcontroller Architecture, Programming and Application", 2nd Edition.
2. Daniel J. Pack and Steven F. Barrett, "Microcontroller Theory and Applications HC12 and S12", Prentice Hall, October 2007.

Course Contents and Lecture Schedule

S.No	Topic	Number of Lecture hours
1	**Intel 8 bit Microcontroller**	
1.1	8051 Introduction and its architecture.	1
1.2	Programming model, Instruction sets	2
1.3	Addressing modes	1
1.4	8051 Hardware design and Testing	2
2	**8051 Peripherals.**	
2.1	Timer/Counters-Intro, modes of operation and uses	1
2.2	Serial interface ,	2
2.3	Interrupts types and its handling.	1
2.4	Handling Multiple interrupts	1

2.5	Key Board interface- Lead per key and Matrix KB	2
2.6	Display interface- LED and LCD	2
3	**Free Scale 16 bit controller**	
3.1	Introduction to HC12 controller.	1
3.2	S12 ALU, Registers and instructions.	4
3.3	Signal Description	1
3.4	Registers and Memory Mapping	2
3.5	Resets and Interrupts	1
3.6	Device Specific Information	1
4	**HC12 Peripherals**	
4.1	Timer/Counter- Modes of operation	2
4.2	PWM and ADC	2
4.3	Debug modules for HC12	2
4.4	General and specific purpose ports	1
4.5	Bus interface modules and Flash memory	2
5	**Programming on HC12**	
5.1	Interrupt handling	1
5.2	PWM based control program.	2
5.3	Software and Hardware delay.	1
5.4	Case study on robotic motor interface.	2

Course designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
D54	3	1	-	4

D54 Wireless Communication Systems 3:1

Preamble: The course 'D54 Wireless Communication Systems' is offered in the fifth semester in continuation with the course on 'D44: Digital Communication Systems' and 'D34 Analog Communication Systems'. Wireless communications has been the most vibrant area in the communication field for the past 10 years, though this has been the topic over 100 years with the invention of the radio telegraph by Guglielmo Marconi. Compared to the wire-line communication, dealing with the fading and multipath interference is vital to the design of wireless communication systems on meeting the increasing demand for higher data rates and techniques to improve spectral efficiency and link reliability. Now, the use of multiple antennas at the transmitter and /or the receiver in a wireless system, popularly known as Multiple Input Multiple Output (MIMO) wireless systems has become as a matured and promising technology for dealing with the fading and interference. The objective of this course is to present the techniques in the physical layer aspects of wireless communication systems and determine the performance of Wireless systems in terms of capacity and probability of error.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies: At the end of the course, a student will be able to

1. Describe the cellular concept of Wireless Communication Systems
2. Characterize the wireless Channel in terms of large scale path loss and fading
3. Characterize the rapid fluctuations of wireless Channel in terms of small scale fading and multipath parameters
4. Determine the capacity, and bit error rate for a given digital modulation scheme of wireless communication system in AWGN
5. Determine the capacity, and bit error rate for a given digital modulation scheme of wireless communication system in Reyleigh fading environment

6. Determine the capacity, and bit error rate for a given digital modulation scheme of wireless communication system in frequency selective fading environment
7. Architect a wireless communication system as per given specifications.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	20	10
2	Understand	20	20	10
3	Apply	60	60	60
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	20

Course level Learning Objectives

Remember:

1. Define slow and fast fading.
2. Define coherence bandwidth and delay spread.
3. List the parameters that are used to define the multipath channel?
4. List the different types of small scale fading.
5. Define the term co channel interference and adjacent channel interference.
6. What are the re-use factors for the wireless standards namely AMPS, GSM and IS-95 systems?
7. Define outage capacity.
8. Draw the block diagram of forward CDMA channel modulation process IS-95 system. Describe each block in it.

Understand:

1. Distinguish between flat fading and frequency selective fading.
2. A Wireless channel has a multipath spread of 1msec. The total channel bandwidth at bandpass available for signal transmission is 5KHz. Determine the coherence bandwidth. Is the channel frequency selective? Justify.
3. Differentiate between soft and hard handoffs.
4. Distinguish between the power limited region and bandwidth limited region in the bandwidth Vs capacity curve?
5. When the demand for wireless service increases, how is it possible to provide more channels per unit coverage area?

6. Consider an AWGN Channel with bandwidth 50MHz, received power 10mwatts, and noise power spectral density $N_0 = 2$x10^{-9}W/Hz.How much does capacity increase by doubling the received power? How much does capacity increase by doubling the channel bandwidth?
7. What is the maximum bit rate that can be sent through the channel with out needing an equalizer, if the RMS delay spread is $0.5\mu s$
8. In mobile multipath channels, if the baseband signal bandwidth is much greater than Doppler spread how do you name the channel? Why is it called so?

Apply:

1. Calculate Brewster angle for a wave impinging on ground having permittivity of $\varepsilon_r = 5$
2. Find the capacity of AWGN Channel has a bandwidth of 1MHz,signal power is 10watts and noise spectral density is 10^{-9}Watts/Hz.
3. Determine the capacity of slow fading channel and prove that the outage probability is $P_{out}(R) = \dfrac{2^R - 1}{SNR}$ where R is the data rate.
4. Find the far field distance for an antenna with maximum distance of 0.5M and operating frequency of 900MHz.
5. If 20MHz of total spectrum is allocated for a duplex wireless cellular system and each simplex channel has 25KHz RF bandwidth, find the number of simplex channels.
6. In a digital cellular equalizer if f=800MHz and the mobile velocity V=90Km/Hr determine the maximum number of symbols that could be transmitted without updating the equalizer assuming a symbol rate of 25.3symbols/sec.
7. Assume four branch diversity is used where each branch receives an independent Rayleigh fading signal. If the average SNR is 20 dB determine the probability that it will drop below 5dB. If the receiver is without diversity what will be the case.
8. Assume a mobile traveling at a velocity of 10m/sec receives two multipath components at a carrier frequency of 1000MHz.The first component is assumed to arrive at $\tau = 0$ with an initial phase of 0 degree and the power of -70dBm and the second component which is 3dB weaker that the first component is assumed to arrive at $\tau = 1\mu s$ also with a initial phase of 0 dB. If the mobile moves directly towards the direction of arrival of the first component and directly away from the direction of arrival the second

component, compute the average narrow band power received over this observation interval.

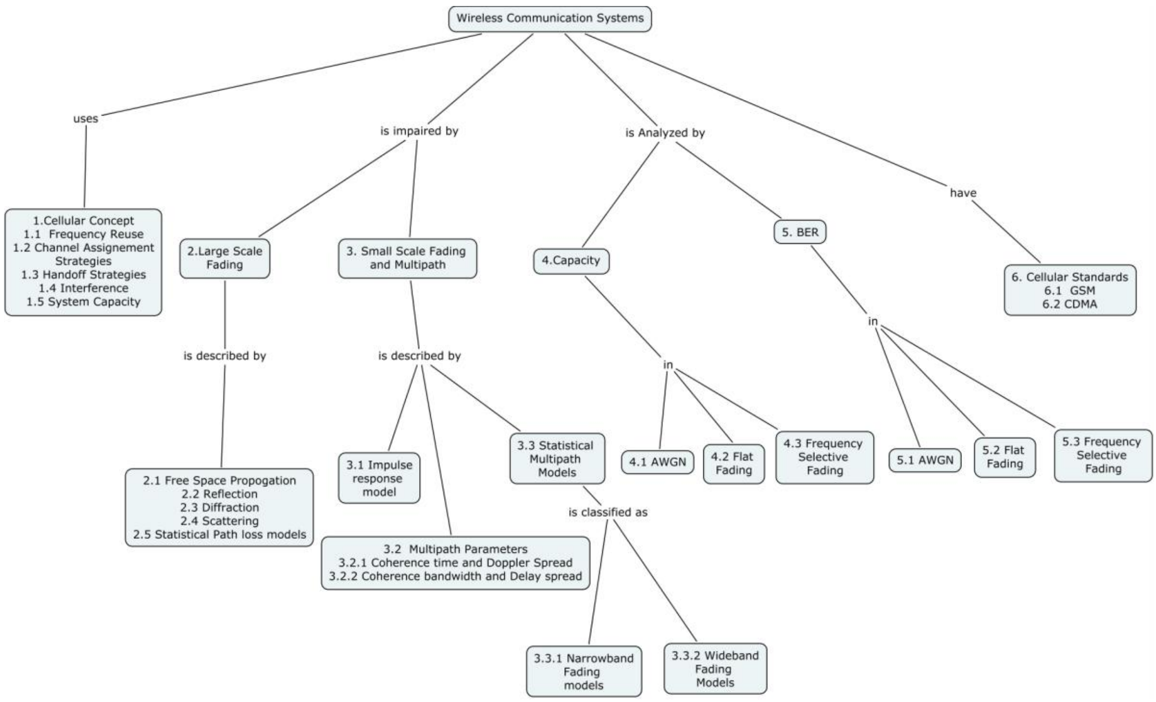
9. Consider a transmitter which radiates a sinusoidal carrier frequency of 1850MHz for a vehicle moving 60m/Hr, Compute the received carrier frequency if the mobile is moving (i) Directly towards the transmitter (ii) Directly away from the transmitter and (iii) in a direction which is perpendicular to the direction of arrival of the transmitter signal.
10. If a total of 33MHz of bandwidth is allocated to a particular FDD Cellular telephone system which uses two 25KHz simplex channels to provide full duplex voice and control channels, Compute the number of channels available per cell if a system uses (a) four cell reuse (b) seven cell reuse and (c) 12 cell reuse. If 1MHz of the allocated spectrum of control channels and voice channels in each cell for each of the three systems.
11. If a signal to interference ratio of 15 dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity if the path loss exponent is (a) n=4 (b) n=3 Assume that there are 6 co-channel cells in the first tier and all of them are at the same distance from the mobile. Use suitable approximations.
12. Assume each user of a single base station mobile radio system averages three calls per hour, each call lasting an average of 5 minutes.
    - What is the traffic intensity for each user?
    - Find the number of users that could use the system with 1% blocking if only one channel is available.
    - Find the number of users that could use the system with 1% blocking if five trunked channels are available.
    - If the number of users you found in above is suddenly doubled, what is the new blocking probability of the five channel trunked mobile radio system? Would this be acceptable performance? Justify why or why not.
13. Determine the maximum and minimum spectral efficiencies received from a stationary GSM transmitter that has a center frequency of exactly 1950MHz, assuming that the receiver is traveling at speeds of (a) 1km/hr, (b) 5km/hr (c) 1000km/hr

Analyze:

1. Analyze the BER performance of wireless communication system that uses BPSK modulation scheme in AWGN environment. If the BPSK signal constellation is rotated by 45^0, what will be the BER performance. Compare and give your inference.

2. A mobile unit is located 6km away from a base station and uses a vertical $\lambda/4$ monopole antenna with a gain of 3dB to receive cellular radio signals. The E field at 1km from the transmitter is measured to be 10^{-3}V/M.The carrier frequency used for this system is 900MHz.
   - Analyze the above case with the ground reflection model.
   - Find the length of the antenna
   - Find the path loss for the two ray model(assume missing data)
   - Find the received power at the mobile using the two ray ground reflection model assuming $h_T = 60m$ and $h_R = 1.5m$ above ground.
3. For a channel with Doppler spread $B_d = 80Hz$, What time separation is required in samples of the received signal such that the samples are approximately independent.
4. A Transmitter provides 15W to an antenna having 12dB gain. The receiver Antenna has a gain of 3 dB and the receiver bandwidth is 30KHz. If the receiver system noise figure is 8 dB and the carrier frequency is 1800MHz, Determine the maximum T-R separation that will ensure that a SNR of 20 dB is provided for 95% of the time. Assume n=4, $\sigma = 8dB$ and d_0=1km.
5. Consider a time invariant frequency selective block fading channel consists of three sub-channels of bandwidth $B = 1MHz$.The frequency response associated with each channel is H_1=1, H_2=2 and H_3=3. The transmit power constraint is P=10MW and the noise Power spectral density is $N_0 = 10^{-9} W/Hz$. Find the optimal power allocation that achieves this Shannon capacity of the channel.
6. A Vehicle receives a 900MHz transmission while traveling at a constant Velocity for 10s. The average fade duration for a signal level 10 dB below the rms level is 1ms. How far does the vehicle travel during the 10s interval? How many fades does the signal undergo at the rms threshold level during the a 10s interval? Assume that the local mean remains constant during travel.

Concept Map



Syllabus

Cellular Concept: Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference, System Capacity **Large Scale Fading:** Free space Propagation, Reflection: Ground Reflection Model, Diffraction: Fresnel Zone Geometry, Knife edge Diffraction Model, Multiple Knife edge Diffraction, Scattering: Radar Cross Section Model, Statistical Path loss Models: Log – distance Path loss model, Log – normal Shadowing, **Small scale fading and Multipath:** Impulse response model, Multipath Parameters: Coherence time and Doppler spread, Coherence bandwidth and Delay spread, Statistical Multipath Models: Narrow band Fading Models: Autocorrelation, Cross Correlation and Power spectral density, Envelope and power distributions, Level Crossing rate and average fade duration, Finite rate Markov Channels, Wideband Fading Models: Power delay profile, Coherence bandwidth, Doppler power spectrum and channel coherence time, Transforms for autocorrelation and scattering functions, **Capacity of Wireless Communication systems:** Capacity in AWGN, Capacity of Flat fading Channels, Channel and system model, Channel Distribution Information(CDI) Known, Channel Side Information at Receiver, Channel Side Information at transmitter and receiver, Capacity of frequency selective fading Channels, Time Invariant Channels, Time varying Channels, **Bit Error Rate Analysis:** BER Performance Analysis in AWGN, flat fading and frequency selective fading channels, Cellular Standards: Global System Mobile(GSM), CDMA(Code Division Multiple Access)

Text Book:

1. Theddore S.Rappaport, " Wireless Communications: Principles and Practice", Second Edition, PHI,2006
2. Andrea Goldsmith, " Wireless Communications", Cambridge University Press, 2005

Reference Books

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communications", Cambridge University Press, 2005 (First Asian Edition, 2006)
2. A. Paulraj, R. Nabar and D Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2003.
3. John G. Proakis, "Digital Communications", McGrawHill, 2000

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
I.	**Introduction:**	
a.	Evolution of Wireless Communications	1
b.	Wireless Systems and Standards	1
1	**Cellular Concept**	
1.1	Frequency Reuse	1
1.2	Channel Assignment Strategies	1
1.3	Handoff Strategies	1
1.4	Interference	2
1.5	System Capacity	1
2.	**Large Scale Fading**	
2.1	Free space Propagation	1
2.2	Reflection	
2.2.1	Ground Reflection(Two Ray) Model	1
2.3	Diffraction	
2.3.1	Fresnel Zone Geometry	1
2.3.2	Knife edge Diffraction Model	1
2.3.3	Multiple Knife edge Diffraction	1
2.4	Scattering	
2.4.1	Radar Cross Section Model	1
2.5	Statistical Path loss Models	

2.5.1	Log – distance Path loss model	1
2.5.2	Log – normal Shadowing	1
3.	**Small scale fading and Multipath**	
3.1	Impulse response model	1
3.2	Multipath Parameters	1
3.2.1	Coherence time and Doppler spread	1
3.2.2	Coherence bandwidth and Delay spread	1
3.3	Statistical Multipath Models	
3.3.1	Narrow band Fading Models	1
3.3.1.1	Autocorrelation, Cross Correlation and Power spectral density	1
3.3.1.2	Envelope and power distributions	1
3.3.1.3	Level Crossing rate and average fade duration	1
3.3.1.4	Finite rate Markov Channels	1
3.3.2	Wideband Fading Models	
3.3.2.1	Power delay profile,	1
3.3.2.2	Coherence bandwidth	1
3.3.2.3	Doppler power spectrum and channel coherence time	1
3.3.2.4	Transforms for autocorrelation and scattering functions	1
4	**Capacity of Wireless Communication systems**	
4.1	Capacity in AWGN	1
4.2	Capacity of Flat fading Channels	2
4.2.1	Channel and system model	1
4.2.2	Channel Distribution Information(CDI) Known	1
4.2.3	Channel Side Information at Receiver	1
4.2.4	Channel Side Information at transmitter and receiver	1
4.3	Capacity of frequency selective fading Channels	
4.3.1	Time Invariant Channels	2
4.3.2	Time varying Channels	2
5	**Bit Error Rate Analysis**	
5.1	BER Performance Analysis in AWGN Systems	2
5.2	BER Performance Analysis for Flat fading channels	2

5.3	BER Performance Analysis for Frequency selective fading channels	2
6	Cellular Standards	
6.1	Global System Mobile(GSM)	2
6.2	CDMA(Code Division Multiple Access)	2

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D55	3	0	-	3

D55 Antenna and Wave Propagation 3:0

Preamble: In the era of multimedia, Internet, Web-world, Mobile and Bluetooth, communication is becoming wireless. Antennas are important component in making wireless communication a reality.

This subject is essential to understand the fundamental principles of Antenna theory, and wave propagation with a lucid explanation of the basic concepts and equations. The primary objectives of Antenna and Wave Propagation are to carry information from source to destination and also to understand the basic theory of electromagnetic waves propagation from transmitter to receiver. This course explains how antenna converts the electric and magnetic energy in to a propagating wave and vice versa. This course also explains the various types of transmitting and receiving antennas including arrays which are used for conventional broadcasting and antennas such as helix, spiral, fractal antennas used for wireless applications. The course introduces simple design procedures for popular antennas.

One of the main competencies that a present day communication engineer has to acquire is the capability to design antennas for wireless applications that provide good bandwidth and gain.

Program Outcomes addressed

a. An ability to understand basic terminology associated with antennas and calculation of power radiated from an antenna and array
b. An ability to design antennas for any wireless applications for a given specification
e. An ability to calculate antenna parameters

Competencies: At the end of the course the student should be able to

1. Explain the process of radiation from an open ended transmission line
2. Explain the behavior of an antenna in terms its parameters
3. Compute the fields and radiation resistance of a family of antenna.
4. Select appropriate antenna for a given applications (TV, radar, wireless)
5. Design dipole, Yagi and patch antenna for a given specification
6. Measure the parameters of an antenna
7. Understand the mechanism of wave propagation

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	20	20	10
2	Understand	40	20	20
3	Apply	40	50	50
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	10	20

Course level Learning Objectives

Remember

1. Define Pattern multiplication
2. Define Maximum usable frequency
3. What are the applications of loop antenna?
4. Obtain the expression for radiated field and draw the pattern for a two element array of isotropic source with equal amplitude, phase shift 180º and element spacing $\lambda/4$.
5. Deduce the electric and magnetic field quantities and draw radiation pattern for a half wavelength dipole
6. Explain the construction and features of frequency independent antenna.

Understand

1. What is polarization of antenna? Does it depend on the respective RF source?
2. Why loop antennas are called as magnetic dipole?
3. Compare the performance of broadside array and end fire array?
4. A two element end-fire array in free space consists of 2 vertical side by side $\lambda/2$ elements with equal out of phase currents. At what angles in the horizontal plane is the field intensity maximum (a) when the spacing is $\lambda/2$? (b) when the spacing is λ?
5. Why high-gain antennas are normally used for EME (moon bounce) communications?
6. Which of the following antenna systems would be the best choice for an EME (moon bounce) station?
   A. A single dipole antenna
   B. An isotropic antenna
   C. A ground-plane antenna
   D. A high-gain array of Yagi antennas

7. How does the earth affect ground wave and space wave propagation?
8. How are VHF signals propagated within the range of the visible horizon?

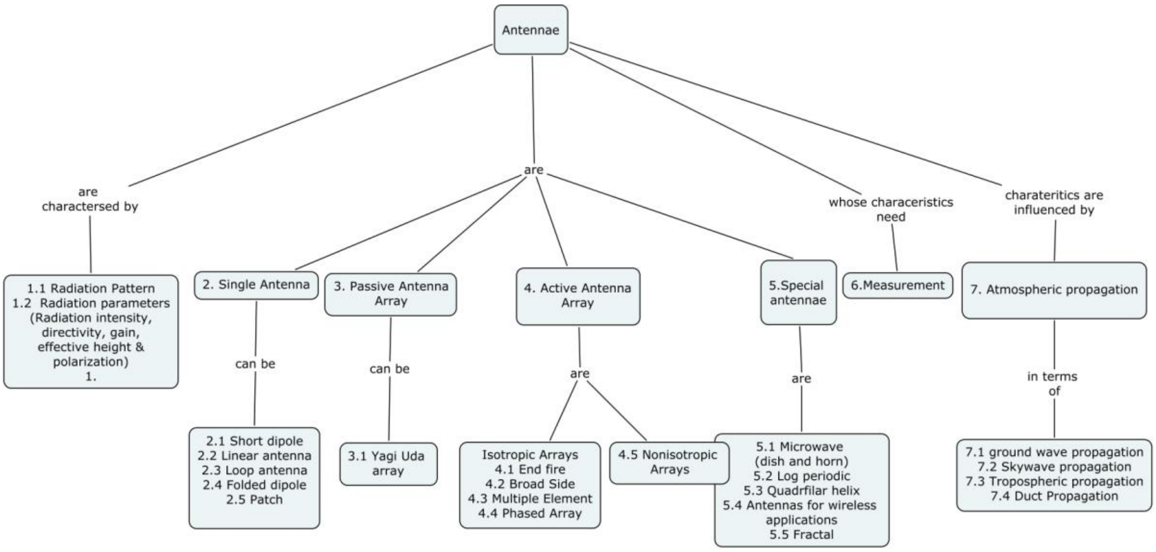
Apply

1. In a radio link, two identical antennas operating at 8GHz are used with power gain of 50db, If the transmitted power is 2.5KW, find the received power for the range of link of 40km.
2. Given a wire dipole of arbitrary length, determine and plot the current distribution of the dipole for its various lengths. Select the suitable length for dipole to give minimum beam width.
3. Two identical vertical radiator are spaced 'd= λ/2' meters apart and fed with currents of equal magnitude but with a phase difference 'β'. Evaluate the resultant radiation for the cases: (a) $\beta=0^{\circ}$ (b) $\beta=-90^{\circ}$ (c) $\beta=+90^{\circ}$ the and propose the phase condition for making the array as broadside array.
4. Justify that the log periodic antenna is suitable for wideband operation.
5. Why do we use high frequency waves in sky wave propagation?
6. Radio waves projected towards the atmosphere do not return if the frequency is raised above a particular frequency which also changes with the angle of projection. Explain.

Create:

1. Design an Aluminium rod dipole antenna operating in the frequency of 100.4MHz.
2. Design a log periodic antenna to operate from 100-500MHz with 11 elements. Give (a) the length of longest element (b) length of shortest element and (c) gain
3. Design a Yagi Uda six element antenna for operation at 500MHz with a folded dipole feed. (a) What is the dimension of the parasitic elements in the antenna (b) frequency band width?
4. Design a 4 element array of λ/2 spacing between elements. The radiation pattern is to have maximum in the direction perpendicular to the array axis.
5. Design a compact microstrip antenna resonating at the frequency of 2.4GHz
6. Design a low cost square patch antenna suitable for cellular mobile communication

Concept Map:



Syllabus:

Antenna Basics and Parameters- Radiation pattern, Parameters - Beam Area, Radiation intensity, Directivity, Gain, Antenna aperture, Effective height, Polarization- field zones, Case Study - Radio communication Link.

Antenna Family – Single antenna, Short dipole, Linear antenna, Loop antenna, Folded dipole, Design of dipole, folded dipole, Patch antenna and its design

Antenna array – Passive array - Yagi-uda antenna array

Antenna array – Active array - Isotropic Array – End fire, Isotropic Array – Broadside, Multiple element array, Phased array, Non isotropic array.

Antennas for special applications - Microwave antennas (Dish, horn), Log periodic antenna, Quadrafilar helix antenna, Antennas for wireless applications, Fractal antenna.

Antenna Measurements – Gain Radiation Pattern measurement

Wave propagation - Ground wave propagation, Sky wave propagation, Tropospheric propagation, Duct propagation.

Text books:

1. John D.Kraus, Ronald J.Marhefka “Antennas for all Applications” Fourth Edition, Tata McGraw- Hill, 2006.
2. K.D.Prasad “Antenna and wave propagation”, Satya prakashan,1996.

Reference books:

1. Constantine A,Balanis "Antenna Theory: Analysis and Design", John Wiley ublishers,2003.
2. H.Griffiths, J.Encianas, A.Papiernik & Serge Drabowitch "Modern Antennas" Chapman & Hall, 1998.

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Antenna Basics and Parameters:**	
1.1	Radiation pattern	2
1.2	Parameters - Beam Area, Radiation intensity, Directivity, Gain, Antenna aperture, Effective height, Polarization- field zones	4
1.2.1	Case Study - Radio communication Link	1
2	**Antenna Family – Single antenna**	
2.1	Short dipole	2
2.2	Linear antenna	2
2.3	Loop antenna	1
2.4	Folded dipole and Design	2
2.5	Patch antenna and design	1
3	**Antenna array – Passive array**	
3.1	Yagi-uda antenna array, design	1
4	**Antenna array – Active array**	
4.1	Isotropic Array – End fire	2
4.2	Isotropic Array – Broadside	2
4.3	Multiple element array	1
4.4	Phased array	1
4.5	Non isotropic array	1
5	**Antennas for special applications**	
5.1	Microwave antennas (Dish, horn)	2

5.2	Log periodic antenna	1
5.3	Quadrafilar helix antenna	1
5.4	Antennas for wireless applications	2
5.5	Fractal antenna	1
6	**Antenna Measurements**	
6.1	Gain and radiation pattern measurement	2
7	**Wave propagation**	
7.1	Ground wave propagation	2
7.2	Sky wave propagation	3
7.3	Tropospheric propagation	1
7.4	Duct propagation	1

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D56	3	0	--	3

D56 Data Communication Networks 3:0

Preamble: Data communication network is the discipline which studies the theoretical, practical and managerial aspects of designing and managing computer networks. The course will enable the students to familiarize the various aspects of computer networks such as what they are, how they work, how to design, build and configure them.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
c. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems

Competencies: The student at the end of the course should able to

1. Describe the components of data communication (wired and wireless LAN) networks
2. Determine the type of network topology [star, bus, ring, mesh] and the device [hub, switch] to which a computer is connected
3. Explain the role and protocols of different Layers of data communication networks
4. Calculate the subnet mask within the network by determining the IP addressing of a system
5. Design FTP, TFTP, R - Login, Telnet services on data communication networks
6. Determine the performance (throughput, bandwidth, load, mean access delay, transfer size) of a given data communication network
7. Monitor and Analyze the network status using NETSTAT and some network monitoring utilities
8. Design a network for a given set of performance and service specifications
9. Implement sliding window, stop-and-wait, and GO-BACK-N protocols with C programming
10. Configure the DNS server

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	20	20	0
2	Understand	40	40	30
3	Apply	40	40	40
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	30

Course Level Learning Objectives

Remember

1. Mention important benefits of computer network.
2. What is Bridge?
3. What are the key functions of data link layer?
4. What do you mean by Protocol?
5. Mention key advantages and disadvantages of stop-and-wait ARQ technique?
6. List the functions performed by the physical layer of 802.3 standard?
7. What is the advantage of token passing protocol over CSMA/CD protocol?
8. What are the drawbacks of token ring topology?
9. Define throughput.
10. What is the main function of UDP protocol?

Understand

1. Explain how two-dimensional parity check extends error detection capability
2. What are the advantages of having a switch rather than a hub to interconnect several machines?
3. Why do you require a limit on the minimum size of Ethernet frame?
4. Why spanning tree topology is necessary for routing using a bridge?
5. Why flooding technique is not commonly used for routing?
6. Differentiate between Single path and Multi-path routing algorithms.
7. Explain how the route is calculated by using Link State Routing.
8. How will you map out some of the routers within your organization?
9. Why is it important for protocols configured on top of the Ethernet to have a length field in their header indicating how long the message is?
10. How the inefficiency of Stop-and-Wait protocol is overcome in sliding window protocol?
11. Distinguish between virtual-circuit and datagram type packet switching

12. Compare circuit switching with packet switching
13. Identify the key issues related to MAC techniques
14. Classify various contention based techniques such as ALHOA, CSMA, CSMA/CD and CSMA/CA
15. Distinguish between TCP and UDP?
16. How the reliability of token ring topology can be improved?
17. What kind of problem can arise when two hosts on the same Ethernet share the same hardware address? Describe what happens and why that behavior is a problem?
18. Explain how network trouble shooting can be done using 'netstat'?
19. Compare different types of packet switching techniques.

Apply

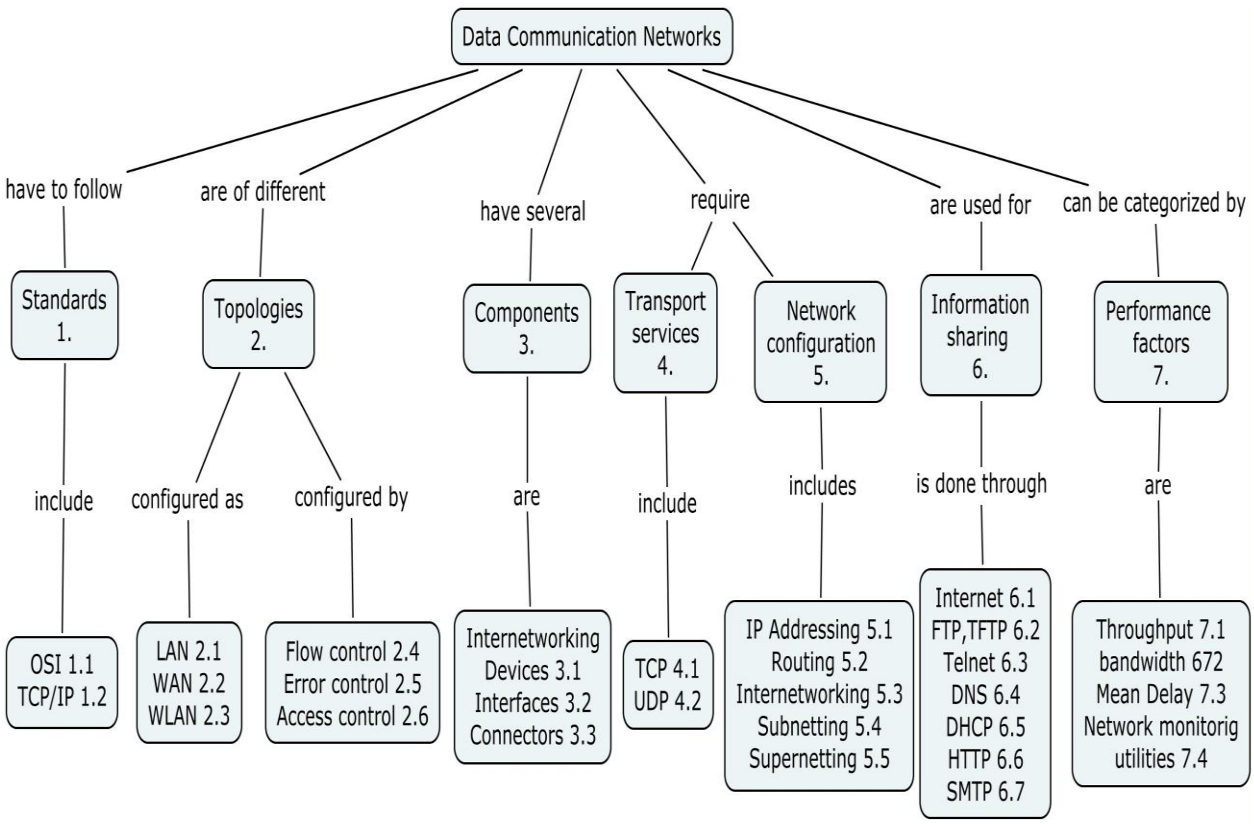
1. If you want to transmit the message 1011001001001011 and protect it from errors using the CRC 8 polynomial x^8+x^2+x+1, use polynomial long division to determine the message that should be transmitted.
2. Compute the propagation delay when ARQ algorithm is running over 20-Km point to point fiber link. Assume the speed of light is 2×10^8 m/s in the fiber.
3. Find the expected time to transmit a frame on a 9600-bps link and on a 50,000 bps link, when the expected frame length on a link is 1000 bits and the standard deviation is 500 bits.
4. Draw a timeline diagram for the sliding window algorithm with SWS = RWS = 3 frames, for the following two situations. Use a timeout interval of about 2 X RTT (a) Frame 4 is lost and (b) Frames 4-6 are lost.
5. Suppose a workstation has an I/O bus speed of 1Gbps and memory bandwidth of 2Gbps.Assuming in and out of main memory, how many interfaces to 45Mbps T3 links could a switch based on this workstation handle?
6. Consider the use of 10 K-bit size frames on a 10 Mbps satellite channel with 270 ms delay. What is the link utilization for stop-and-wait ARQ technique assuming $P = 10^{-3}$?
7. Consider a point to point link 50 Km. in length. At what bandwidth would propagation delay equal transmit delay for 100 bytes packet? What about 512 byte packets?
8. Suppose a 128 Kbps pt. to pt. link is set up between earth and rover on mars. The distance from earth to mars is approximately 55 Gm and data travels over the link at the speed of light.
    - Calculate minimum RTT for link
    - Calculate the delay bandwidth product for the link.

- A camera on the rover takes pictures of its surroundings and sends these to Earth. How quickly after a picture is taken can it reach Mission control on Earth? Assume that each image is 5MB in size. Suppose you are designing a sliding window protocol for a 1 Mbps point – to- point link to the stationary satellite evolving around Earth at 3 X 10^4 Km altitude. Assuming that each frame carries 1 KB of data, what is the minimum number of bits you need for the sequence number in the following cases? RWS = 1; RWS = SWS

Create

1. Consider a corporate network with the given IP Address 120.34.0.0. Create and configure eight sub networks with 40 Hosts attached to each subnetwork.IP currently uses 32-bit addresses. If we could redesign IP to use the 6-byte MAC address instead of the 32-bit address, would we be able to eliminate the need for ARP? Explain why or why not?
2. An organization has a class-c network 200.1.1 and wants to form subnet for four departments, with hosts as follows: Dept. A - 72 hosts, Dept. B - 35 hosts, Dept. C - 20 hosts, Dept. D - 18 hosts. There are 145 hosts in all. Give a possible arrangement of subnet masks to make this possible. Suggest what the organization might do if department D grows to 34 hosts.

Concept Map:



Syllabus:

Networking standards – OSI model, TCP/IP model, **Topologies** – Bus, star, Ring, Mesh LAN – Ethernet, Token Ring WAN – Circuit switching, Packet switching WLAN – spread spectrum, distribution systems Flow control – stop and wait protocol, sliding window protocol Error control – CRC, checksum. **Networking Components** – Internetworking devices – hub, repeater, bridge, switch, router Interfaces and connectors **Services –** FTP, TFTP, Telnet, R-login, DNS, DHCP, HTTP, SMTP **Network Configuration –** IP Addressing, Routing, subnetting, supernetting **Performance factors –** Throughput, Bandwidth, mean access delay network monitoring utilities – netstat, tcdump, nslookup, tracert

Reference Books

1. Larry L.Peterson and Bruce S.Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers., San Francisco, Fourth Edition, 2007.
2. Fred Halsall, "Data Communications, Computer Networks and Open Systems", Addison Wesley, Fourth Edition, 2004
3. Andrew S. Tanenbaum, "Computer Networks", PHI, Fourth Edition,2003.
4. Behrouz A. Forouzan, "Data Communication and Networking", Tata McGraw-Hill, 2004
5. Dimitri Bertsekas and Robert Gallager, "Data Networks" Prentice hall of India Pvt. Ltd., Second edition, 1994.
6. Mani Subramanian, "Network Management – principles and Practice", Pearson Education, 2001.

Course Contents and Lectures schedule

No.	Topics	No of Lectures
1	**Networking standards**	
1.1	OSI model	1
1.1	TCP/IP model (Internet)	2
2	**Topologies**	
2.1	Bus, star, Ring	1
2.2	LAN – Physical properties with access control algorithms	3

2.3	WAN – Circuit switching, Packet switching	2
2.4	WLAN – spread spectrum, CSMA/CA, distribution systems	2
2.5	Flow control – stop and wait protocol, sliding window protocol	2
2.6	Error control – CRC, checksum	1
3	**Networking Components**	
3.1	Hub, repeater, bridge, switch, router	2
3.2	Interfaces	1
3.3	Connectors	1
4	**Transport Services**	
4.1	UDP – simple demultiplexer	1
4.2	TCP – 3 way Handshaking, State Transition diagram	2
5	**Network Configuration**	
5.1	IP – Fragmentation and forwarding	2
5.2	IP Addressing	2
5.3	Routing protocols – RIP, OSPF	3
5.4	Network design with Subnetting	4
5.5	Supernetting	1
6	**Information sharing**	
6.1	FTP, TFTP	1
6.2	Telnet, R-login	1
6.3	DNS	1
6.4	DHCP	1
6.5	HTTP	1
6.6	SMTP	1
7	**Performance factors**	
7.1	Throughput, Bandwidth	2

7.2	Mean access delay	2
7.3	Network monitoring utilities – netstat, tcpdump, nslookup, tracert	2
	Total	45

Course Designers:

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Sub code	Lectures	Tutorial	Practical	Credit
D57	0	0	3	1

D57 Digital Communication Lab 0:1

Objective: The goals are to supplement the theory courses (D44 Digital Communication systems and D54 Wireless Communication Systems) and to assist the students in obtaining a better understanding of the operation of digital modulation schemes and to provide experience in analyzing and test of digital communication systems using simulation software as well as lab instruments

List of Experiments:

1. Design and Implementation of Uniform Quantizer
2. Design and Implementation of Scrambler and Descrambler
3. Design and Implementation of Convolutional Coders
4. Design and Implementation of Cyclic code Encoder and its corresponding Syndrome Calculator
5. Binary Digital Modulation Techniques
    a. Design and implementation of ASK Generator and Detector
    b. Design and implementation of PSK Generator and Detector
    c. Design and implementation of FSK Generator and Detector
6. Quadrature Phase Shift Keying modulation & Detection.
7. Differential Phase Shift Keying
8. BER Analysis of binary digital Modulation Schemes (ASK, PSK and FSK) in the presence of Additive White Gaussian Noise
9. Generation of PN Sequence and Gold Sequences
10. BER Analysis of Direct Sequence Spread Spectrum Communication system in the presence of AWGN and interference.

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Sub code	Lectures	Tutorial	Practical	Credit
D58	0	0	-	1

D58 Microprocessor and Microcontroller Lab 0:1

Objective: The goals are to supplement the theory courses (D42 Mixed Signal Circuits and Interfacing and D36 Microprocessor) to assist the students in obtaining a better understanding of the operation of Microprocessors, mixed signal device interfacing concepts as well as to provide knowledge in designing of microcontroller based system and embedded system using codewarrier software, 8051 compiler and Free scale embedded trainer kit.

List of Experiments:

1. Simulation of single precision and double precision arithmetic operation for 8086 in MASM.
2. Simulation of sorting of numbers for 8086 using MASM.
3. Simulation of single precision and double precision arithmetic operation for 8051 in Keil.
4. Design, simulation and implementation of Temperature indicator in 8051 (Use keil software for simulation)
5. Simulation of single precision and double precision arithmetic operation for S12 in code warrier.
6. Simulation of double precision assembly code for MAC operation for Cold fire S12 in code warrier.
7. Simulation of double precision C code for MAC operation for Cold fire S12 in code warrier.
8. Design, simulation and implementation of Temperature indicator for coldfire S12 controller. (Use code warrier for simulation)
9. Design, simulation and implementation of USART communication between a TCE_ECE_RS232 tester box to S12 kit.
10. Design, simulation and implementation of SPI communication between an external RTC device to S12 kit
11. Design, simulation and implementation of I2C communication between an external Analog to digital conversion device to S12 kit

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REVISED CURRICULUM AND DETAILED SYLLABI

FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

SIXTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2010-2011 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2000 certified
Autonomous Institution affiliated to Anna University)

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Sub Code	Lectures	Tutorial	Practical	Credit
D61	3	0	-	3

D61 Management Theory and Practice 3:0

[Common to D61/ G71/ C61]

Preamble

Management is the science of managing operations for an enterprise or organization. It deals with managing men, material, machinery and money. It has become an essential need to analyze the basic concepts of management theory and to understand the ways and means of implementing them in practice. The course work highlights the systematic approach for the management of various departments in an organization.

Program outcomes addressed

b). ability to identify, formulate and solve engineering problems

g). ability to function on multidisciplinary teams

h). ability to communicate effectively in both oral and written forms

i). ability to consider social, environmental, economic and ethical impact of engineering activities in a given context

Competencies

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

1. Manage the operations in total for an enterprise.
2. Work with team spirit and group coordination.
3. Ability to design Organizational Structure
4. To facilitate an effective communication both within and outside a firm.
5. Formulate the selection and recruitment procedures for a department
6. Evolve proper performance appraisal system
7. Analyze and identify an effective site selection and design a proper layout.
8. Prepare maintenance schedules for an organization.
9. Ability to measure overall productivity and suggest means to improve it
10. Plan the material handling systems for the organization.

Assessment Pattern

SNo	Blooms Category	Tet1	Test2	Test3
1	Remember	10	10	20
2	Understand	10	10	40
3	Apply	30	30	40
4	Analyze	-	-	-
	Evaluate	-	-	-
6	Create	-	-	-

Course Level Learning Objectives

Remember

1. Define Management
2. What are the various functions of management?
3. Distinguish MBO and MBE.
4. Define Group Cohesiveness
5. What do you mean by semantic barrier of communication?
6. What type of industry requires process type layout?
7. Define Morale
8. Mention the significance of Market Research?
9. Give an example of centralized layout.
10. Mention the types of maintenance
11. What do you understand by the term Productivity?

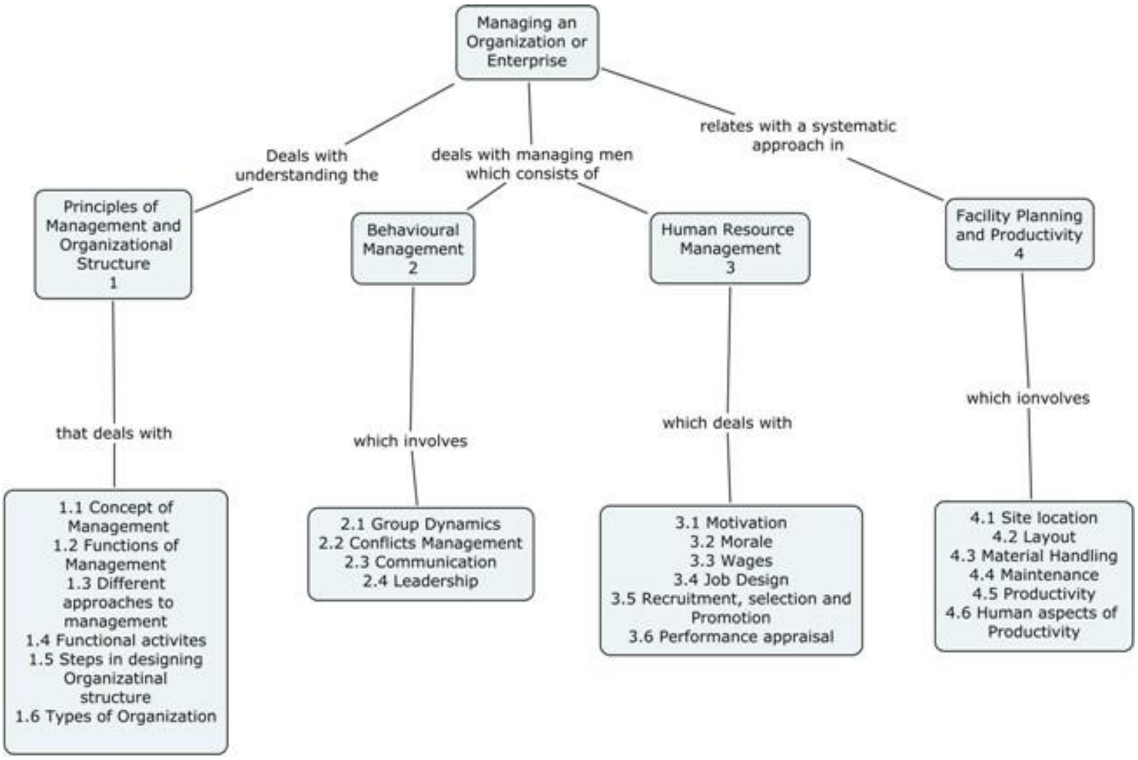
Understand

1. Briefly explain all the functions of Management
2. Explain various controlling techniques.
3. What are the merits of Modern Type of Organization?
4. List out all the stages of Group formation and explain
5. What are the barriers of communication?
6. What are the factors associated with morale?
7. Compare job enrichment and job enlargement
8. Compare the merits and demerits of product and process layouts
9. Enumerate all the human factors associated with productivity
10. Differentiate periodical and preventive maintenance
11. Enumerate all the ways of measuring productivity.
12. What are the requirements of an effective material handling system?

Apply

1. Bring out all the steps in the formation of a Quality Circle in an educational institution.
2. Suggest the modalities of selection of a trainee engineer to be recruited for a software firm
3. You as a manager prepare a proposal to locate a site to establish a telecommunication industry / Automobile Industry
4. Suggest all the possible ways to increase the overall productivity of a manufacturing sector
5. Prepare a preventive maintenance schedule for an electronic equipment manufacturing company which operates for three shits in 24 hours for 8 hours per shift by 6.00 AM to 2.00 PM, 2.00 PM to 10.00 PM and 10.00 PM to 6.00 AM

Concept map



Syllabus

Management and Functions of Management

Concept of management, organization, Administration-Management is a Science or an Art- Taylors Scientific Management – Henry Fayol's Principles of management -Functions of management- planning, Organizing, Staffing, Coordinating, Directing and Controlling-different approaches to management-various functional activities of different departments-Strategic planning-Management by Objectives [MBO], Management by Exception [MBE]-Organization Structure- Principles, Steps in designing an Organization, Types of Organization.

Behavioural Management

Group dynamics, types of groups, formation of group, Group cohesiveness, conflicts management- Communication –meaning and types, barriers in communication, communication in Groups- Leadership styles

Human Resources Management

Objectives-employer-employee relations-Motivation-Morale-Ways of achieving high morale-collective bargaining-Wage and wage payments-incentives-job design ,job analysis-job description, job rotation, job evaluation and merit rating-Recruitment, Selection and training of employees-Promotion-Performance appraisal – Outsourcing Management - Issues

Facility Planning and Productivity

Site location-Factors to be considered-layout-objectives, types, factors influencing layout, layout procedure-Materials handling-principles, factors affecting the choice of materials handling, Materials handling equipment-Plant maintenance-need functions and types-Productivity-definition and concept, measurement-techniques for productivity measurement-Human aspects of productivity

Text Book

1. Harold Koontz, Heinz weihrich "Essentials of Manangement", Tata McGraw Hill ,6th Edition,2004
2. O.P. Khanna, Industrial Engineering and Management , Dhanpat Rai Publications,2006

References

1. Chase, Jacobs, Aquilano, "Production and Operations Management " 8th Edition, Tata McGraw Hill Companies Inc 1999
2. Fred Luthans "Organizational Behavior", Tata McGraw Hill, 2005
3. Edwin Flippo, "Personnel Management", Tata McGraw Hill,2004
4. R.N. Gupta, "Principles of Management", S. Chand and Co Ltd, 2008

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Principles of Management and Organizational Structure**	
1.1	Concept of management, Organization, Administration, Management is science or art, Taylor's Scientific Management, Henry Fayol's Principles of management	3
1.2	Functions of management, Planning, organizing, Staffing, Coordinating, Directing and controlling	3
1.3	Different approaches to management	1
1.4	Functional activities, Strategic Planning, MBO, MBE	1
1.5	Principles and Steps Designing Organization structure	2
1.6	Types of Organization	1
2	**Behavioural Management**	
2.1	Group Dynamics, types of group, formation of group, group cohesiveness	3
2.2	Conflicts management	2
2.3	Communication, meaning and types, barriers in communication , communication in groups	3
2.4	Leadership styles	2
3	**Human Resource Management**	
3.1	Employer employee relations, Motivation	3
3.2	Morale, ways of achieving high morale, collective bargaining	1
3.3	Wages, wage and wage payments, incentives	1

No.	Topic	No. of Lectures
3.4	Job Design, job analysis-job description, job rotation, job evaluation and merit rating	3
3.5	Recruitment, Selection and Promotion	3
3.6	Performance appraisal – Outsourcing Management - issues	3
4	**Facility Planning and Productivity**	
4.1	Site Location , factors to be considered	1
4.2	Layout objectives, types , factors influencing layout, layout procedure	2
4.3	Material Handling, principles, factors affecting the choice of materials handling, materials handling equipments	2
4.4	Maintenance, need, functions and types	2
4.5	Productivity, definition and concept, measurement-techniques for productivity measurement	1
4.6	Human aspects of Productivity	2
	Total	**45**

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Sub Code	Lectures	Tutorial	Practical	Credit
D62	3	0	--	3

D62 High Performance Communication Networks 3:0

Preamble: This course presents the principles of circuit switched network, placket switched network, Asynchronous transfer mode, Wireless network design and optical networks and their performance along with the switching techniques.

Prerequisite: D56: Data Communication Networks

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
c. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems

Competencies:

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

1. Identify the requirements of high speed networks
2. Describe the operation of High speed networks such as frame relay, ATM and high speed LAN
3. Determine and Manage congestion control in ATM cell networks
4. Identify and Analyze the characteristics of wireless networks in terms of path loss, fading and interference
5. Design the link level wireless networks like modulation techniques, channel coding and link layer retransmission.
6. Identify and Analyze the high speed optical networks
7. Describe the operation of high speed switching techniques.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	40	30	20
2	Understand	40	30	30
3	Apply	20	40	40
4	Analyze	0	0	10
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. What are the functions of session layer in OSI Model
2. Mention the data rate for Narrowband ISDN and Broadband ISDN
3. Mention the feature of DSL technology.
4. Define x.25 and Frame relay protocol stacks
5. Specify the application of different classes in ATM network
6. Differentiate step index and graded index fiber.

Understand

1. Explain the operation of 802.5 Token ring network and FDDI
2. Discuss the operation of CSMA/CA protocol in WLAN along with its frame formats.
3. Describe Frame relay congestion control procedure.
4. Discuss about ATM cell transmission including operation, administration and maintenance operation.
5. Discuss in detail about Link management protocol, LLC and Adaptation protocol
6. Draw ISDN protocol Architecture and explain its operation in detail

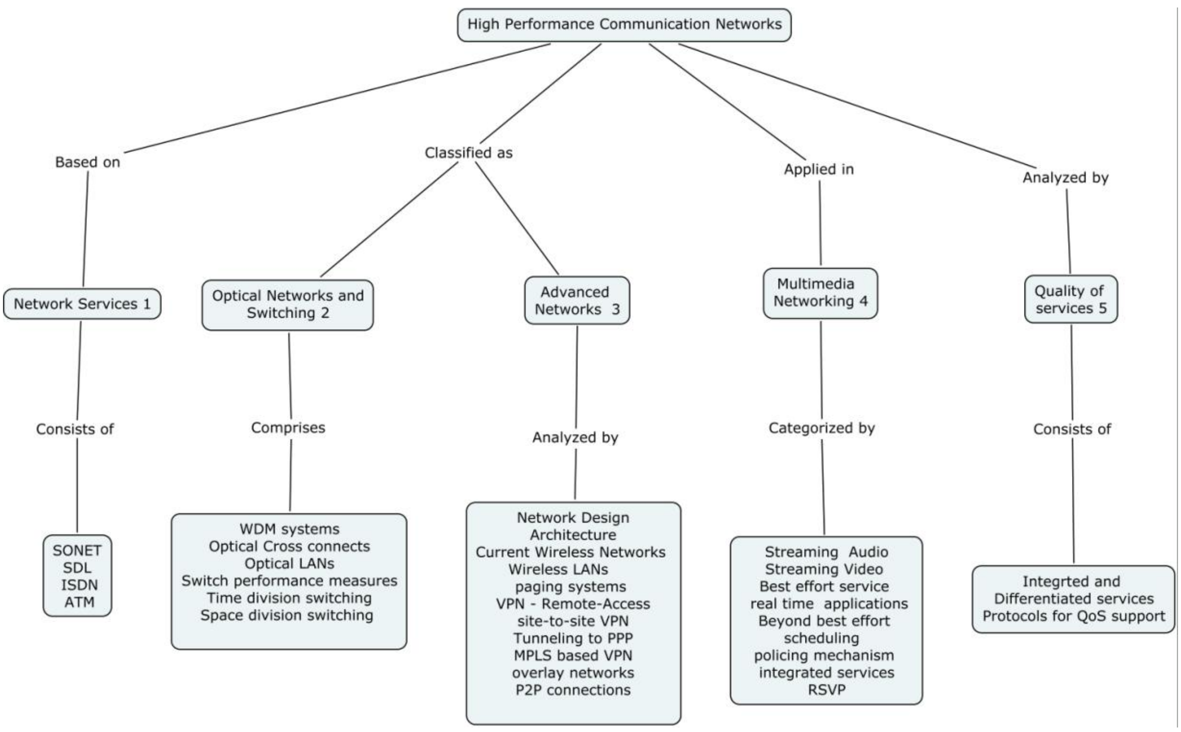
Apply

1. Determine the average energy per bit in optical networks.
2. Calculate the total delay experienced by a packet generated by a source travels over one link, gets buffered at a switch, is then routed to another link, and so on, until it arrives at its destination with example.
3. Determine the applications of code division multiple access along with its principle of operation.
4. Determine the methods used to mitigate Intersymbol interference in wireless networks
5. Relate the applications and operations of cellular systems and cordless phone.
6. Calculate the packetization delay for 1)53 byte ATM cells ii) a thousand byte packet transfer service for a)voice samples that are sampled 8000 times per sec and encoded into a 64 bits per sec stream and b)MPEG1 which takes 30 video frames per sec and encodes them into a 1Mbps stream.(The packetization delay depends on the speed of information transfer).

Analyze

1. Analyze why packet switching is more efficient than circuit switching for bursty traffic?
2. Identify the propagation delay of a link from an earth station to a geostationary satellite and also identify the end-to-end delay of a voice conversation that is relayed via such a satellite?
3. Distinguish the methods used to achieve high data rates for different DSL technologies
4. Analyze the efficiency of DQDB similar to the analysis of token ring network when there are N equally spaced stations arranged from left to right.Assume T is transmission time at each station of a 53 byte frame.(Assume the link speed is 100 Mbps and T= $53*8*10^{-8}$ secs
5. Identify the drawbacks of time division multiplexing of input signals and propose alternative techniques to overcome the drawbacks.
6. Distinguish error-correction schemes (instead of error detection followed by retransmission) in data storage applications(such as audio CDs and magnetic disks) and in real-time applications(e.g., controlling a satellite)

Concept Map



Syllabus:

Overview - History of Communication Networks, Networking Principles, Future Networks. Traffic characterization and Quality of service, Network services, High performance Networks, Network Elements, SONET – DWDM – DSL – ISDN – BISDN – ATM, **Optical Networks and Switching:** Optical Links, WDM Systems, Optical cross connects, Optical LANs and Optical Paths and Networks. Switch Performance measures, Time and Space Division Switching, **Advanced Networks Concepts:** Network Design- Architecture, Mobility Management, Network reliability, Current Wireless Networks - Wireless LANs, Wide Area Wireless Data Services, paging systems, VPN - Remote-Access, site-to-site VPN, Tunneling to PPP, MPLS based VPN, overlay networks-P2P connections, **ltimedia Networking Applications:** Streaming stored Audio and Video – Best effort service – protocols for real time interactive applications – Beyond best effort – scheduling and policing mechanism – integrated services – RSVP- differentiated services.

Text Book

1. Jean Walrand and Shyam Parekh, "Communication Networks: A Concise Introduction" Morgan and Claypool Publishers, 2010.

Reference Books

1. Jean warland and Pravin Wadaja, "High Performance Communication Networks", 2nd Edition, Jean Harcourt Asia Pvt. Ltd., 2001.
2. J.F. Kurose & K.W. Ross," Computer Networking- A top down approach featuring the internet", Pearson, 2nd edition, 2003.
3. William Stallings, "High Speed Networks and Internet", 2nd Edition, Pearson Education, 2002.
4. Irvan Pepelnjk, Jim Guichard and Jeff Apcar, "MPLS and VPN Architecture", Volume 1 and 2, Cisco Press, 2003

Course Contents and Lectures schedule

S.No.	Topics	No of Lectures
1	**Overview of High performance networks**	
1.1	History of Communication Networks	1
1.2	Networking Principles, Future Networks	2
1.3	Traffic characterization and Quality of service	2
1.4	Network services, High performance Networks, Network Elements	2

S.No.	Topics	No of Lectures
1.5	DSL – ISDN – BISDN	2
1.6	ATM	1
2	**Optical Networks and Switching**	
2.1	Optical Links, WDM Systems	2
2.2	Optical cross connects	1
2.3	Optical LANs and Optical Paths and Networks	2
2.4	Switch Performance measures,	2
2.5	Time and Space Division Switching	2
3	**Advanced Networks Concepts**	
3.1	Network Design- Architecture,	2
3.2	Mobility Management, Network reliability,	1
3.3	Current Wireless Networks - Wireless LANs,	2
3.4	Wide Area Wireless Data Services, paging systems,	2
3.5	VPN - Remote-Access, site-to-site VPN	2
3.6	Tunneling to PPP, MPLS based VPN	2
3.7	overlay networks-P2P connections.	2
4	**Multimedia Networking Applications**	
4.1	Streaming stored Audio and Video	2
4.2	Best effort service	1
4.3	protocols for real time interactive applications	1
4.4	Beyond best effort	2
4.5	scheduling and policing mechanism	2
4.6	Integrated services	2
4.7	RSVP	1
4.8	Differentiated services.	2
	Total Number of Hours	45

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
D63	3	-	-	3

D63 Digital Image Processing 3:0

Preamble: The purpose of this course is to provide the basic concepts and methodologies for Digital Image Processing in three different levels. At the lowest level, the course introduces the terminology of image processing, how digital images are generated, how the data is stored, some of the different formats (bmp, gif, tiff, jpeg, etc) and the algorithms deal directly with the raw pixel values. In the middle level, it addresses how the algorithm utilizes low level results for the processes such as segmentation and edge linking. At highest level, it addresses how the algorithm attempts to extract the semantic information from those provided by the lower levels for classification and recognition.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies: At the end of the course the student should be able to

1. Describe image acquisition, sampling and quantization
2. Understand different types of image transforms and their properties
3. Enhance and restore images in spatial as well as frequency domains
4. Segment given images in terms of edge, threshold and region.
5. Apply morphological operations like dilation, erosion, opening and closing on given images.
6. Represent, recognize and classify objects from the given images.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	20	20	20
2	Understand	40	40	20
3	Apply	40	40	40
4	Analysis	0	0	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning Objectives

Remember

1. What is meant by mach bands and simultaneous contrast?
2. What is meant by illusion?
3. List the properties of first and second order derivatives.
4. Define blind deconvolution.
5. Give the PDF of Erlang noise and sketch the PDF.
6. Write the masks to detect horizontal and vertical lines in an image.
7. State convolution and correlation.

Understand

1. Why Geometric transformation is called as Rubber sheet transformation?
2. Explain sharpening in frequency domain filters.
3. Obtain chain code for the alphabet 'H'.
4. How do you link edge pixels through global processing?
5. Discuss region based segmentation.
6. Explain topological descriptors.
7. Consider two 8-bit images whose gray levels span the full range from 1 to 255. Will reversal of the order of the images yield a different result?

Apply

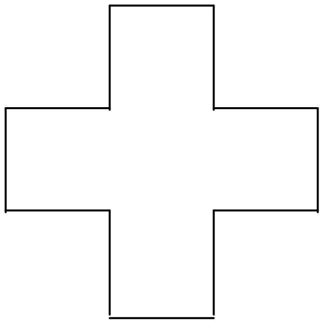
1. Find Walsh Transform and its inverse for the following image data.

   5 6
   5 9 [2x2] matrix

2. For a 5 bit input matrix perform histogram equalization.

10	10	15	0	0
5	0	10	10	15
15	15	2	0	10
5	5	0	10	30

3. Obtain the shape number for the following fig.



4. Obtain the signatures for a pentagon and a rectangle.

5. Compute the first difference of the code 0101030303323232212111.

6. Find the filter output using Alpha trimmed mean filter for the following matrix. Assume d=10.

5	10	15	20	5
10	10	15	20	5
5	10	20	5	5
20	15	15	10	0
15	0	5	15	20

7. Suppose that you form a low pass spatial filter that averages the four immediate neighbors of a point (x, y) but excludes the point itself.
   a) Find the equivalent filter H(u, v) in the frequency domain.
   b) Show that your result is low pass filter.

8. Consider the two image subsets S1 and S2, shown in the following figure. For v= {1}, Determine whether these two subsets are (a) 4-adjacent (b) 8-adjacent or (c) m-adjacent.
   i) Convert a one-pixel-thick 8-path to a 4-path.
   ii) Convert a one-pixel-thick m-path to a 4-path.
   iii) Show that the boundary of the region is defined in a closed path.

	S1	S2	
0	0 0 0 0	0 0 1 1	0
1	0 0 1 0	0 1 0 0	1
1	0 0 1 0	1 1 0 0	1
0	0 1 1 1	0 0 0 0	0
0	0 1 1 1	0 0 1 1	1

9. Consider the image segment shown
   1. Let v = {0,1} and compare the lengths of the shortest 4-, 8- and m-path between p and q. If a particular path does not exist between these two points explain, why?
   2. Repeat for V= {1, 2}

3 1 2 1 (q)
2 2 0 2
1 2 1 1
(p) 1 0 1 2

10. A binary image contains straight lines oriented horizontally, vertically, at 45^o and -45^o. Give a set of 3X3 masks that can be used to detect one pixel long breaks in these lines. Assume that the gray level of the line is 1 and that the gray level of the background is 0.

Analyze

1. a. Give a morphological algorithm for converting an 8-connected binary boundary to an m-connected boundary. You may assume that the boundary is fully connected.

   b. Does the operation of your algorithm require more than one iteration with each structuring element? Explain your reasoning

   Is the performance of your algorithm independent of the order in which the structuring elements are applied? If your answer is yes, prove it. Otherwise give an example that illustrates the dependence of your procedure on the order of application of the structuring elements.

2. Show that the Sobel and Prewitt gradient masks of figs (a) and (b) give isotropic results only for horizontal and vertical edge and for edges oriented at +45 & -45.

Fig(a)

-1	-1	-1
0	0	0
1	1	1

2. -1	3. 0	4. 1
5. -1	6. 0	7. 1
8. -1	9. 0	10. 1

-1	-1	0
-1	0	1
0	1	1

0	1	1
-1	0	1
-1	-1	0

Fig(b)

-1	0	1
-2	0	2
-1	0	1

-1	-2	-1
0	0	0
1	2	1

-2	-1	0
-1	0	1
0	1	2

0	1	2
-1	0	1
-2	-1	0

3. With reference to this equation

$$\nabla^2 h(r) = -\left[\frac{r^2 - \sigma^2}{\sigma^4}\right] e^{\frac{-r^2}{2\sigma^2}}$$

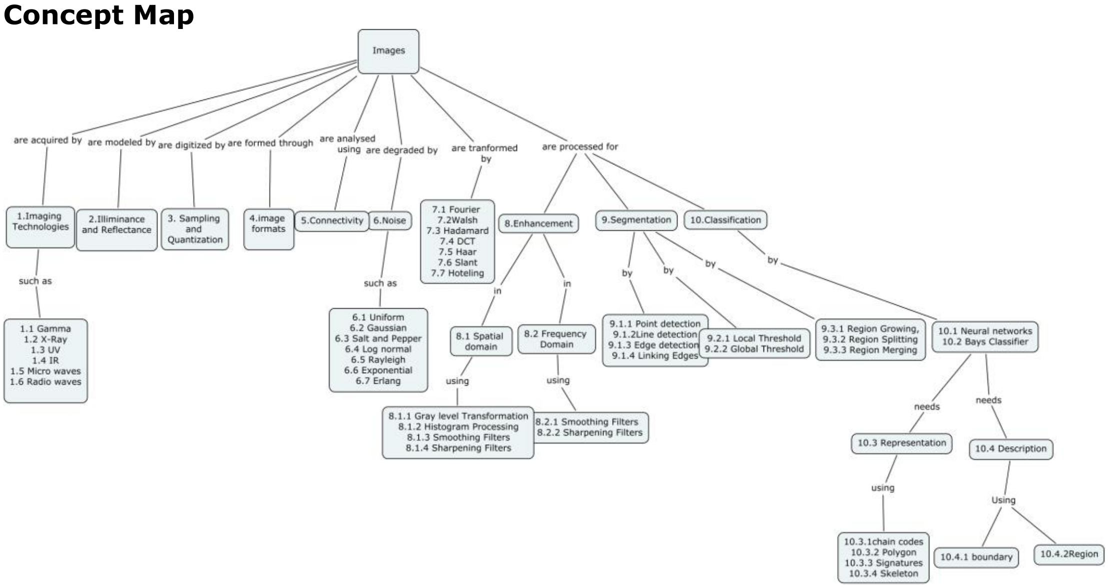
   (i) Show that the average value of the Laplacian $\Delta^2 h=0$

(ii) Prove that the average value of any image convolved with this operator is also zero.

(iii) Would (ii) be true in general for the approximation to the Laplacian given in Eqs(10.1-14) and (10.1-15)? Explain.

4. The Bayes decision functions $d_j(x)=p(x/\omega_j)p(\omega_j)$, $j=1,2,\ldots W$, were derived using a 0-1 loss function. Prove that these decision functions minimize the probability of error.(Hint: The probability of error p(e) is 1-p(c) where p(c) is the probability of being correct. For pattern vector x belonging to class ω_j $p(c/x)=p(\omega_j/x)$. Find p(c) and show that p(c) is maximum (p(e) is minimum when $p(x/\omega_j)\,p(\omega_j)$is maximum)
5. Specify the structure and weights of a neural network capable of performing exactly the same function as a minimum distance classifier for two pattern class in N-dimensional place.
6. You are contracted to design an image processing system for detecting imperfection on the inside of certain solid plastic wafers. The wafers are examined using an X-ray imaging system which yields 8-bit images of 512×512 resolution. In the absence of imperfection the images appear “bland” having a mean gray level of 100 and variance 400. The imperfections appear as blob like regions in which 70% of the pixels have excursion in intensity of 50 gray levels or less about a mean of 100. A wafer is considered defective such a region occupies an area exceeding 20 ×20 pixels in size. Propose a system based on texture analysis.

Concept Map



Syllabus

Imaging Technologies -Image sensing and acquisition- Components of an Image processing system – X-Ray-MRI-PET-SAR-IR imaging–Image Sampling and Quantization –Basic relationship between pixels -Walsh transform – Hadamard – Discrete cosine – Haar – Hotelling transform. **Image Enhancement***:* Sources of noise- Model of image degradation –noise models -linear position invariant degradations-Geometric transformations-Gray level Transformations – Histogram processing – spatial filtering – smoothing, sharpening filters– Smoothing, sharpening Frequency domain filters – Homomorphic filtering –Spatial filtering: Mean, order statistics, adaptive filters -Frequency domain filtering: smoothing-sharpening **Image Segmentation***:* Point detection – line detection – Edge detection –Edge linking and boundary detection - Thresholding – Role of Illumination – Global Thresholding – optimal thresholding – Threshold selection – Region oriented segmentation – Basic formulation – Region growing by pixel aggregation – Region splitting & merging **Representation:** Chain codes – Polygonal approximation – signatures – Boundary segments – skeleton of region – **Description:** Boundary descriptors – simple descriptors – shape numbers – Fourier descriptor – moments – Regional Descriptors – simple descriptors– Texture – Moments – Morphology - dilation and erosion – opening and closing – Hit or miss transform – Basic morphological algorithm. **Object classification and Recognition –** recognition Based On Decision-Theoretic Methods–Neural networks– Bayes classifier.

Text book:

1. Rafael.C.Gonzalez and Richard.E. Woods, "Digital Image Processing", Pearson Education, 2003
2. G.J.Awcock and R.Thomas, "Applied Image Processing", McGraw-Hill, 1996

Reference books:

1. Rafael. C. Gonzalez, Richard. E. Woods and Steven L. Eddins, "Digital Image Processing using MATLAB", Pearson Education, 2004
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson Education 2003
3. Rafael. C. Gonzalez and Richard. E. Woods, "Digital Image Processing", Addison Wesley 1993.
4. Santanu Chaudhury, Shree K Nayar, "Computer Vision, Graphics and Image Processing-Recent Advances" , Viva Books, 1999

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Imaging Technologies**	
1.1	Gamma, X-Ray, UV, IR	1
1.2	Microwaves, Radio waves	1
2.	**Image Model**	1
2.1	Illuminance, Reflectance	1
3.1	**Digitization**	
3.2	Sampling and Quantization	1
4.	**Image Formats**	1
5.	**Connectivity**	2
6.	**Noise**	2
7.	**Transforms**	
7.1	Fourier	2
7.2	Walsh	1
7.3	Hardmard	1
7.4	Discrete Cosine	0.5
7.5	Haar	1
7.6	Slant	1
7.7	Hotelling	1
8.	**Image Enhancement**	
8.1	Spatial domain	1
8.1.1	Gray level Transformation	1
8.1.2	Histogram Processing	2
8.1.3	Smoothing Filters	1
8.1.4	Sharpening Filters	1
8.2	Frequency Domain	1
8.2.1	Smoothing Filters	2
8.2.2	Sharpening Filters	2
9.	**Segmentation**	
9.1.1	Point detection	1
9.1.2	Line detection	1
9.1.3	Edge detection	2
9.1.4	Linking Edges	2
9.2.1	Local Threshold, Global Threshold	1
9.3.1	Region Growing	1
9.3.2	Region Splitting	1

No.	Topic	No. of Lectures
9.3.3	Region Merging	1
10.	**Classification**	1
10.1	Neural networks	1
10.2	Bays Classifier	2
10.3	Representation	1
10.3.1	chain codes	1
10.3.2	Polygon	1
10.3.3	Signatures	1
10.3.4	Skeleton	1
10.4	Description	1
10.4.1	boundary	1
10.4.2	Region	1

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
D64	3	1	-	4

D64 RF and Microwave Engineering 3:1

Preamble: Emerging Radio Frequency (RF) standards and technologies are converging to deliver a host of new functionalities and capabilities to the ongoing wireless revolution. This has lead to a huge demand for industry-ready RF engineering graduates. This course on D64: RF and Microwave Engineering is offered in the sixth semester in continuation with the courses on "Electromagnetic fields and Antennas and wave propagation" This course is essential to understand the explication of RF circuits and systems so as to help the students internalize RF & Microwave engineering concepts and build sound domain knowledge. This course focuses on the learning of characterization of two port networks, planar transmission lines, impedance matching concepts, passive circuit design, active circuit design and measurements.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

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

1. Characterize reciprocal networks, Lossless networks in terms of Z, Y, ABCD and S parameters
2. Calculate Z, ABCD and S parameters of two-port lumped networks including attenuator, coupler, isolators and power divider
3. Design lumped RF impedance matching networks
4. Understand the behavior of planar transmission lines including microstrip, coplanar waveguide, strip line and slot line
5. Design distributed RF impedance matching networks
6. Design RF distributed passive components including dividers, couplers and filters

7. Understand the behavior of RF distributed active components including switches, mixers and highe power transistors.
8. Understand how parameters of RF circuit elements are measured using Network Analyzer, Spectrum Analyzer, Power meter, Frequency meter and Impedance meter.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	20	20	10
2	Understand	20	20	10
3	Apply	40	40	60
4	Analysis	0	0	0
5	Evaluate	0	0	0
6	Create	20	20	20

Learning Objectives

Remember

1. Prove that the impedance and admittance matrices are lossless and symmetric.
2. State Kronecker delta property.
3. Write down the ABCD matrix for a transformer with N:1 ratio.
4. List the factors which are responsible for impedance matching
5. What is a stub?
6. Mention the quantities used to characterize a directional coupler.
7. Define coupling factor, directivity.
8. Verify that the given matrix [S] = $\begin{bmatrix} 011 \\ 101 \\ 110 \end{bmatrix}$ is not an unitary matrix.

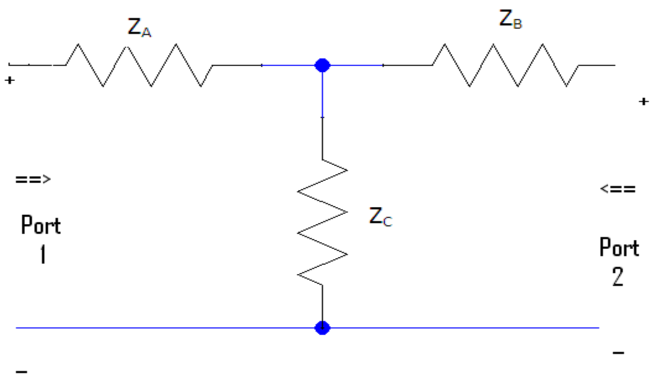
Understand

1. Why equivalent voltage and currents are essential?
2. Distinguish Low frequency circuit analysis and microwave circuit analysis.
3. Why tuning is essential?
4. Why quarter wave transformer is essential?
5. What is the need for tapered line?
6. What is even and odd mode excitation?
7. Explain the concept of coupled lines.

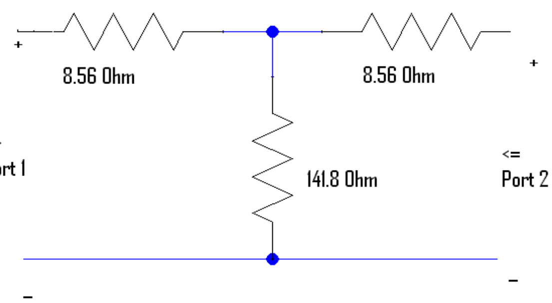
8. A maximally flat low pass filter is to be designed with a cut off frequency of 8 GHz and a minimum attenuation of 20 dB at 11 GHz. How many filter elements are required?.
9. Justify that any three port network cannot be lossless, reciprocal and matched at all ports.
10. Justify that Quadrature couplers are capable of producing 90 degree phase shift in the output port and the power available is 3dB.

Apply

1. Find the Z parameters of the two port T network shown in figure



2. Find the S parameters of the 3 dB attenuator circuit shown in figure



3. Derive S parameters from [Z] or [Y] parameters.
4. A certain two port network is measured and the following scattering matrix is obtained:
   i. $[S] = \begin{bmatrix} 0.1\angle 0 & 0.8\angle 90^\circ \\ 0.8\angle 90^\circ & 0.2\angle 0 \end{bmatrix}$
   ii. From this data determine whether the network is reciprocal or lossless.
5. A lossless T junction power divider has a source impedance of 50 ohms. Find the output characteristic impedances so that the input power is divided in a 2:1 ratio. Compute the reflection coefficients seen looking into the output ports.

6. The S parameters for the HP HFET-102 GaAS FET at 2 GHz with the bias voltage Vgs=0 are given as follows: $S_{11}=0.894\angle-60.6^\circ$, $S_{21}=3.122\angle123.6^\circ$, $S_{12}=0.020\angle62.4^\circ$, $S_{22}=0.781\angle-27.6^\circ$. Determine the stability of this transistor by calculating K and $|\Delta|$.
7. A single pole switch is to be constructed using a PIN diode with the following parameters: Cj=0.1 pF, Rr =1Ω,Li=0.4 nH. If the operating frequency is 5 GHz, and Zo=50 ohms, What circuit (series or shunt) should be used to obtain the greatest ratio of off-to–on attenuation?
8. Determine the scattering matrix for each of the lossless transmission lines shown below, relative to a system impedance of Zo. Verify that each matrix is unitary.

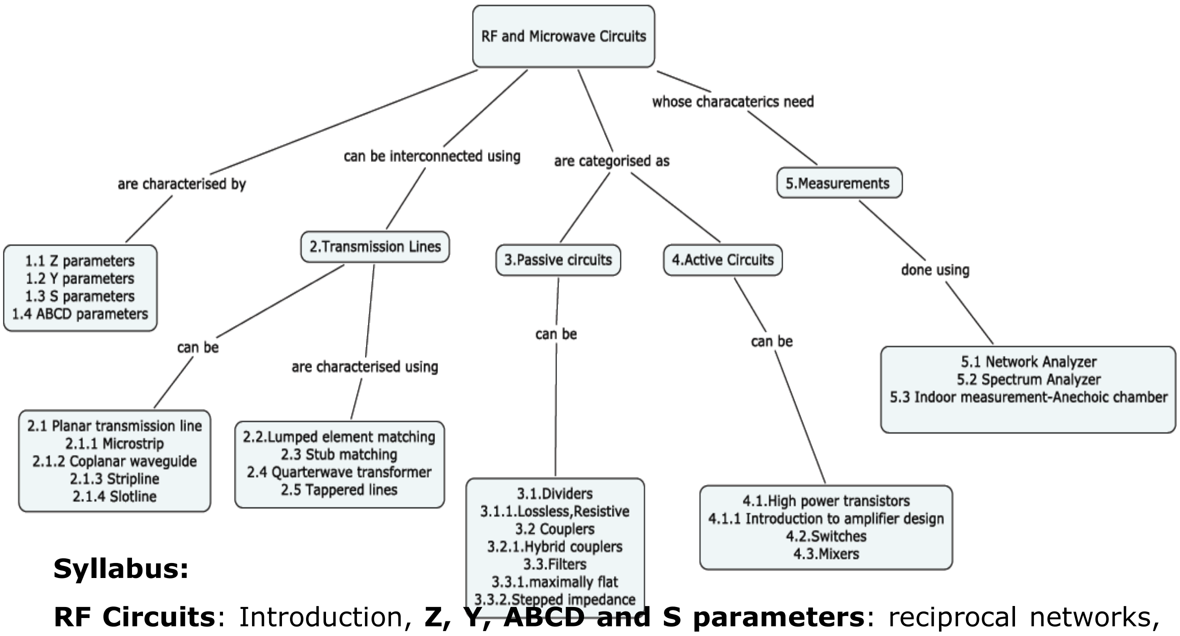
9. Find the S parameters for the series and shunt loads shown below. Show that S12=1-S11 for the series case and that S12=1+S11 for the shunt case. Assume characteristic impedance Zo.

Create

1. Design an L section matching network to match a series RC load with an impedance ZL=200-j100 Ω to a 100 Ω line, at a frequency of 500 MHz.
2. For a load impedance ZL= 15+j10 Ω, design two single stub shunt tuning networks to match this load to a 50 Ω line. Assume the load is matched at 2 GHz and the load consists of a resistor and inductor in series.
3. Design a double stub shunt tuner to match a load impedance ZL=60-j80 Ω to a 50Ω line. The stubs are to be short circuited stubs and are spaced λ/8 apart. Assume that this load consists of a series resistor and capacitor and the match frequency is 2 GHz.
4. Design a maximally flat low pass filter with a cut-off frequency of 2 GHz, impedance 50 Ω, and at least 15 dB insertion loss at 3 GHz.

5. Design a stepped impedance low pass filter having a maximally flat response and a cut off frequency of 2.5 GHz. It is necessary to have more than 20 dB insertion loss at 4 GHz, the filter impedance is 50 Ω, the highest impedance is 150 Ω and the lowest is 10 Ω.

Concept Map:



Syllabus:

RF Circuits: Introduction, **Z, Y, ABCD and S parameters**: reciprocal networks, Lossless networks, Relation between impedance, admittance, scattering and transmission parameters, **Planar transmission Lines:** Microstrip, Slot line, Strip and coplanar lines. **Impedance matching:** Matching with lumped elements, Stub matching- Single and double stub using Smith chart solutions, Quarter wave transformer, tapered lines- Exponential taper, triangular taper. **Passive circuit design:** Dividers**:** Lossless divider, Resistive divider, Couplers**:** even odd mode excitation**,** Hybrid Couplers, Filter design: Insertion loss method, maximally flat low pass filter, stepped impedance low pass filter **Active Circuit Design:** High power transistors, Introduction to amplifier design**,** Single pole switch, PIN diode switch, Concepts of mixers, Single ended mixers, Single balanced mixers, **Measurements:** Network analyzer, Spectrum analyzer, Indoor measurement-Anechoic chamber.

Text Books

1. David M. Pozar," Microwave Engineering," John Wiley & Sons, 1998.
2. Annapurna Das & Sisir K Das, Microwave Engineering," Tata McGraw Hill, 2000**.**

Reference Books:

1. David M. Pozar," Microwave & RF Design of Wireless Systems," John Wiley & Sons, 1998.

2. R.E.Collin," Fundamentals of Microwave Engineering," Tata McGraw Hill, 1995.
3. www.agilent.com

Course Contents and lecture schedule:

Sl.No:	Topic	No. of Lectures
	RF and Microwave Engineering	
	Introduction	2
1	**Z, Y, ABCD and S parameters**	
1.1	Z parameters	2
1.2	Y parameters	1
1.3	Transmission parameters	1
1.4	Scattering parameters	1
1.5	Reciprocal and Lossless networks	2
1.6	Relation between all the parameters	1
2	**Transmission Lines**	1
2.1	**Planar Transmission Lines**	
2.1.1	Microstrip	0.5
2.1.2	Coplanar wave guide	0.5
2.1.3	Strip line	0.5
2.1.4	Slot line	0.5
	Impedance Matching	
	Review of Smith chart	1
2.2	Lumped element matching	2
2.3	Stub matching	
2.3.1	Single stub matching –Series	2
2.3.2	Single stub matching –shunt	2
2.3.3	Double stub matching	2
	Problems on Smith chart	2
2.4	Quarter wave Transformer	1
2.5	Tapered Lines	1
3	**Passive circuit design**	
3.1	**Dividers** –Properties	2
3.1.1	Lossless and resistive dividers	1
3.2	Couplers –Even and odd mode excitation	1
3.2.1	Hybrid couplers	2
3.3	**Filters**	

3.3.1	Filter design by insertion loss method / Maximally flat- problems	2
3.3.2	Stepped impedance LPF	2
4	**Active circuit design**	
4.1	High power transistors	1
4.1.1	Introduction to amplifier design	
4.2	Single Pole switch , PIN diode switch	2
4.3	Mixer concepts	1
4.3.1	Single ended and balanced mixers	2
5	**Measurements**	
5.1	Network Analyzer	1
5.2	Spectrum Analyzer	1
5.3	Indoor measurement-Anechoic chamber	2

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D67	-	-	3	1

D67 Networking Lab 0:1

Objective: The goals are to supplement the theory course 'D56 Data Communication Networks' to assist the students in obtaining a better understanding of the characteristics of data communication networks.

List of Experiments:

1. Finding IP Address for the local host/given host name and vise versa and also comparing two IP Addresses/Host names.
2. Scanning the range of port numbers of the local host.
3. Implementation of Time Server- Client Model using Transmission Control Protocol/ User Diagram Protocol
4. Implementation of File Server- Client Model Using Transmission Control Protocol/User Diagram Protocol
5. Implementation of Chat Server- Client Model Using Transmission Control Protocol/User Diagram Protocol
6. Implementation of Stop and Wait Flow control Protocol
7. Implementation of Go Back n flow control protocol
8. Implementation of Sliding Window Protocol

9. Computing the throughput and time delay required to transfer an image file in a given network with the following parameters
    a. Round trip Time delay
    b. Data Packet Size
    c. Bandwidth

    Assume that the data packets are continuously sent.
10. Implementation of Structured Cabling concepts using
    - Straight through cable
    - Cross over cable
    - Roll over cable
11. Study of Routers – Internal router components such as Memory and Interfaces, Router modes and Command lists.
12. Monitoring the network status using routers.

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D68	0	0	3	1

D68 RF Circuits Lab 0:1

Objective: The goals are to supplement the theory courses 'D55 Antenna and Wave Propagation' and 'D64 RF circuits' to assist the students in obtaining a better understanding of the characteristics of RF sources and passive components and to provide experience in analyzing and testing of RF components using simulation software as well as lab instruments.

List of Experiments:

1. Using Klystron source
    a. Mode Characteristics
    b. Frequency measurement
    c. Device Characterization
    d. Gain measurement for a given Horn Antenna
2. Using Gunn Diode
    a. V-I characteristics
    b. Frequency and wavelength measurement
3. Observation of wired antenna characteristics
4. Design and Simulation of passive devices using CAD Model

   a. Transmission line for High frequency and Matching Network
   b. Filter
   c. Coupler and Power divider
   d. Patch Antenna

5. Passive component testing, cable loss calculation and delay calculation using Network analyzer
6. Antenna testing using Spectrum analyzer

Course Designers

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REVISED CURRICULUM AND DETAILED SYLLABI

FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

SEVENTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2010-2011 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2000 certified
Autonomous Institution affiliated to Anna University)

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Sub Code	Lectures	Tutorial	Practical	Credit
D71	3	0	-	3

D71 Accounting and finance 3.0

Preamble: Engineering profession involves lots of decision making. The decisions may range from operation to non-operation. For taking decisions of these kinds an engineer needs among other things data about the organizations routine operations and non-routine operations. Accounting is a science which provides all the data by recording, classifying, summarizing and interpreting the various transactions taking place in an organization and thereby helps an engineer in taking vital decisions in an effective manner. Finance is an allied but a separate field relying on accounting, and enables engineers in taking useful financial and cost related decisions by providing well defined concepts, tools and techniques.

Program outcomes addressed

- Engineering graduates will understand the basic concepts, processes, tools and techniques of accounting and finance.
- Engineering graduates will apply the concepts, processes, tools and techniques of accounting and finance and take effective decisions in organizational settings.

Competencies:

At the end of the course, the students will be able to

1. Develop an understanding about what accounting is and its importance in decision making.
2. Understand the recording function of accounting.
3. Understand the classification function of accounting.
4. Understand the summarizing function of accounting.
5. Understand the analysis and interpretation function of accounting.
6. Perform the various functions of accounting.
7. Prepare trial balance and there from financial statements like trading account, Profit & loss account and balance sheet.
8. Interpret the financial statements of an organization.
9. Understand the meaning of financing and its functions and objectives.
10. Understand some of the basic concepts, tools and techniques of finance and their applications.

Assessment pattern

S.No	Bloom's category	Test 1	Test 2	Test 3/End-Semester Examination
1	Remember	20	20	20
2	understand	30	30	30
3	Apply	50	50	50
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	create	0	0	0

Course level learning objectives

Remember

1. The meaning of the term "accounting" and definition of accounting
2. The concepts and conventions of accounting.
3. Its importance in decision making.
4. The functions of accounting
5. The meaning of the term Depreciation and causes of Depreciation
6. The meaning of the term "Cost accounting"
7. The bases of cost classification
8. The relationship between volume of output cost of production and profit
9. The meaning of the terms "Budget and Budgetary control"

Understanding

1. Understand the definition of accounting
2. Explain the various functions of accounting.
3. Discuss the concepts and conventions of accounting.
4. Understand the process of preparing final accounts.
5. Understand the concept of depreciation and methods of providing depreciation
6. Explain the classification of cost.
7. Describe the process of preparing cost sheet.
8. Discuss the importance of budgets and budgetary control
9. Understand the functions of financing
10. Explain the process of preparing working capital budget.

Apply

1. Journalise the following business transactions:

A) A brings in cash Rs.10, 000 as the capital and purchases land worth Rs.2000.

b) He purchases goods worth Rs.5, 000.

C) He returns goods worth Rs.500 as they are defective.

d) He sells goods for Rs.7, 000.

e) He incurs traveling expenses of Rs.200.

2. Record and classify the following transactions in the books of Suresh

Suresh introduces capital of Rs.20, 000 into his business.

He purchases furniture worth Rs.2000.

He purchases goods worth Rs, 8,000.

He incurs Rs.200 as freight expenses.

He sold goods for cash Rs.5, 000 and for credit Rs.2000

He paid salary Rs.3, 000

He paid electricity expenses Rs.800.

3. Prepare Trading and profit and loss account and Balance sheet on 31.12.96 from the following trial balance extracted from the books of Mr. Kumar as on 31.12.96.

Debit Balances	Rs.	Credit Balances	Rs.
Buildings	30,000	Capital	40,000
Machinery	31,400	Purchase returns	2,000
Furniture	2,000	Sales	2,80,000
Motor car	16,000	Sundry creditors	9,600
Purchases	1,88,000	Discounts received	1,000
Sales return	1,000	Provision for bad and doubtful debts	600
Sundry debtors	30,000		
General expenses	1,600		
Cash at bank	9,400		
Rates and taxes	1,200		
Bad debts	400		
Insurance premium	800		
Discount allowed	1,400		
Opening stock	20,000		
Total	3,33,200		3,33,200

4. Senthil purchased machinery for Rs.4, 00,000 on 1st April 2000.On 1st April 2001 additional machinery was purchased for Rs.40, 000.prepare the asset account for three years. Depreciation is to be provided at 10%p.a using straight line method. The firm closes its books on 31st March of every year.

5. A factory is currently working at 50% capacity and the product cost is Rs.180 per unit as below:

Material ------------- Rs.100
Labor -------------- Rs.30
Factory overhead— Rs.30 (40%fixed)
Administration overhead Rs.20 (50% fixed)

The product is sold at Rs.200 per unit and the factory produces 10,000 units at 50%capacity.

Estimate profit if the factory works to 60% capacity. At 60%working raw material increases by 20% and selling price falls by 20%.

6**.** The following particulars are extracted from the books of a company relating to commodity "A" for the half year ending 30th June1993.

Purchase of raw materials ------------------ Rs.1, 32,000
Direct wages ----------------- Rs.1, 10,000
Rent, rates, insurance and works cost-------- Rs.44, 000
Carriage inward --------- Rs.1584
Stock on 1-1-93
Raw materials--------------------------------- Rs.22, 000
Finished product (1600 tones) - Rs.17, 000
Stock on 30-6-93
Raw materials ------------------- Rs.24, 464
Finished products (3,200 tones) ---------- Rs.35, 200
Work-in-progress on 1-1-93 ------------- Rs.17, 600
Work-in-progress on 30-6-93 ------ Rs.5280
Factory supervision ------------------------ Rs.8, 800
Sales-Finished products ---------------- Rs.33, 000

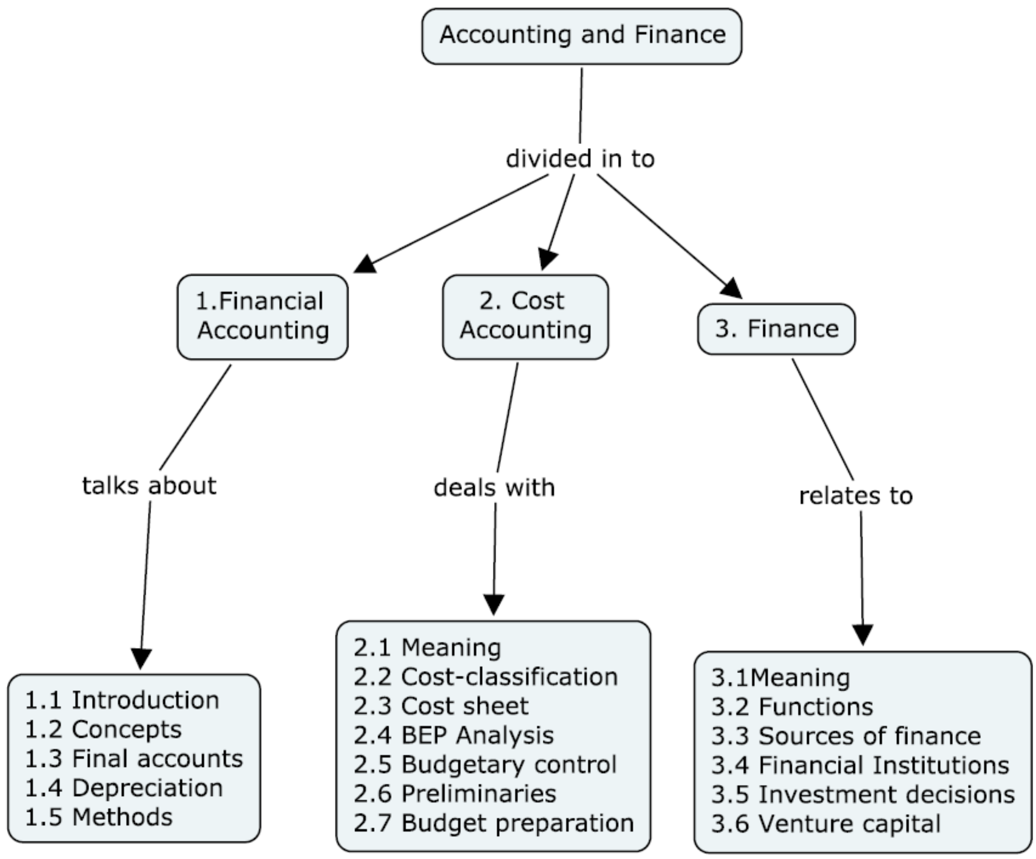
Advertising discount allowed and selling cost at Re.0.75per tones sold.25, 600 tones of commodity was sold during the period.

You are required to ascertain:

i) prime cost ii) factory cost iii) cost of sales iv) profit v) No of tones of the commodity sold.

7. From the following information calculate the Break even point in terms of units and Break even point in terms of sales
Sales in Rs.10, 000, Variable costs (direct material and direct labor) Rs.6, 000, Fixed cost Rs.2, 000 profit Rs.2, 000, No. of units produced 1,000 units.

Concept Map



Course content and lecture schedule

S.No	Topics	No. of Lectures
1.	**Financial Accounting**	
1.1	Introduction and Definition	1
1.2	Accounting concepts and conventions	2
1.3	Final Accounts- Preparation of Trading, Profit &Loss account and Balance sheet.	6
1.4	Depreciation –Meaning-Need and objectives	2
1.5	Basic factors-Methods for providing depreciation	3
2.	**Cost Accounting**	
2.1	Meaning and importance	2
2.2	Cost-Elements of cost-Cost classification	2
2.3	Preparation of Cost sheet-Material costing-valuation of purchases-pricing of material issues.	6
2.4	Break-even analysis-managerial applications	2
2.5	Budgetary control-introduction-objectives of budgetary control	1
2.6	Preliminaries for operation of budgetary control	1
2.7	Budget-Types of budgets and their preparation	4
3	**Finance**	
3.1	Meaning-Definition-objectives	2
3.2	Functions of finance	1
3.3	Source of finance-short-term, medium-term, long-term	2
3.4	Role of special financial institutions in financing	2
3.5	Investment decisions-Short-term investments and long-term investments	5
3.6	Venture capital	2
	Total	**46**

Syllabus

Accounting: Introduction and Definition-Accounting concepts and conventions-final Accounts-Preparation of Trading, Profit and Loss account and Balance sheet. Depriciation-Meaning-Need and objectives-Basic factors-Methods for providing depreciation.

Cost Accounting: Meaning and importance-Cost-Elements of Cost-cost Classification-Preparation of cost sheet-Material costing-Valuation of purchases-pricing of material issues. Break-even analysis-managerial applications. Budgetary control-Introduction-objectives of budgetary control-preliminaries for operation of budgetary control-Budgets-types of budgets and their preparation.

Finance: Meaning-Definition-Objectives-functions of finance-source of finance-short-term, Long-term and medium-term-Role of special financial institution in financing-Investment decisions-short-term Investments and long-term investments-Venture Capital.

Text Books:

1. M.c.Shukla, T.s.Grewal, S.c.Gupta: "Advanced Accounts", Volume 1, 2007 Reprint, S.Chand &Company Ltd.2007.
2. S.P.Jain, K.L.Narang "Advanced Accountancy-Volume I", Thirteenth Revised Edition, Kalyani Publishers.2006.
3. V.K.Saxena, C.D.Vashist: "Advanced cost and Management Accounting", Seventh Enlarged Edition, Sultan Chand and Sons, 2008.

Reference Books:

1. Prasanna Chandra, "Financial Management-Theory and Practice" Sixth Reprint, Tata McGraw-Hill publishing company Limited, 2007.
2. Ramachandra Aryasri, A, Ramana Moorthy, V.V, Engineering Economics and financial Accounting", Tata McGraw hill, 2007.
3. S.N.Maheswari, "Advanced accountancy" Vikas publishing, 2007.

Course Designers:-

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Sub code	Lectures	Tutorial	Practical	Credit
D72	3	0	-	3

D72 RF Wireless Systems 3:0

Preamble: The purpose of this course is to provide a organized overview of the fundamental subjects required for the design and analysis of the RF stages of modern wireless systems. It also includes the design of key components used in wireless systems such as amplifiers, mixers, oscillators, and phase-locked loops. Major wireless applications, such as cellular and GPS, DBS, WLANs systems are described with many design examples.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

c. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems

Competencies: At the end of the course, the student should be able to

1. Understand the fundamental design steps for an amplifier and a low noise amplifier.
2. Understand the fundamental design steps for an oscillator and phase noise.
3. Understand the concepts of mixer and its conversion loss parameter.
4. Understand concepts of transceiver and receiver specification.
5. Apply concept of individual blocks for the receiver design of a wireless system.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	30	30	20
2	Understand	30	30	20
3	Apply	40	40	60
4	Analysis	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning Objectives

Remember

1. Define power gain
2. Define conversion loss.
3. Define capture range of a PLL circuit
4. Define settling time.
5. Define acquisition time.
6. Define noise figure.
7. Define receiver dynamic range.
8. Define transducer power gain.

Understand

1. Why do we go for stability circles in the amplifier?
2. Give the reason for the tradeoff between the constant circle and constant noise figure circle.
3. What is the significance of up conversion?
4. What is image frequency?
5. What is the impact of noise figure in mixer circuit?
6. Justify the use of stability circles in an oscillator design.
7. What is the impact of phase loop error in the PLL design?
8. From the basics of oscillator design, explain the concept of phase noise.
9. Justify the need for RF filter in the receiver circuit.
10. Why do we consider the noise in a receiver?
11. What is the effect of spurious response in a receiver design?.
12. What is the effect of AGC in receiver circuit design?.

Apply

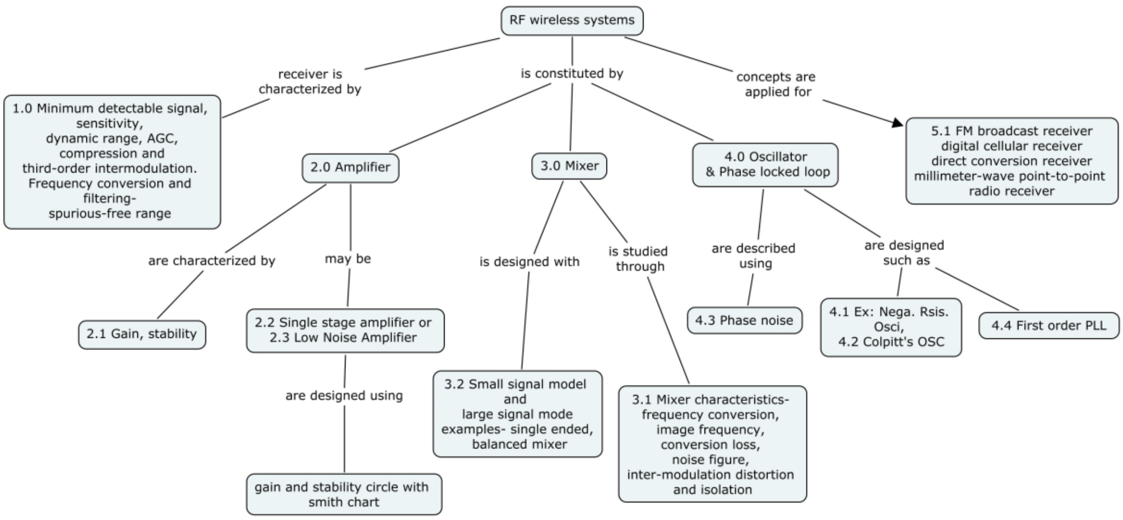
1. A microwave transistor has the following S parameters at 10 GHz, with a 50 Ω reference impedance: $S_{11} = 0.45\angle 150^o, S_{21} = 2.05\angle 10^o, S_{12} = 0.01\angle{-10^o}, S_{22} = 0.40\angle -150^o$. the source impedance is Z_s=20 Ω and the load impedance is Z_L = 30 Ω. Compute the power gain, the available gain, and the transducer power gain.
2. Design an amplifier for maximum gain at 4.0 GHz using single-stub matching sections. Calculate and plot the input return loss and the gain from 3 to 5 GHz. Use a GaAs FET with the following S parameters (Z_0 = 50 Ω): at 3 GHz, $S_{11} = 0.80\angle -89^o, S_{21} = 2.86\angle 99^o, S_{12} = 0.03\angle 56^o, S_{22} = 0.76\angle -41^o$, at 4 GHz $S_{11} = 0.72\angle -116^o, S_{21} = 2.6\angle 76^o, S_{12} = 0.03\angle 57^o, S_{22} = 0.73\angle -54^o$, at 5 GHz $S_{11} = 0.66\angle -142^o, S_{21} = 2.39\angle 54^o, S_{12} = 0.03\angle 62^o, S_{22} = 0.72\angle -68^o$.
3. A GaAs FET is biased for minimum noise figure and has the following S parameters and noise parameters at 4 GHz:

$(Z_0 = 50\Omega:) S_{11} = 0.60\angle-60^o, S_{21} = 1.9\angle 81^o, S_{12} = 0.05\angle 26^o, S_{22} = 0.5\angle-60^o;\ F_{min} = 1.6\ \mathrm{dB}, \Gamma_{opt} = 0.62\angle 100^o, R_N = 20\Omega.$

for design purpose, assume the device is unilateral, and calculate the maximum error in G_T resulting from this assumption. Then design an amplifier having 2.0 dB noise figure with the maximum gain that is possible with this noise figure.

4. Design a transistor oscillator at 4 GHz using a GaAs FET in a common gate configuration, with a 5 nH inductor in series with gate to increase the instability. Choose a terminating network to match a 50 Ω load, and an appropriate tuning network. The S parameters of the transistor in a common source configuration are, with $Z_0 = 50\Omega: S_{11} = 0.72\angle-116^o, S_{21} = 2.6\angle 76^o, S_{12} = 0.03\angle 57^o, S_{22} = 0.73\angle-54^o.$
5. An oscillator uses an amplifier with a noise figure of 6 dB and a resonator having Q of 500, and produces a 100 MHz output at a power level of 10 dBm. If the measured f_α is 50 KHz, plot the spectral density of the output noise power, and determine the phase noise (in dBc/Hz) at the following frequencies: (a) At 1 MHz from the carrier. (b) At 10 KHz from the carrier. (Assume K=1).
6. Two amplifiers are cascaded. The driver has 10 dB gain and an output intercept point of dBm, the output amplifier has 6 dB gain and an intercept point of 30 dBm. What is the amplifier output intercept point if: (a) x= 30 dBm? (b) x= 24 dBm? (c) x= 20 dBm? (d) What is poor about the design with cases (a) and (c)
7. Typical values for a phase detector gain and the gain factor of a 200 MHz VCO are K_d= 2 V/rad and K_0 = 2 MHz/V. if the reference frequency is 20 MHz, find the acquisition time and loop bandwidth for a first- order phase locked loop.

Concept map



Syllabus

Receiver design: Receiver architectures, **dynamic range** – minimum detectable signal, sensitivity, dynamic range, AGC, compression and third-order intermodulation. **Frequency conversion and filtering**- Selection of IF frequency, filtering, spurious-free range. **Design and Performance Issues**- Choice of operating frequency, multiple access and duplexing, circuit switching and pocket switching, propagation, radiated power and safety, and other issues. **Introduction to wireless system components**- Basic radio system, Amplifiers, mixers, oscillators. **Amplifier and low noise amplifier:** FET and Bipolar transistor models, two-port power gains, stability and testing, Amplifier design using S parameters, Low Noise Amplifier design. **Mixer: mixer characteristics**- frequency conversion, image frequency, conversion loss, noise figure, inter-modulation distortion and isolation, **single ended diode mixer**- small signal model and large signal model, **balanced mixer**, small signal analysis of balanced mixer. **Oscillator and PLL: Oscillator –** RF Oscillator**,** one port negative resistance oscillator, phase noise, effect of phase noise on receiver performance. **PLL** - basic PLL circuit, phase detector, VCO, analysis of PLL, first order loop. **Examples of practical receivers**- FM broadcast receiver, digital cellular receiver, millimeter wave point-to-point radio receiver, direct conversion receiver. **Cellular telephone systems and standards**- Cellular and the public switched telephone network, AMPS cellular telephone system and digital PCS standards.

Text Book:

1. David M Pozar: Microwave and RF design of wireless systems, John Wiley & Sons, 2001.

Reference Books:

1. Guillermo Gonzalez: Microwave transistor Amplifiers Analysis and design, Prentice Hall, Second edition, 1984.
2. David M Pozar: Microwave Engineering, John Wiley & Sons, Second edition, 1988.

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lectures
1.	**Receiver design**	
1.1	Receiver architectures	2
1.2	**Dynamic range** – minimum detectable signal, sensitivity, dynamic range, AGC, compression and third-order intermodulation	3

S.No.	Topic	No. of Lectures
1.3	**Frequency conversion and filtering**- Selection of IF frequency, filtering, spurious-free range	3
1.4	**Design and Performance Issues**	2
1.5	**wireless system components**- Basic radio system, Amplifiers, mixers, oscillators	2
2.	**Amplifier**	
2.1	Gain and Stability	2
2.2	Amplifier design using S parameters	3
2.3	Low Noise Amplifier design	3
2.4	Tutorials	2
3.	**Mixer**	
3.1	**Mixer characteristics**- frequency conversion, image frequency, conversion loss, noise figure, inter-modulation distortion and isolation	2
3.2	**Single ended diode mixer**- small signal model and large signal model	3
3.3	**Balanced mixer** - small signal analysis	3
4.	**Oscillators and PLLs**	
4.1	**Oscillator-** RF oscillator**,**	3
4.2	One port negative resistance oscillator	3
4.3	Phase noise and effect of phase noise on receiver performance	2
4.4	**PLL**- Basic PLL circuit, phase detector, VCO, analysis of PLL, first order loop.	3
5.	**Application/ case study**	
5.1	**Examples of practical receivers**- FM broadcast receiver, digital cellular receiver, millimeter wave point-to-point radio receiver, direct conversion receiver	2
5.2	**Cellular telephone systems and standards**- Cellular and the public switched telephone network, AMPS cellular telephone system and digital PCS standards.	2
	Total Number of hours	**45**

Course Designers:

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Sub code	Lectures	Tutorial	Practical	Credit
D77	-	-	3	1

D77 RF and Image Processing Lab 0:1

Objective: The goals are to supplement the theory course covering Radio Frequency (RF) systems and Image processing and to assist the students in obtaining a better understanding of the characteristics of RF systems using EM CAD softwares and implementation of image processing algorithms using MATLAB tools.

List of Experiments:

RF Experiments

1. Design and Simulation of Matching Network
2. Design and Simulation of a SPST and SPDT Switch
3. Design and Simulation of a Printed Dipole Antenna
4. Design and Simulation of Low Noise amplifier
5. Testing of Fiber Optic Communication

Image Processing Experiments

6. Simulation for Image Sampling and quantization
7. Simulation for Image Transforms (DFT,DCT, Haar, Slant, DST, Hotelling)
8. Simulation for Histogram Equalization (Filtering- Mean, Median, Image negative)
9. Simulation for Edge detection (Point, Lines)
10. Simulation for Morphological operations (Opening, Closing, Erosion, Dilation)

Course Designers:

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CURRICULUM AND DETAILED SYLLABI

OF

ELECTIVES

FOR

B.E. DEGREE (Electronics and Communication) PROGRAM

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2008-2009 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2000 certified
Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

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Sub code	Lectures	Tutorial	Practical	Credit
DCA	3	0	-	3

DCA Statistical Signal Processing 3:0

Preamble:

The course "DCA: Statistical Signal Processing" is offered as elective subject in continuation with the course on "D33: Signal Processing", "D54 Digital Signal Processing". This course aims at developing optimal signal processing algorithms for estimating scalar and vector parameters of a system in noise. Further, it also aims at developing algorithms for detecting the desired signals from the noisy received signal.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

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

1. Formulate the estimation problem
2. Determine the CRLB for the given estimation problem
3. Design an estimator based on Maximum Likelihood, Maximum A Posteriori, Least square and Minimum Mean Square Error Method
4. Formulate the detection problem
5. Describe the Statistical decision Theory
6. Detect known signal in Gaussian noise, using matched filter and generalized matched filter
7. Detect random signal in Gaussian noise, using Estimator-Correlator

Assessment Pattern

S.No	Bloom's Category	Test 1	Test 2	Test 3/ End-semester examination
1	Remember	20	20	10
2	Understand	20	20	10
3	Apply	60	60	80
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course level Learning Objectives

Remember:

1. When an estimator is said to be unbiased?
2. State the invariance property of the Maximum Likelihood Estimator.
3. Define CRLB
4. State Neyman Pearson Theorem
5. What is Receiver Operating Characteristics?
6. What is Generalized Matched Filter?

Understand:

1. Compare the mean square error of MVU and Bayesian estimator (mmse)
2. Distinguish between ML and MAP criterions
3. In Bayesian estimator, if the cost function is absolute error, the estimator is defined to be the median of the posterior PDF. Justify
4. Explain the function of 'Claivoyant Detector'?
5. Can an optimal estimator be obtained from CRLB? Explain
6. Compare the estimation performance of ML, MAP and MMSE based estimators.

Apply

1. The data $x(n) = Ar^n + w(n)$ for $n = 0,1,....N-1$ are observed, where w(n) is WGN with variance σ^2 and $r > 0$ is known.
   i. Find the CRLB for A.
   ii. Show that an efficient estimator exists and find its variance.
   iii. What happens to the variance as $N \to \infty$

2. Consider the observations $x(n) = A + w(n) \quad n = 0,1\cdots N-1$, where A is real number and w(n) is WGN with variance σ^2. Let the estimator $\hat{A} = \frac{1}{N}\sum_{n=0}^{N-1} x(n)$. Prove that the PDF $\hat{A}$ is $N(A, \sigma^2 / N)$

3. Independent bivariate Gaussian samples $\{\mathbf{x}(0), \mathbf{x}(1)\cdots\mathbf{x}(N-1)\}$ are observed. Each observation is a 2×1 vector which is distributed as $\mathbf{x}(n) \sim N(\mathbf{0,C})$ and $\mathbf{C} = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$. Find the CRLB for the correlation coefficient ρ.

4. The data $x(n) = r^n + w(n)$ for $n = 0,1,....N-1$ are observed, where w(n) is WGN with variance σ^2 and r is to be estimated.
   i. Find the CRLB for r.
   ii. Does an estimator exists and if so find its variance

5. We observe two samples of a DC level in correlated Gaussian noise $x(0) = A + w(0), x(1) = A + w(1)$, where $\mathbf{w} = [w(0)\ w(1)]^T$ is zero mean with covariance matrix $\mathbf{C} = \sigma^2 \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$. The parameter ρ is the correlation coefficient between w(0) and w(1).
   i. Compute the CRLB for A
   ii. Compare the result in (a) when w(n) is WGN.
   iii. Explain what happens when $\rho = \pm 1$.

6. MAP Estimator:
   i. Assume that the conditional PDF $p(x[n] \mid \theta) = \theta \exp(-\theta x(n)) \quad x[n] > 0$ where the x[n]'s are independent and identically distributed and the prior PDF is $p(\theta) = \lambda \exp\{-\lambda\theta\} \quad \theta > 0$. Determine MAP estimator for θ.
   ii. The data $x(n) = A + w(n)$ for $n = 0,1,....N-1$ are observed, where A is unknown and the noise variance σ^2 is also unknown. The

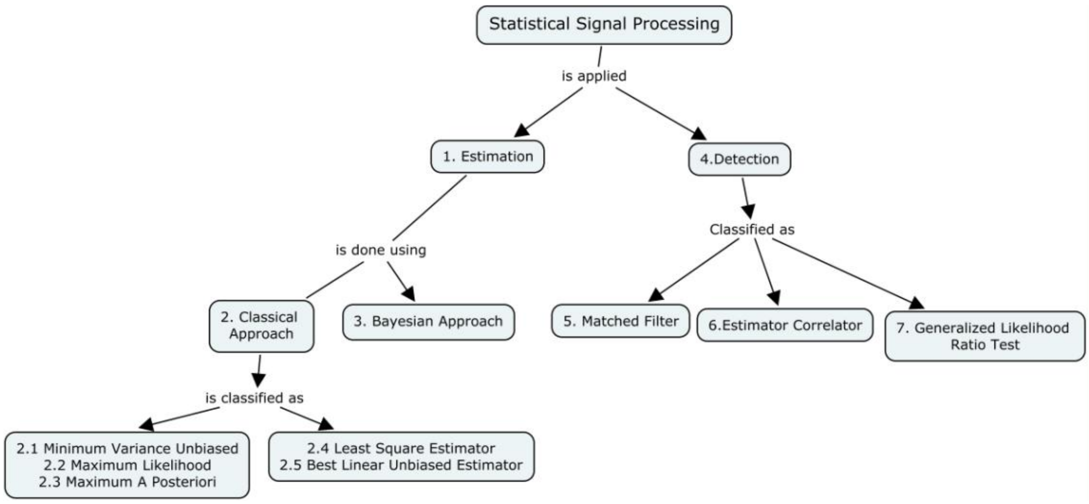
conditional PDF $p(\mathbf{x}/A,\sigma^2) = \frac{1}{\left(2\pi\sigma^2\right)^{\frac{N}{2}}} \exp\left(-\frac{1}{2\sigma^2}\sum_{n=0}^{N-1}\left(x(n)-A\right)^2\right)$.

The prior PDF for σ^2 is $p(\theta) = \frac{\lambda \exp\left(-\frac{\lambda}{\sigma^2}\right)}{\sigma^4} \quad \sigma^2 > 0$

7. Consider the detection problem $\begin{array}{l} H_0 : x(n) = w(n), \quad n = 0,1,...N-1 \\ H_1 : x(n) = A + w(n), \quad n = 0,1,...N-1 \end{array}$

w(n) is WGN with variance σ^2 and A is deterministically known. Derive expressions for Probability of False Alarm and Probability of Detection.

Concept Map:



Syllabus

Estimation: Mathematical Estimation problem, Assessing Estimator Performance, **Classical Approach:** Minimum Variance Unbiased Estimation, CRLB, Maximum Likelihood Estimation, Maximum a Posteriori Estimator, Least Square Estimator, Best Linear Unbiased Estimation, **Bayesian Estimator, Signal Processing Examples:** Range Estimation, Frequency, Estimation, Bearing Estimation, Autoregressive Parameter Estimation **Detection:** Neyman Pearson Theorem, Receiver Operating Characteristics, **Matched Filter:** Generalized Matched Filter, Multiple Signal, Estimator Correlator, Generalized Likelihood Ratio Test: Composite Hypotheis Testing, Multiple Hypotheis Testing.

Text Book

1. Steven M.Kay, " Fundamentals of Statistical Signal Processing", Vol I Estimation Theory, Prentice Hall Inc, 1998
2. Steven M.Kay, " Fundamentals of Statistical Signal Processing", Vol II Detection Theory, Prentice Hall Inc, 1998,

Reference Books

1. Monson H.Hayes, " Statistical Digital Signal Processing and Modeling", John Wiley, 1996
2. Sophocles. J. Orfanidis: "Introduction to Signal Processing", Prentice Hall, 1996
3. John G. Proakis: "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Education, 1995.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Estimation**	
1.1	Mathematical Estimation Problem	1
1.2	Assessing Estimator Performance	1
2	**Classical Approach**	
2.1	Minimum Variance Unbiased Estimation	2
2.2	Maximum Likelihood Estimation	2
2.3	Maximum A Posteriori Estimation	2
2.4	Least Square Estimation	2
2.5	Best Linear Unbiased Estimation	2
3	**Bayesian Approach**	3
3.1	**Signal Processing Examples**	
3.1.1	Range Estimation	1
3.1.2	Frequency Estimation	1
3.1.3	Bearing Estimation	1
3.1.4	Autoregressive Parameter Estimation	1
4	**Detection**	2
4.1	Neyman Pearson Theorem	2
4.2	Receiver Operating Characteristics	1
4.3	Examples	2
5	**Matched Filter**	3

No.	Topic	No. of Lectures
5.1	Generalized Matched Filter	2
5.2	Multiple Signal Detection	2
5.3	Examples	2
6.	**Estimator Correlator**	3
6.1	Examples	3
7	**Generalized Likelihood Ratio Test**	2
7.1	Composite Hypothesis Testing	2
7.2	Multiple Hypothesis Testing	2
7.3	Examples	2

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Sub Code	Lectures	Tutorial	Practical	Credit
DCB	3	0	--	3

DCB Advanced Digital Systems 3:0

Preamble:

The course 'DCB Advanced Digital System' is offered as elective subject in continuation with the core subjects 'D23 Basics of Digital Systems' and 'D42 Designing with PLDs and FPGAs'. This course describes the architecture of SSI and MSI logic families and their various parameters of interest for defining its characteristics. Further, it also aims at the design of combinational and sequential logic circuits and optimization strategies.

Program Outcomes addressed:

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

e. Graduate who can participate and succeed in competitive examinations.

Competencies:

At the end of the course, the student should be able to

1. Explain the characteristics of RTL, ECL, TTL, MOS and CMOS logic families.
2. Understand the need for testing and the strategies to generate test vectors.
3. Design combinational logic circuits for a given specification
4. Design optimal synchronous/asynchronous sequential logic circuits for a given requirements.
5. Design optimal synchronous/asynchronous digital system with multi-input controllers.
6. Validate the digital systems, designed for given specifications, by generating test vectors.

Assessment Pattern:

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	10	10
2	Understand	30	10	10
3	Apply	30	50	40
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	20	30	40

Course Level Learning Objectives

Remember

1. List the advantages and disadvantages of RTL family.
2. Recall the different operating regions of BJT and FET transistors.
3. Mention the logic threshold for CMOS and TTL logic.
4. List the different fast adders.
5. Draw the logic diagram of carry look ahead generator.
6. Define static hazard and dynamic hazard.
7. Define D-calculus
8. Mention the three major sections present in the Emitter-Coupled Logic and explain their operation with suitable diagram.
9. Mention the concepts for the construct the MDS diagram for the system controllers.

Understand

1. Explain the operation of the basic circuitry in DTL and modified DTL logic.
2. Describe the operation of the Schotty TTL with suitable circuit.
3. Summarize the various steps for the design of synchronous sequential circuits.
4. Explain hazards with a suitable timing diagram.
5. Explain the operational characteristics of controlling systems and the controlled system.
6. Compare Open collector and Totem pole output configuration of TTL with the help of their basic circuitry.
7. Distinguish between mealy and Moore type Finite state machine.
8. Distinguish between FSM and ASM charts.

Apply

1. Table shows the specification of the shottky TTL 74S00 IC

Parameter	Value
V_{CC}	5 V
I_{CCH}	10 mA
I_{CCL}	20 mA
V_{OH}	2.7 V
V_{OL}	0.5 V
V_{IH}	2 V
V_{IL}	0.8 V
I_{OH}	1 mA
I_{OL}	20 mA
I_{IH}	0.05 mA
I_{IL}	2 mA
t_{PLH}	3 ns
t_{PHL}	3 ns

Calculate the Power dissipation, Propagation delay and Noise Margin for the IC

2. Calculate the Fan-In and Fan-out for the IC; use the current specification from the above table.
3. Implement the logic expression Y= AB+CD+CE using the Resistor Transistor Level logic IC.
4. Assume that the exclusive –OR gate has propagation delay of 10ns and that the AND or OR gates have a propagation delay of 5ns. Calculate the total propagation delay time of a four-bit carry look ahead adder?

5. Draw the state diagram for an FSM that has an input w and an output z. The machine has to generate z=1 when the previous four values of w were 1001 or 1111; otherwise, z=0. Overlapping input patterns are allowed.
6. Determine the optimal test vectors to detect the stuck at faults for the given logic expression Y=AB+C.
7. Find a hazard free minimum cost implementation of the function

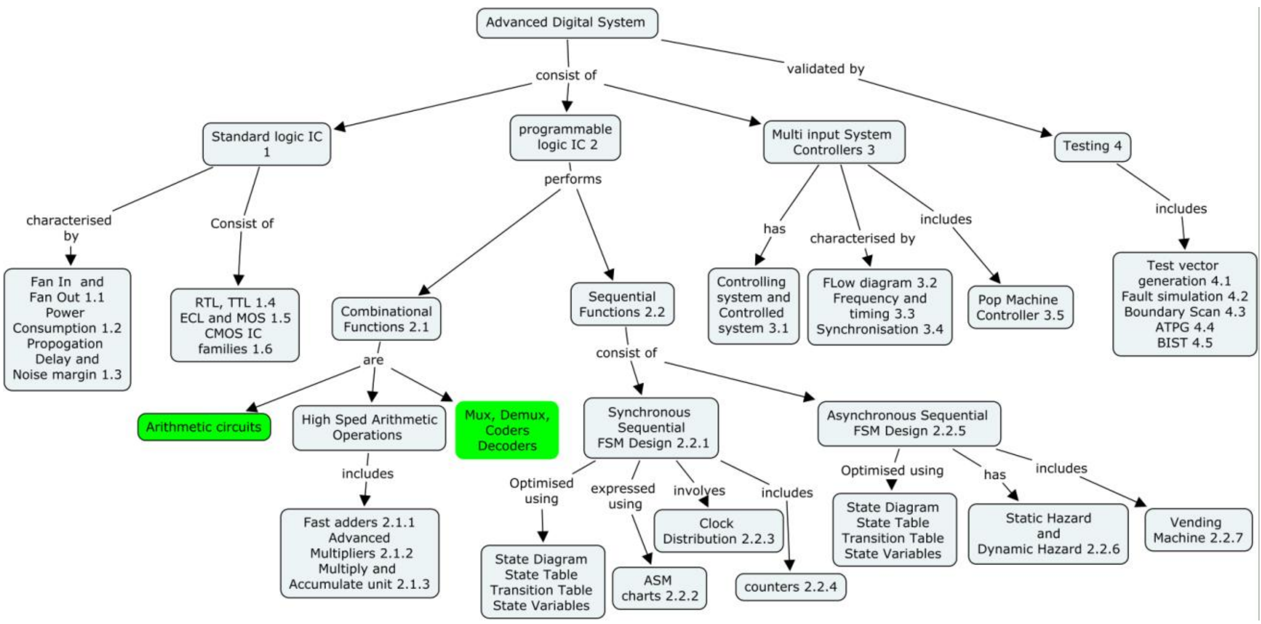
   F(x1,...x4)=m(0,4,11,13)+D(2,3,5,10)

Create

1. Design a sequential circuit that has two inputs, w1 and w2 and an output z. Its function is to compare the input sequences on the two inputs. If w1=w2 during any four consecutive clock cycles, the circuit produces z=1; otherwise, z=0.
2. Design a three-bit counter like circuit controlled by the input w. If w=1, then the counter adds 2 to its contents, wrapping around if the count reaches 8 or 9. If w=1 then the counter subtracts 1 from its contends, acting as a normal down-counter. Use D flip flop in the circuit.

3. Design a flow diagram that describes the sequential behavior of the system which will load a register and then will sequentially replace the contents of that register with its 2's complement.
4. Design a control mechanism for Vending machine that accepts nickels and dimes. It dispenses merchandise when 20 cents is deposited; it does not give change if 25 cents is deposited.
5. Design an FSM that implements the vending machine control using as few states as possible. Find a suitable state assignment and derive the next-state and output expression.
6. Design a system controller for the pop machine that will direct the control of the coin receiver, coin changer and pop drop mechanics while dispensing soda pop at 30 Rs per can and making the proper change retrieval for the following coin sequences of 5 and 10.

Concept Map:



Course Plan and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Standard logic IC**	
1.1	Fan In and Fan Out	1
1.2	Power Consumption	1
1.3	Propagation delay and Noise Margin	1
1.4	RTL and TTL	2

1.5	ECL and MOS	1
1.6	CMOS IC families	2
2	**Programmable logic IC**	
2.1	Combinational Functions	1
2.1.1	Fast adders	3
2.1.2	Advanced Multipliers	2
2.1.3	Multiply and Accumulate Unit	1
2.2	Sequential Functions	1
2.2.1	Optimization of Synchronous Sequential FSM Design	4
2.2.2	ASM charts	1
2.2.3	Clock Distribution	1
2.2.4	Case Study: Counters	1
2.2.5	Optimization of Asynchronous Sequential FSM Design	4
2.2.6	Static and Dynamic Hazard	1
2.2.7	Case study: Vending Machine	1
3.	**Multi Input System Controller**	
3.1	Controlling system and Controlled system	1
3.2	Flow diagram	1
3.3	Frequency and timing	2
3.4	Synchronization	2
3.5	Case study: Pop Machine Controller	1
4	**Testing**	
4.1	Test Vector Generation	1
4.2	Fault Simulation	1
4.3	Boundary Scan	2
4.4	ATPG	2
4.5	BIST	2

Syllabus:

Standard logic IC: Fan In and Fan Out, Power Consumption, Propagation delay and Noise Margin, RTL and TTL, ECL and MOS, CMOS IC families. **Programmable logic IC:** Combinational Functions, Fast adders, Advanced Multipliers, Multiply and Accumulate Unit, Sequential Functions, Optimization of Synchronous Sequential FSM Design, ASM charts, Clock Distribution, Case Study: Counters, Optimization of Asynchronous Sequential FSM Design, Static and Dynamic

Hazard, Case study: Vending Machine. **Multi Input System Controller:** Controlling system and Controlled system, Flow diagram, Frequency and timing Synchronization, Case study: Pop Machine Controller. **Testing:** Test Vector Generation, Fault Simulation, Boundary Scan, ATPG, BIST.

Reference:

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", PHI, fourth edition, 2008
2. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic Design with VHDL design", Tata Mc-graw hill, second edition, 2005
3. Michael John Sebastian Smith, " Application Specific Integrated Circuits", Addison Wesley, Ninth Indian Reprint, 2004
4. William I. Fletcher, "An Engineering Approach to Digital Design",EEE, Fourth Indian Reprint, 1996
5. Kwang-ting Cheng, Vishwani D. Agarwal and Cheng kwang ting Cheng, "Unified Methods for VLSI Simulation and Test generation" Springer, 1989

Course Designer

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Sub code	Lectures	Tutorial	Practical	Credit
DCC	3	-	-	3

DCC Digital Signal Processor 3:0

Preamble:

The course "DCC: Digital Signal Processor" is offered as elective subject in continuation with the core subjects 'D54 Digital Signal Processing' and "D33: Signal Processing". This course describes the architecture and instruction set of DSP processor for the implementation of baseband communication systems.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

f. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

1. Explain the architecture of Blackfin processor.
2. Differentiate von-neuman architecture, Harvard and modified Harvard architecture.
3. Understand the difference between microprocessor and DSP processor.
4. Write assembly language programs that examine load/store, move, logical operations, bit operations, shift/rotate operations, arithmetic operations and program flow control instructions.
5. Write optimal (balanced) program using C and assembly language for implementing a simple FIR system.
6. Generate a signal using a DSP development board EZ-KIT.
7. Implement a typical digital communication system using Blackfin processor ALP in Visual DSP++ Environment.

Tools

Visual DSP++

Assessment Pattern

S.No	Bloom's Category	Test 1	Test 2	Test 3/ End-semester examination
1	Remember	20	10	10
2	Understand	20	20	10
3	Apply	60	50	60
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	20	20

Course level Learning Objectives

Remember

1. Identify the inbuilt peripherals in Blackfin processor.
2. Mention the computational units available in Blackfin processor.
3. Lists the flags and their positions in ASTAT register.
4. Write the significance of each bit in TIMERx_CONFIG registers.
5. Write the features of Visual DSP++.
6. Define zero overhead looping.

Understand

1. How is Blackfin processor able to support multi-issue capability?
2. List the flags affected while executing AND instruction.
3. Differentiate the multiplication operation with fractional operands and integer operands.
4. In what way, instruction alignment unit supports program sequencer?
5. Write the content of R0 after executing the instructions given below.

   R0 contains 0000 B6A3;

   R0 >> =0X04;
6. What is the need for code optimization?

Apply

1. Represent -0.01171875 in 1.15 format.
2. Find the largest positive value represented by 4.12 format.
3. Let R1=0xABCD 89AC and R2=0x1245 7654; find the result in R3 after executing the instruction R3=R1+|-R2;
4. The base register is chosen as B0 = 0xFF80 0000, and the index register is initialized to the base address as I0 = 0xFF80 0000. The length of the circular buffer is L0 = 44 (or 0x2C) bytes, and the modifier M0 = 16 (or 0x10) bytes. At which access the index pointer returns to 0xFF80 0000.

5. Write an assembly language program to perform 10 tap FIR Filtering.
6. Convert the fixed point number 0xFED8 to floating point number.
7. Express the following floating-point numbers in normalized single-precision IEEE-754 format:

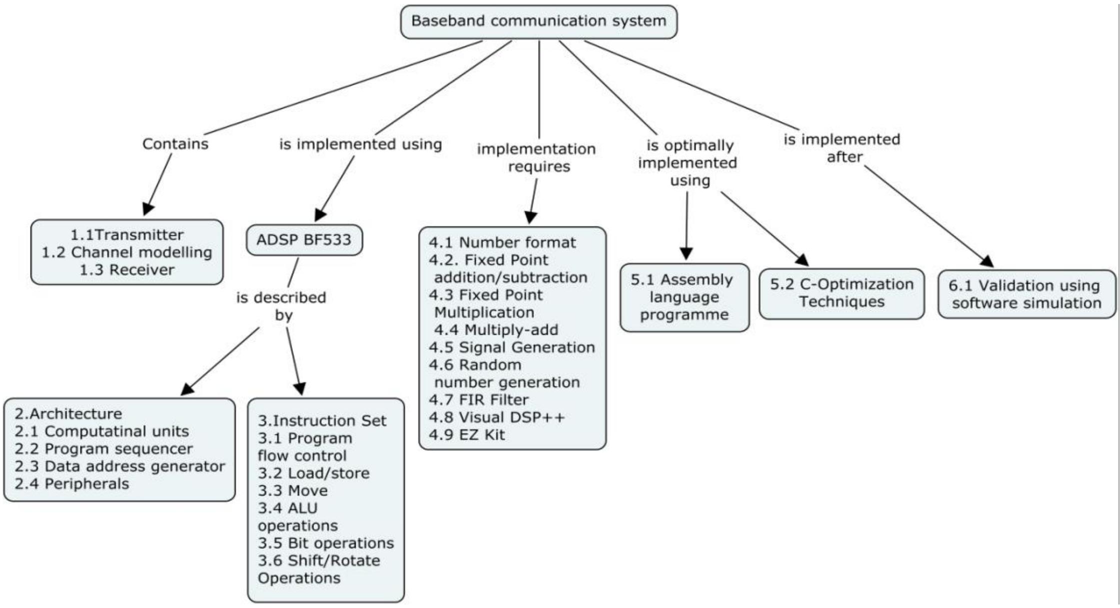
   i) 0.125

   ii) Smallest positive number 2−126.
8. Write a simple program to generate a sinusoidal signal.
9. How to insert pragma in C program?
10. How to use DSP library function in C program?
11. Write a program for generating random number.
12. Write an ALP to obtain FFT of a given sequence.
13. Write a optimized program for FIR filter.
14. Write an ALP for FIR Filter using index-style programming.
15. Write an ALP to perform 32-bit fixed-point extended multiplication.

Create

1. Write an assembly language program in Blackfin processor to implement a simple PSK transmitter and receiver.
2. Write an assembly language program in Blackfin processor to implement PSK transmitter which includes data generator and modulator and to implement a PSK receiver which has matched filter and threshold detector. Assume that the channel is slow and flat fading channel and the noise is AWGN with mean zero and variance one.
3. Design and implement 8 band FIR-based graphic equalizer using Blackfin simulator.
4. Write an assembly language program in Blackfin processor to implement OFDM transmitter and receiver.
5. Write an assembly language program in Blackfin processor to implement a FIR echo canceller that correctly estimates the echo impulse response and cancels the echo.

Concept Map:



Syllabus

Introduction to Communication systems: Transmitter, Channel modeling, Receiver **Architecture of Blackfin Processor:** Core architecture, Computation Units**,** Program Sequencer, Data Address Generators and Memory, Peripherals. **Instruction set of Blackfin Processor:** Program flow control, Load/Store, move, Arithmetic and Logical operations, Bit operations, Shift/Rotate operations **Programming in Blackfin Processor:** Number format, Fixed point addition/subtraction, Fixed point multiplication, multiply-add using single/dual MACs, Signal generation, random number generation, FIR Filter design, Visual DSP++, EZ kit **Code Optimization:** Assembly code for efficient programming, C Optimization techniques **System Simulation:** Simulation of PSK Transmitter and Receiver.

Text Books

1. ADSP-BF533 Blackfin Processor Hardware Reference 2005.
2. Blackfin Processor Instruction Set Reference 2004.

Reference Book

1. Woon-Seng Gan, Sen.M.Kuo, Embedded Signal Processing with Micro Signal Architecture, John Wiley Sons, 2007

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Introduction to Communication systems:**	
1.1	Transmitter	1
1.2	Channel modeling	1
1.3	Receiver	1
2	**Architecture of Blackfin Processor**	
2.1	Core architecture	2
2.2	Computation Units	2
2.3	Program Sequencer	2
2.4	Data Address Generators and Memory	2
2.5	Peripherals	2
3	**Instruction set of Blackfin Processor**	
3.1	Program flow control, move	2
3.2	Load/Store, move	2
3.3	Arithmetic and Logical operations	2
3.4	Bit operations	1
3.5	Shift/Rotate operations	1
4	**Programming in Blackfin Processor**	
4.1	Number format	2
4.2	Fixed point addition/subtraction	1
4.3	Fixed point multiplication	1
4.4	multiply-add using single/dual MACs	2
4.5	Signal generation, random number generation	2
4.6	FIR Filter design	2
4.7	Visual DSP++	3
4.8	EZ kit	3

No.	Topic	No. of Lectures
6	**Code Optimization**	
6.1	Assembly code for efficient programming,	3
6.2	C Optimization techniques	2
7	**System Simulation**	
7.1	Simulation of PSK Transmitter and Receiver	3

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Sub Code	Lectures	Tutorial	Practical	Credit
DCD	3	0	--	3

DCD OPTICAL COMMUNICATION NETWORKS 3:0

Preamble: **'**Optical communication networks' is the discipline which studies the theoretical, practical aspects of designing optical communication networks. The course will enable the students to familiarize the various aspects of optical communication networks such as what they are, how they work, how to design, build and configure them.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
c. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems

Competencies:

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

1. Understand the principles of optical fiber systems
2. Understand the behavior of optical communication network components including fibers, lasers, LEDs, optical receiver, multiplexers, isolators and filters.
3. Determine the information carrying capacity of a given fiber.
4. Determine the performance of a given point-point optical communication system.
5. Understand the behavior of first generation and second generation optical networks
6. Solve the problems of wavelength assignment and routing in WDM networks.
7. Understand the behavior of optical packet switched networks using optical time division multiplexing.
8. Architect a optical communication network to meet a given set of specification

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/ End Sem
1	Remember	20	20	10
2	Understand	30	30	20
3	Apply	50	50	50
4	Analyze	0	0	0
5	Evaluate	0	0	20
6	Create	0	0	0

Course Level Learning Objectives

Remember

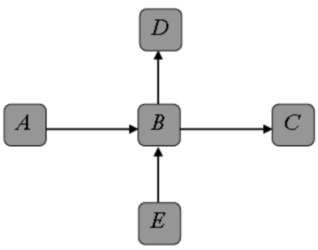
1. What are the advantages of optical fiber communication?
2. What is transmission window?
3. What is photonic crystal fiber?
4. Define quantum efficiency of an LED.
5. List the sublayers of optical layer
6. Draw the functional block diagram of SONET/SDH system?
7. What is graph coloring?
8. What are the functions of optical switch?
9. What is optical time division multiplexing?
10. What is access network?

Understand

1. Why the attenuation of light signal is more near the wavelength of 1400nm?
2. What is the difference between dispersion and distortion?
3. How does dispersion limit the performance of a fibre optic system?
4. What are the major advantages of hetrostructured LED over a homostructured one?
5. What is the difference between a surface emitting LED (SLED) & Edge emitting LED (ELED)
6. Compare first generation and second generation optical network.
7. How will you tune a fabry parrot filter?
8. How do you eliminate deadlock?
9. Why do we need an optical layer?
10. How does access network provide broadband access from the customers premises to the edge network?

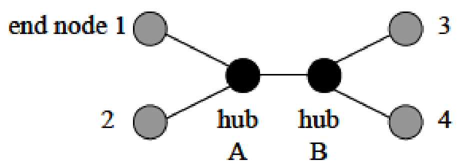
Apply

1. A 1.3μm light wave system uses a 50-km fiber link and requires at least 0.3 mW at the receiver. The fiber loss is 0.5 dB/km. Fiber is spliced every 5 km and has two connectors of 1-dB at both ends. Splice loss is only 0.2 dB each. Determine the minimum optical power that must be launched into the fiber.
2. Consider a piece of step-index optical fiber with a refractive index at the fiber core of 1.47 and a fractional refractive index change for the core and the cladding of 0.02. Determine the maximum fiber core diameter allowed if this fiber is designed to be single-mode over the wavelength range from 1310nm to 1550nm?
3. Suppose and APD has has following parameters: dark current *ID* = 1 nA, leakage current *IL* = 1 nA, η = 0.85, *M* = 100, excess noise factor *F* = $^{M1/2}$, *RL* = 10^3, bandwidth is 1 kHz. Suppose a sinusoidally varying 850 nm signal signal having modulation index *m* = 0.85 falls at the photodiode at room temperature (27^o C). Average optical power P_o = -50 dBm. Plot the value of the SNR as a function of *M* for 20≤ *M* ≤ 100. At what value of *M* does the maximum SNR occurs?
4. A 0.88 μm optical communication system transmits data over a 10 km single mode fibre by using 10 ns pulses. The dispersion parameter of the fibre is D = 80 ps/(km-nm). The LED has a spectral width Δλ of 51 nm. Determine the maximum bit rate possible.
5. Consider the switching node B in the network shown below. Each directed link is a single fiber. Assume that there are 3 s-d pairs: A-C, A-D, and E-C. Each s-d pair sends and receives traffic at 4 Gbps. In addition, assume that one wavelength channel can carry up to 10 Gbps.



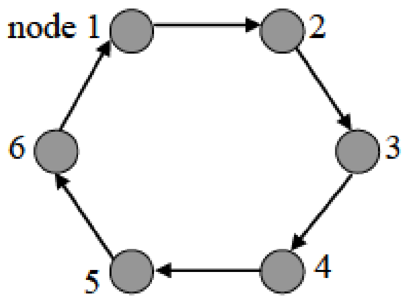
   a. Assume the use of electronic switching architecture at node B. Identify the amount of traffic (in Gbps) that must be processed electronically at node B.
   b. Assume the use of transparent optical switching architecture at node B, and that we bypass electronic processing of traffic at node B. Identify the number of wavelength channels used on the fiber from A to B.

6. Consider the network topology shown below. Each undirected link represents two fibers, one for the transmission in each direction. There are 4 end nodes and 2 hub nodes.



Consider the following s-d pairs each of which has 1 wavelength unit of traffic: 1-3, 1-4, 2-3, 2-4, 3-1, 3-2, 4-1, 4-2, 4-3. Specify the wavelength assignment (WA) that uses the minimum number of wavelengths.

7. Consider the unidirectional ring and the traffic (in wavelength unit) shown below. Note that each directed link represents *one* fiber in the clockwise direction. Specify the WA according to the smallest last (SL) sequential coloring heuristics. How many colors are used?



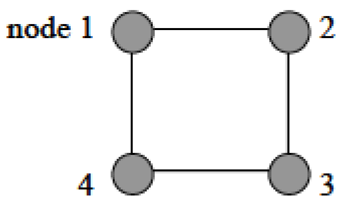
$$
\begin{array}{c} \\ \\ \left[t^{ij}\right] = \end{array}
\begin{array}{c c}
 & j = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 \end{matrix} \\
\begin{matrix} i=1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{matrix} &
\begin{bmatrix}
0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 2 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 \\
0 & 2 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\end{array}
$$

traffic matrix: entry (i, j) is traffic from node i to node j.

Evaluate:

1. An engineer has the following components available:
   (a) GaAlAs laser diode, operating at 850 nm, fiber coupled power 0 dBm
   (b) Ten sections of cable each of which is 500 m long, has 4 dB/k m attenuation, has connectors at both ends
   (c) 2 dB/connector connector loss
   (d) A PIN photodiode receiver, -45 dBm sensitivity
   (e) An avalanche photodiode receiver, -56 dBm sensitivity
   The engineer wishes to construct a 5-km link operating at 20 Mb/s. Which receiver should be used if a 6-dB operating margin is required.

2. An optical transmission system transmits non-return-to-zero (NRZ) data at 2.488 Gbit/s on a single-mode fiber. The optical transmitter operates at 1550 nm and is carefully controlled that negligible optical power is transmitted at the "0" bits. The "0" bits and the "1" bits are assumed to be equally-probable. A PIN photo-detector is used to detect the optical signal. The quantum efficiency of the photo-detector is 0.8. Assuming the receiver circuit has an equivalent resistance of 1kΩ, the receiver bandwidth matches with the signal bandwidth, negligible dark and leakage current at the photo-detector, the operating temperature is 27°C (Note that Bandwidth =1/(2×Bit Period) for NRZ)
   a. Compute the signal-to-noise ratio (SNR) with a received power of -20 dBm. (i) shot noise (ii) thermal-noise dominated. Which one, (i) or (ii), is a more practical and reasonable assumption? Explain.
   b. Find the minimum average optical power received at the detector in order to achieve an SNR by 20 dB by assuming the receiver is shot-noise dominated or thermal-noise dominated. Which one, (i) or (ii), is a more practical and reasonable assumption? Explain.
   c. Find the minimum average optical power received at the detector in order to achieve a bit-error-rate ≤ 10-12 if the receiver is thermal noise dominated.
   d. If the optical transmitter has an averaged output optical power of 3 dBm, the modulated si) gnal has spectral width 0.1 nm. Determine the maximum transmission distance allowed to guarantee a bit-error-rate ≤ 10^{-12} when the receiver is assumed to be thermal noise limited. Given that the fiber loss coefficient at 1550 nm is 0.25 dB/km and the chromatic dispersion coefficient at 1550 nm is 16ps/km/nm. (b) Find the band-gap energy and the emission wavelength of the other LED.
3. Consider a 4-node transparent optical network shown below. Assume that adjacent nodes are connected by two fibers, one for the transmission in each direction. In addition, assume that there are 2 wavelengths in each fiber.



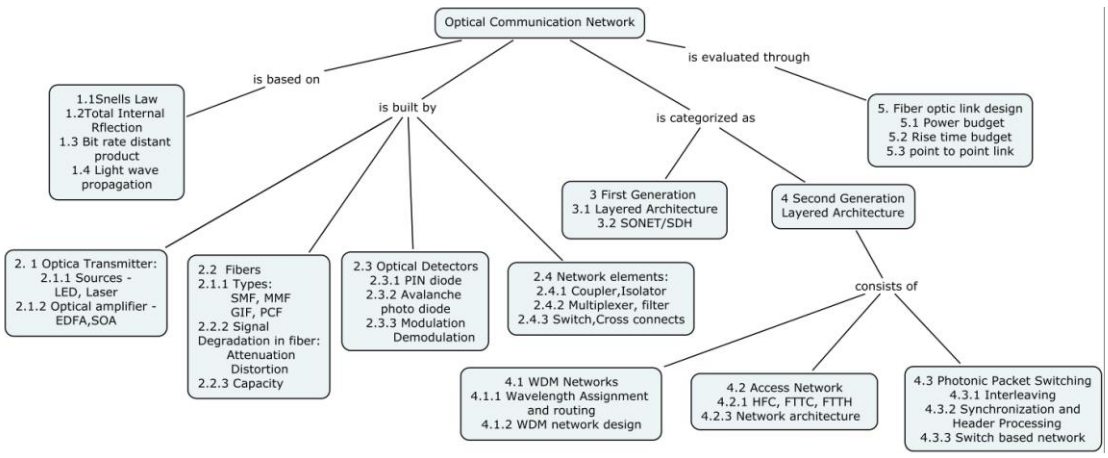
Assume that calls (i.e., lightpath demands) arrive in the following sequence

2-1, 2-4, 4-3, 1-3, 2-4, … where each value pair is the s-d pair for the call. Suppose that we use fixed routing with the paths 1-4-3, 2-1, 2-1-4, and 4-3 for s-d pairs 1-3, 2-1, 2-4, and 4-3 respectively. Evaluate the performance of following on-line WA schemes to each call (i.e., put on $\lambda_{1,}$ put on λ_2 , or blocked)

(*a*) First-fit WA: Assign the first possible wavelength starting from the smallest wavelength index.

(*b*) Most-used WA: Assign the wavelength with the highest utilization (before the new call). The utilization of wavelength λ*i* is the number of fibers on which wavelength λ*i* is used.

Concept Map



Syllabus:

Overview of optical fiber communication: Motivation for optical communication, Optical spectral bands, Key elements of optical fiber systems, Nature of light, snells law – total internal reflection, bit rate distant product, light wave propagation

Optical Transmitter: Sources- Light Emitting Diode - structure, quantum efficiency and power**,** Laser – laser diode mode and threshold condition, rate equation, quantum efficiency and resonant frequency, optical amplifiers: EDFA-SOA **Optical Fibers:** Single mode fiber, Graded index fiber, photonic crystal fiber, Signal Degradation in optical fiber: Attenuation, Distortion **Optical Detectors:** pin photo detector, Avalanche photodiode, **Network Elements:** coupler, isolator, multiplexers, filters, optical switches, Optical cross connects **First generation optical network: SONET/SDH** – multiplexing, physical layer, infra structure, Architecture **WDM networks:** Wavelength assignment and routing, WDM network design, **Access Network:** HFC, FTTC, FTTH, network architecture **Photonic Packet switching:** Interleaving, Synchronization, Header

Processing, switch based network **Fiber Optic Link Design:** Power budget, rise time budget, point to point link design

Text books:

1. Gerd Kaiser, "Optical fiber communications", 4th ed. McGraw Hill Int., 2008.
2. Rajiv Ramaswami Kumar N. Sivarajan, "Optical Networks", Harcourt Asia Limited, 2nd ed. 2004.

Reference Books:

1. A.K.Ghatak and K.Thiagarajan, "Introduction to Fiber Optics", Cambridge university press, 1998.
2. J.Gower, "Optical communication systems", Prentice Hall of India, 2001.
3. John Senior, "Optical fiber communications-principles and practices", Prentice Hall of India, 1994.
4. Uyless Black, "Optical Networks" Pearson Education, 2002.
5. David Greenfield, "The Essential Guide to Optical Networks" Prentice Hall PTR 2001.

Course Contents and Lectures schedule

S. No	Topics	No. of Lectures
1	**Overview of optical fiber communication**	
1.1	Motivation for optical communication, Applications-telecom networks, cable TV networks, Optical spectral bands, Key elements of optical fiber systems	2
1.2	Nature of light, Basic optical laws and definitions	1
2.1	**Optical Transmitter**	
2.1.1	Optical Sources: Light Emitting Diode - structure, quantum efficiency and power	2
	Laser – laser diode mode and threshold condition, rate equation, quantum efficiency and resonant frequency	2
2.1.2	Optical Amplifiers: EDFA – SOA	2
2.2	**Optical Fibers**	
2.2.1	Fiber Types: Single mode fiber Graded index fiber, photonic crystal fiber	1
2.2.2	Optical fiber modes and configurations	1

2.2.3	Signal Degradation in optical fiber: Attenuation, Distortion	3
2.3	**Optical Receivers**	
2.3.1	p-i-n photo detector	1
2.3.2	Avalanche photodiode	1
2.3.3	Modulation - Demodulation: Direct Detection, Coherent Detection	3
2.4	**Network Components**	
2.4.1	coupler, isolator	2
2.4.2	multiplexers, filters,	2
2.4.3	optical switches, Optical cross connects,	2
3	**First Generation Optical Networks**	
3.1	SONET/SDH – multiplexing, physical layer, infra structure	2
3.2	Layered Architecture	2
4	**Second Generation Optical Networks**	
4.1	**WDM Networks**	
4.1.1	WDM network design	2
4.1.2	Wavelength Assignment and routing	2
4.2	**Access network**	9
4.2.1	HFC, FTTC, FTTH	1
4.2.2	Network architecture	2
4.3	**Photonic packet switching network**	
4.3.1	Interleaving	2
4.3.2	Synchronization- Header Processing	2
4.3.3	Switch based network	2
5	Fiber Optic Link Design	
5.1	Power budget	
5.2	Rise time Budget	
5.3	Point to point link design	

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Sub Code	Lectures	Tutorial	Practical	Credit
DCE	3	0	--	3

DCE: ASIC DESIGN 3:0

Preamble: This course 'DCE: ASIC DESIGN is preceded by three credit course 'D23 – Basics of Digital Systems' offered in second semester, 'D42 - Designing with PLDs and FPGAs' offered in fourth semester and 'DCB: Advanced Digital Systems'. This course provides the students, the knowledge about ASIC design and construction. It considers programmable ASIC analysis, backend design and improvement algorithms.

Program Outcomes addressed:

c. Graduates will demonstrate knowledge of mathematics, science and engineering.

d. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

f. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

g. Graduate who can participate and succeed in competitive examinations.

Competencies:

1. Explain the different phases of the design flow for digital ASICs
2. Demonstrate how hardware description language patterns are realized in hardware
3. Evaluate the testability of a design
4. Demonstrate an understanding of how to optimize the performance, area, and power of a complex digital functional block, and the tradeoffs between these.
5. Apply techniques to analyze the timing of the final implementation
6. Demonstrate an understanding of issues involved in ASIC design, including technology choice, design management on ASIC design.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	30	20	10
2	Understand	30	20	10
3	Apply	40	40	40
4	Analyze	0	20	40
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember:

1 List out the sequence of steps involved to design an ASIC

2 Define Hypergarph

3 Mention the semicustom characteristics of an FPGA.

4 State Greedy algorithm

5 Define Clock skew

6 Recall the goals and objectives of system partitioning.

7 Define seeding

Understand:

1 Draw the ASIC design flow

2 Explain the function of each block in ASIC design flow

3 Illustrate channel definition in floor planning with suitable examples.

4 Compare the different types of Gate Array semi custom ASIC.

5 Explain in detail about routing algorithms.

6 Illustrate I/O and power planning with neat sketches.

7 Give the expression for sources of power dissipation in CMOS logic

Apply:

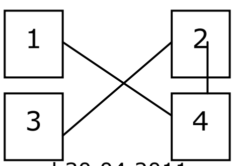
1 Draw the network graph for the given cost matrix and partition the graph using K-L algorithm

$$C = \begin{matrix} 0 & 0 \\ 1 & 0 \end{matrix}$$

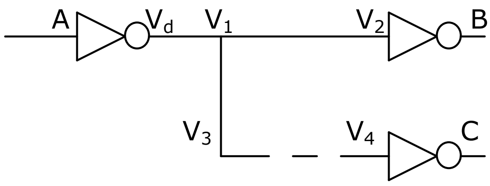
2 Determine the local optimum solution for the above cost matrix

3 Calculate the Eigen value and Eigen vectors for the given network

4 Implement the given network graph in one dimensional and two dimensional placement structures



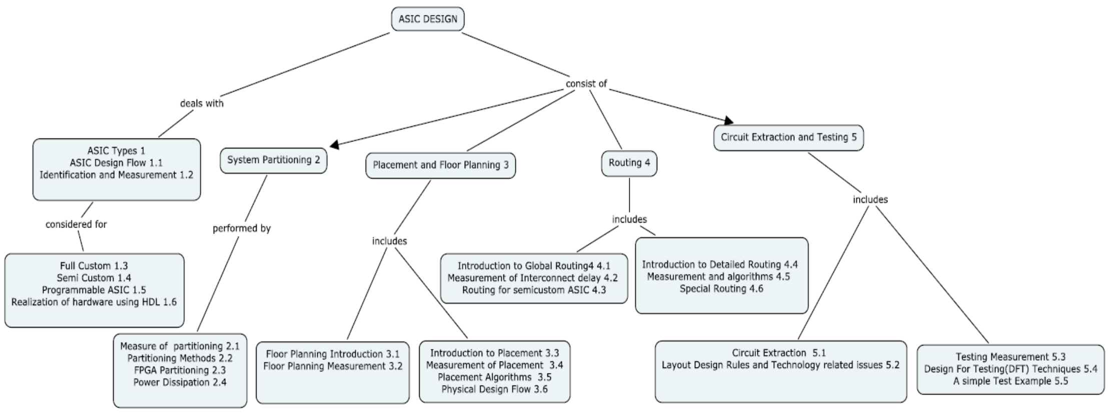
5 Compute the interconnect delay for the given circuit.
6 Find the expression of Elmore's constant for the given circuit.



Analyze

1 Distinguish the different types of semi custom ASIC
2 Identify the procedure to partition the network using iterative improvement algorithm
3 Distinguish the difference between Global routing inside flexible blocks and between blocks
4 Identify the steps involved to place logic cells of a network in two dimensional structures.
5 Identify the algorithms used for the detailed routing of general shaped areas
6 Distinguish various constraints while detailed routing using LEA

Concept Map:



Lecture Plan:

No.	Topic	No. of Lectures
1.	**ASIC Types**	
1.1	ASIC Design Flow	1
1.2	Identification and Measurement	1
1.3	Full Custom	1
1.4	Semi Custom	2
1.5	Programmable ASIC	1

1.6	Realization of hardware using HDL	1
2	**System Partitioning**	
2.1	Measure of partitioning	1
2.2	Partitioning Methods	4
2.3	FPGA Partitioning	1
2.4	Power Dissipation	1
3	**Placement and Floor Planning**	
3.1	Floor Planning Introduction	2
3.2	Floor Planning Measurement	2
3.3	Introduction to Placement	1
3.4	Measurement of Placement	1
3.5	Placement Algorithms	3
3.6	Physical Design Flow	1
4	**Routing**	
4.1	Introduction to Global Routing	1
4.2	Measurement of Interconnect delay	2
4.3	Routing for semicustom ASIC	2
4.4	Introduction to Detailed Routing	1
4.5	Measurement and algorithms	3
4.6	Special Routing	2
5	**Circuit Extraction and Testing**	
5.1	Circuit Extraction process	3
5.2	Layout Design Rules and Technology related issues	2
5.3	Testing Measurement	1
5.4	Design For Testing(DFT) Techniques	3
5.5	A simple Test Example	1

Syllabus

ASIC Types: ASIC Design Flow, Identification and Measurement, Full Custom, Semi Custom, Gate Array ASIC, Cell Based ASIC, Programmable ASIC. **System Partitioning :** Connectivity Measurement, Constructive Partitioning, Iterative Partitioning Improvement, The K-L Algorithm, The Ratio-Cut Algorithm, The Look-Ahead Algorithm, Simulated Annealing, FPGA Partitioning, Simple Partitioning Example. **Floor Planning and Placement**: Floor Planning, Goals and Objectives, Measurement of Delay, Tools, Channel Definition, Placement Definitions, Goals and Objectives, Measurement of Placement, Goals, Placement Algorithms, Simple Placement Example, Physical Design Flow. **Routing**: Global Routing, Measurement of Interconnect delay, Methods, Fixed blocks and Flexible Blocks, Timing Driven Methods, Detailed Routing, Goals and Objectives, Measurement of Channel Density, Algorithms, Special Routing. **Circuit Extraction and Testing:** Circuit extraction process, Layout Design Rules and Technology related issues, Testing Measurement, Design For Testing (DFT) Techniques, A simple Test Example.

Reference:

1. Michael John Sebastian Smith, " Applications Specific Integrated Circuits", Pearson Education, Ninth Indian reprint,13th edition,2004.
2. Neil H.E.Weste, Eshraghian, "Principles of CMOS VLSI Design": Addison Wesley, 1999.

Course Designer

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Sub code	Lectures	Tutorial	Practical	Credit
DCF	3	0	-	3

DCF Antennas for Wireless Communication 3:0

Preamble: The tremendous success enjoyed by the cellular phone industry and advances in radio frequency integrated circuits have in recent years fostered the development of various wireless technologies, including RFID, mobile internet, body-centric communications, and UWB communication. For aesthetic reasons, all these systems require small antennas that can be embedded into the mobile units. Furthermore, the development of new services and radio technologies demand for low cost, light weight, miniaturized, efficient antennas for portable wireless devices.

One of the main competencies that a present day antenna engineer has to posses is the capability to design antennas for portable wireless devices that have good bandwidth, gain and radiation characteristics.

This subject is essential to understand the need for designing miniaturized antennas for wireless applications such as Mobile handsets, Radio frequency identification, Laptop, Wearable devices and Ultra wide band communication. This course presents various types of antenna geometry suitable for the above mentioned wireless devices, the issues in respect of their design and development.

Program Outcomes addressed

a. An ability to apply the knowledge of mathematics, science and engineering
b. An ability to design a component to meet the desired social needs within realistic constraints.
a. An ability to develop and conduct experiment and interpret data.

Competencies: At the end of the course the student should be able to

1. Explain the behavior of an antenna in terms its parameters
2. Simulate the radiation pattern of antennas using EM CAD simulator software-ADS
3. Explain the design issues in wireless device including handset, RFID, Laptop, wearable devices and UWB communication
4. Select an antenna for the above mentioned wireless applications
5. Design planar antennas for given specifications
6. Develop prototype of a designed antenna
7. Measure the parameters and radiation pattern of an antenna

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	40	20	20
2	Understand	40	30	20
3	Apply	20	30	30
4	Analyze	0	0	0
5	Evaluate	0	0	00
6	Create	0	20	30

Learning Objectives

Remember

1. What are the features of 3G wireless systems?
2. Explain the spectrum allocation for various wireless applications.
3. List some of the antennas used in handset.
4. Explain the radiation mechanism of PIFA antenna and their parameters.
5. What are the effects of environment on RFID Tag antenna?

Understand

1. What are the effects of user on the mobile unit performance?
2. Why monopole antennas are preferred for wireless communication in Laptop?
3. Compare active and passive RFID's
4. What wireless antenna can be used to cover a small campus area of a few buildings?
5. How wearable antenna plays an important role in military? Explain the structure of any one printed antenna suitable for wearable device.

Apply:

1. Propose simulation steps to facilitate the design of patch antenna on a multilayer substrate having effective dielectric constant of 5.5.
2. Derive the maximum reading distance of a tag in a RFID system.
3. Evaluate the performance of PC card antenna and INF antenna in a laptop prototype.
4. Prepare a model chart for developing antenna for wearable devices considering different RF constraints.
5. Explain in detail how conventional planar antenna can be modified to provide wide bandwidth

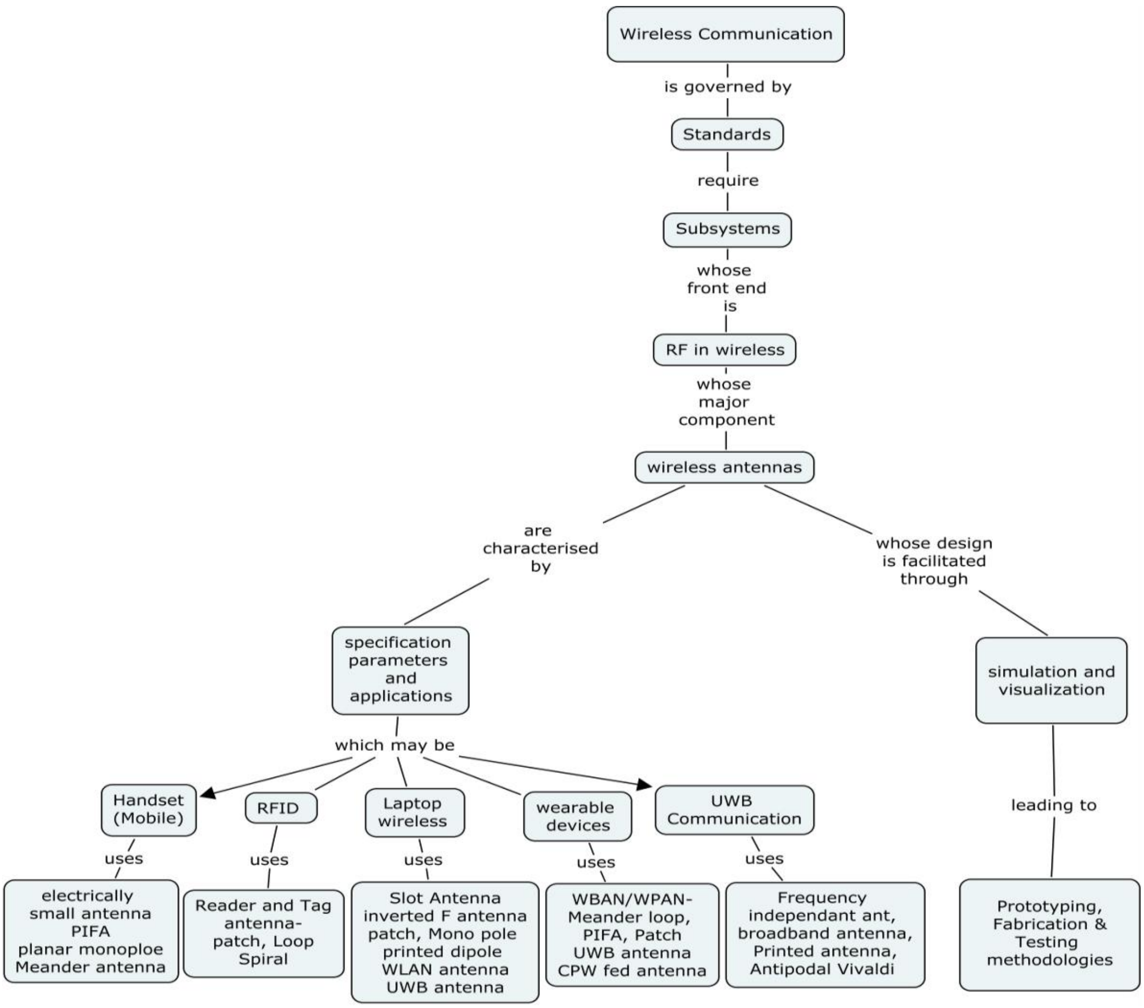
Create:

1. Design a mini wireless antenna for Laptop computer applications.
2. Design a planar inverted F antenna operating in Cellular GSM lower band.
3. Suggest a suitable planar antenna system for the given specification:

Center Frequency - 5GHz
Dielectric constant – 3.38
Thickness - 1.52mm
VSWR - 2:1
Bandwidth > 500MHz

4. Design a 4 element MIMO antenna operating at 2.4GHz application.
5. Design a conformal, flexible E shaped antenna for wearable antenna application.

Concept Map:



Syllabus:

Introduction: Evolution of wireless communications, Key terms and concepts, Wireless systems and standards - Wireless front end- Wireless antenna- Antenna systems for portable Wireless devices, EM simulation software- Agilent Advanced Design System, Fabrication and testing methodologies.

Handset Antennas: Performance Requirements, Electrically Small Antennas, Classes of Handset Antennas- External, Internal antenna, Efficiency and bandwidth, SAR, Practical Design- Simulations, Materials and Construction, prototype, Measurements.

RFID Tag Antennas: RFID Fundamentals, RFID System Configuration, Classification of RFID Systems, Principles of Operation, Frequencies, Regulations and Standardization, Design Considerations for RFID Tag Antennas, Radio Link, Parameters, Effect of Environment on RFID Tag Antennas.

Laptop Antennas: Wireless in Laptop, Laptop Antenna Issues, Possible Antennas for Laptop Applications, Mechanical and Industrial design constraints, Link budget model, Antenna Design Methodology. An INF Antenna, Antennas for WWAN, Integrated Antenna, Dualband antenna, Ultra-Wide Band Antennas.

Antennas for Wearable Devices: Wireless Body Area Networks, wearable antenna and parameter, Antenna Design Requirements for Wireless BAN/PAN, Characterization of Wearable Antennas, BAN channel characterization, UWB Wearable Antennas, Compact Wearable Antenna for Healthcare Sensors

Antennas for UWB Applications: UWB Wireless Systems, Challenges in UWB Antenna Design, Frequency-Independent Designs, Planar Broadband Designs, Planar Printed PCB Designs, Planar Antipodal Vivaldi Designs.

Text books:

1. J.C.Liberti, JR and Theodore Rappaport, "Smart Antennas for Wireless communication" Prentice Hall of India, 1999.
2. Zhi Ning Chen, "Antennas for Portable devices" Wiley Publishers, 2007

Reference books:

1. Kin Lu Wong, "Planar Antennas for Wireless communication", Wiley Interscience, 2003.
2. Grishkumar and K.P.Ray, "Broadband microstrip antennas" Artech House, 2003
3. John D.Kraus, Ronald J.Marhefka "Antennas for all Applications" Fourth Edition, Tata McGraw- Hill, 2006.
4. Zhi Ning Chen, Michael Yan Wah Chia, " Broadband Planar Antennas" John Wiley & Sons Ltd, 2006.
5. http://edocs.soco.agilent.com

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Cellular communication antennas**	

1.1	Evolution of wireless communication	1
1.2	Key terms and concepts, Wireless systems and standards	1
1.3	Wireless front end- Wireless antenna- Antenna systems for portable Wireless devices	2
1.4	EM simulation software - Agilent Advanced Design System	1
1.5	Fabrication and testing methodologies.	1
2	**Handset Antennas:**	
2.1	Performance Requirements, Electrically Small Antennas	1
2.2	Classes of Handset Antennas -External, Internal antenna	2
2.3	Efficiency and bandwidth, SAR	1
2.4	Practical Design- Simulations, Materials and Construction	2
2.5	prototype, Measurements	2
3	**RFID Tag Antennas:**	
3.1	RFID Fundamentals, RFID System Configuration, Classification of RFID Systems	2
3.2	Principles of Operation, Frequencies, Regulations and Standardization	2
3.3	Design Considerations for RFID Tag Antennas	1
3.4	Radio Link, Parameters, Effect of Environment on RFID Tag Antennas	2
4	**Laptop Antennas:**	
4.1	Wireless in Laptop, Laptop Antenna Issues Display Construction	2
4.2	Possible Antennas for Laptop Applications, Mechanical and Industrial design constraints	1
4.3	Link budget model, Antenna Design Methodology.	2
4.4	An INF Antenna Implementation, Integrated Antenna, Antennas for WWAN	2

4.5	Dualband antenna, Ultra-Wide Band Antennas.	2
6	**Antennas for Wearable Devices**:	
6.1	Wireless Body Area Networks, wearable antenna and parameter	2
6.2	Characterization of Wearable Antennas, BAN channel characterization	1
6.3	Antenna Design Requirements for Wireless BAN/PAN	1
6.4	UWB Wearable Antennas	2
6.5	Compact Wearable Antenna for Healthcare Sensors	1
7	**Antennas for UWB Communication:**	
7.1	UWB Wireless Systems, Challenges in UWB Antenna Design	2
7.2	Frequency-Independent Designs	2
7.3	Planar Broadband Designs	2
7.4	Planar Printed PCB Designs	2
7.5	Planar Antipodal Vivaldi Designs	1

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Sub code	Lectures	Tutorial	Practical	Credit
DCG	3	0	-	3

DCG: Design of Power Supplies 3:0

Preamble:

This course aims at imparting the necessary knowledge base with respect to comprehending the various topologies of linear and switched mode power supplies, analysis of the various power supply topologies and then leading to design of the power supplies for typical applications like battery charging.

The course will start with a brief review of the power semiconductor switches used in the power supply circuits. As all the dc-dc converters need to use some power semiconductor switch for their operation, the drive circuits of the three most popular devices viz. BJT, MOSFET and IGBT will be addressed. Concepts and circuits for protecting and de-stressing the devices will also be discussed.

Almost all power supplies will draw the energy from the mains grid. As a consequence the first stage is always a AC-DC converter. The most popular AC-DC converter is the rectifier-capacitor filter. This topology will be discussed, analyzed and designed.

In most multi-output power supplies, the final stages of the uncontrolled outputs are in general linear power ICs. Therefore, a proper understanding of the concepts, ability to analyse and design linear power supplies is essential. Thus the review of the power semiconductor switches and drive circuits will be followed by a treatment on the linear power supply strategies and their design aspects.

Next the dc-dc switched mode converter topologies as applied to power supplies will be dealt, with both analysis and design.

This will include the non-isolated primary converter (viz. Buck, boost and the buck-boost) and their isolated derivatives like the push-pull, half bridge and the full bridge topologies. The popular flyback topology which is the derivative of the non-isolated buck-boost topology will also be addressed.

Following the discussion on the dc-dc converters, typical applications of dc-dc converters like power supplies, unity power factor converters and battery chargers will be addressed with special emphasis on batteries and battery charging circuits.

Program Outcomes Selected

- Graduates will demonstrate knowledge of mathematics, science and engineering.
- Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

- Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
- Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.
- Graduate will be able to communicate effectively in both verbal and written form.
- Graduate will develop confidence for self education and ability for life-long learning.
- Graduate who can participate and succeed in competitive examinations.

Competencies: The student, at the end of the course, should be able to

1. Understand the requirements of an ideal switch and the characteristics of important power semiconductor switches thereby enabling one to model and simulate the power semiconductor switches
2. Estimate the conduction and switching power losses in various power semiconductor switches.
3. Design drive circuits for BJTs, MOSFETs and IGBTs
4. Understand the operation of rectifiers and the effect of the various loads on rectifier functioning and draw current and voltage waveforms at various points in the circuit.
5. Design capacitor-filter rectifier circuits.
6. Analyze and characterize the linear regulators
7. Design the various types of linear regulators
8. Analyze the steady-state operation of a DC–DC converter
9. Design non-isolated and isolated DC–DC converters

Assessment pattern:

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	10	10	0
2	Understand	10	10	10
3	Apply	40	30	30
4	Analyze	10	20	20
5	Evaluate	0	0	0
6	Create	30	30	40

Learning Objectives

Remember

1. List the advantages of MOSFET.
2. Why is IGBT a voltage controlled device?
3. What are the different types of controlled rectifier?
4. List the types of Power Converters.
5. In any converter topology, the inductor should be placed in such a manner where its current will not become ____________ at instant of operation.
6. In any converter topology, the capacitor should be placed in such a manner where its ______ will not become discontinuous at instant of operation.
7. What are the basic topologies of switching regulators?
8. Efficiency primarily affects the volumetric ___________ of the linear regulator.
9. In a shunt regulator, the output voltage is regulated by virtue of the zener diode being operated in the ___________________ region.
10. The current absorbs the changes in the______ and ________ currents.
11. In a shunt regulator, under no-load condition, the whole input current flows into the ______.
12. How can the regulation of a shunt regulator be improved by using an output BJT device?
13. A transistor or BJT operating in the linear region can be used as a __________ element in a series regulator.
14. If the input voltage is a constant, then the current through the bias resistor R_b of the series regulator can be considered as a _________ current.
15. Current regulators are built using _________ regulators.
16. The no-load condition for the current regulator is when the output resistor value is ________.
17. In any converter topology, the inductor should be placed in such a manner where its current will not become ____________ at instant of operation.
18. In any converter topology, the capacitor should be placed in such a manner where its ______ will not become discontinuous at instant of operation.
19. The capacitor value is calculated by applying the ______________rule.

Understand

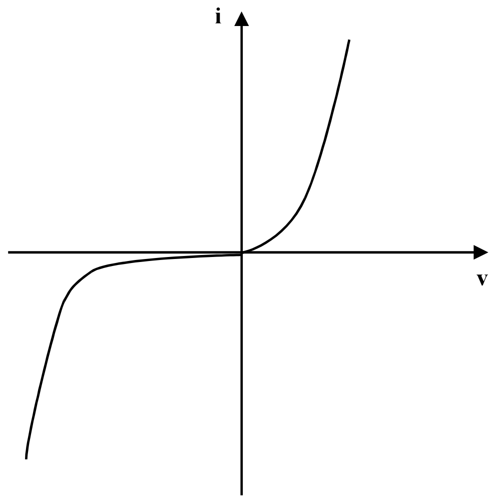
1. What is a power converter?
2. Mention the advantages and disadvantages of on – off control method of ac voltage control.
3. Why the series inverter is called so?
4. State the use of flywheel diode.
5. Differentiate full converter and semi-converter.
6. What is frequency modulation control of a converter?
7. What is meant by a static circuit breaker?
8. What is the necessity of voltage control in inverters?
9. Why thyristors are not preferred for inverters?
10. Explain time ratio control of choppers.
11. List the parameters for controlling power in a transmission line.
12. Under what conditions a single phase fully controlled converter gets operated as an inverter.

Apply

1. Using engineering approximations, obtain a simpler static characteristic of a diode.
2. A BJT is driving a 10A resistive load from a 100V dc supply. The base drive signal is switching at frequency of 50KHz and duty cycle of 0.75. The BJT has the following datasheet specifications: V_{besat} = 0.7V, V_{ceo} = 30V, I_{cm} = 15A, V_{cesat} = 0.3V, h_{FEmin} = 100, t_d = 1□s, t_s = 2□s, t_r = 1.5□s, t_f = 1.5□s. Calculate the power loss in the BJT.
3. Analyze with typical values, the effect on the gate-source oxide layer of a MOSFET when the unprotected gate lead is touched by our body or hands. Suggest remedial measures that can the above mentioned problem.
4. Develop the design equations for designing the basic voltage divider base drive circuit.
5. Consider a zener shunt regulator circuit wherein the input voltage Vi varies between 10 – 20V and the zener diode used is a 5V, 1W device. If the maximum allowable zener current is 150mA, then what is the value and power rating of the series resistance used in the regulator?
6. In a series regulator, the output voltage sensing resistors, R_1 and R_2 are 5.6Kohms each. The output voltage is a regulated 15V. The zener diode value

is 5.1V. Using the first level model, calculate the base current through the transistor Q_2?

7. The input voltage of a series regulator varies between 20V and 30V. The output is a regulated 15V dc. If the bias resistor R_b has a value of 2K ohms, then using the first level model, estimate the nominal current through the bias resistor.
8. Consider a linear series regulator with R_1=3.6KΩ, R_2=2.5KΩ, R_b=3.6KΩ, R_z=20KΩ, Vz=7V, R_L=1KΩ, Vi=20V to 30V, Vi-nominal=25V. Using the first level model, find the line regulation coefficient for Ω_1=100 and Ω_2=1000.
9. Using engineering approximations, obtain a simpler static characteristic of a diode.



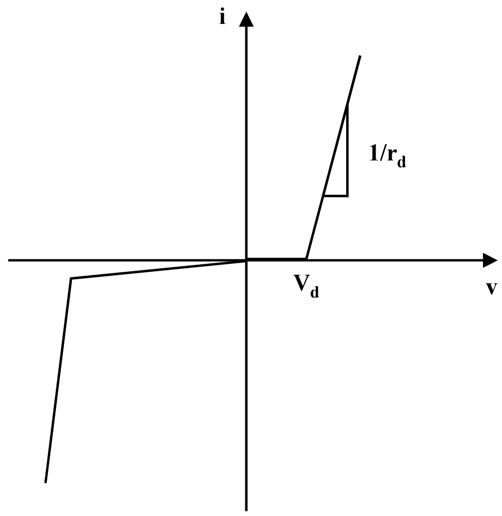


Fig.1.1a. Actual characteristic Fig.1.1b piece-wise linear characteristic

10. A diode and a 10 ohm resistor are connected in series to a square wave voltage source of 50V peak. The reverse recovery time for the diode is given to be 200ns. Find the reverse recovery charge.

11. For three phase thyristor controlled half wave rectifier feeding load R as shown in Fig.2. Show that the average output voltages are given by

    $V_o = (3\sqrt{3}\ V_m \cos\alpha) / 2\pi$ for $0 \le \alpha \le \pi/6$

    $V_o = (3/2\pi)\ V_m\ [1+\cos(\alpha + \pi/6)]$ for $\pi/6 \le \alpha \le 5\pi/6$

    Where Vm is the maximum value of phase voltage and α is the firing angle delay.

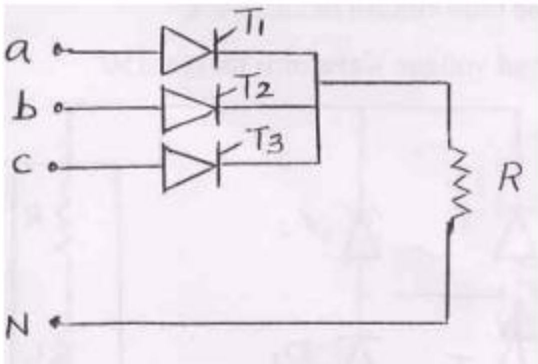


Fig.2. Three phase thyristor controlled half wave rectifier

12. The input to a chopper is from a 100V dc source. The chopper is switched at a frequency of 100KHz with a pulse width of 4□s. What is the average output voltage of the chopper?
13. A dc chopper has an input voltage of 200 V and a load of 20 ohm resistance. When chopper is on, its voltage drop is 1.5 V and the chopping frequency is 10 KHz. If the duty cycle is 80%, find i) Average output voltage ii) RMS output voltage iii) Chopper on time.

Analyze

1. Derive relationship for the power dissipation within the transistor between the applied collector-emitter voltage, the collector current and the switching frequency of the transistor for a resistive load in the collector.

2. A MOSFET is operated such that the operating point is in the active region. The MOSFET has a gate-source threshold voltage value of 2.5V. A gate-source voltage of 5V is applied to the gate source terminals of the MOSFET which results in the flow of drain current. On increasing the gate-source voltage to 7.5V, what is the factor by which the drain current increases?

3. Using first level non-idealities, analyze the effect of current through Rb of the series regulator. Suggest a solution to alleviate the loss of regulation due to current flow through Rb.
4. Analyze the effect of the output voltage, duty ratio and the load current in the determination of the inductor value of the buck converter.
5. Analyse the conditions which must be satisfied for turning on an SCR with a gate signal.
6. Analyse briefly and compare the various methods employed for the the control of output voltage and harmonic control of inverters.
7. Analyze the validity of the input-output relationship of the boost converter near unity duty ratio. Explain.
8. Analyze the effect of load resistance on the operation of the linear series regulator using the model with first level device non-idealities.
9. Analyze the operating principle of the linear regulator.
10. How does one obtain the minimum duty ratio for a boost converter topology?
11. A buck converter is supplied with an input voltage that varies between 20V and 30V. The output is required to be regulated at 5V. Find the duty cycle range.
12. A buck converter that is switching at 50KHz is supplied with an input voltage that varies between 20V and 30V. The output is required to be regulated at 5V. A load resistor of 5 ohms is connected across the output. If the maximum allowable inductor current ripple is 10% of the load current, then estimate the value of the inductance to be used in the buck converter.
13. A boost converter is supplied with an input voltage that varies between 5V and 10V. The output is required to be regulated at 15V. Find the duty cycle range.
14. A boost converter that is switching at 50KHz is supplied with an input voltage that varies between 5V and 10V. The output is required to be regulated at 15V. A load resistor of 15 ohms is connected across the output. If the maximum allowable inductor current ripple is 10% of the average inductor current, then estimate the value of the inductance to be used in the boost converter.
15. A forward converter is switched at 50KHz with a duty cycle of 0.3. It is supplying a 50W load at an output voltage of 5V. The input to the forward

converter is derived from the 230V mains by using a capacitor input filter rectifier. Estimate the turns ratio of the transformer.

16. For a buck converter supplying a 10A load, the inductor current ripple is designed to be 10% of the maximum load current. Calculate the load current at which the converter is at the boundary of CCM and DCM.
17. Between the push-pull topology and the half-bridge topology, which is better from the point of view of flux saturation effects and why?
18. A flyback converter is switched at 50KHz with a duty cycle of 0.4. It is supplying a 48W load. The turn ratio is 5. The input voltage of the flyback converter is derived from a 12V battery. The flyback inductor value as viewed from the primary side is 10mH. What is the output voltage? What is the peak current through the primary switch? What is the peak current through the secondary diode? What is the voltage developed across the primary switch when it is OFF? What is the peak inverse voltage of the secondary diode?

Evaluate

1. Between the BJT and the IGBT, which is closer to the Ideal SPST switch?
2. Evaluate the effect of the base current wave shape on the turn-ON switching behavior of a BJT?
3. A linear regulator is used to regulate an unregulated dc source with nominal voltage of 15V. The shunt resistor value is 100 ohms and the series resistor value is 250 ohms. A load resistor of 1Kohms is connected across the output. What is the output voltage? What is the input power drawn from the unregulated input source? What is the efficiency of the linear regulator?
4. Evaluate the effect of the first level non-ideality in the zener diode, on the output voltage regulation.
5. From among the various power semiconductor devices, how does one use the idealized device static characteristics to select a specific power semiconductor device to act as a power switch in a particular dc-dc converter topology?
6. Consider a linear series regulator with R_1=3.6KΩ, R_2=2.5KΩ, R_b=3.6KΩ, R_z=20KΩ, Vz=7V, R_L=1KΩ, Vi=20V to 30V, Vi-nominal=25V, $\Omega_1=\Omega_2$=100. If the output voltage is expressed as $V_o = k_1V_i + k_2V_z$, evaluate k_1 and k_2 using the first level model?
7. Evaluate the effect of the output lead resistance on the output regulation by comparing two layout scenarios wherein the output lead resistances are as shown in the figures below.

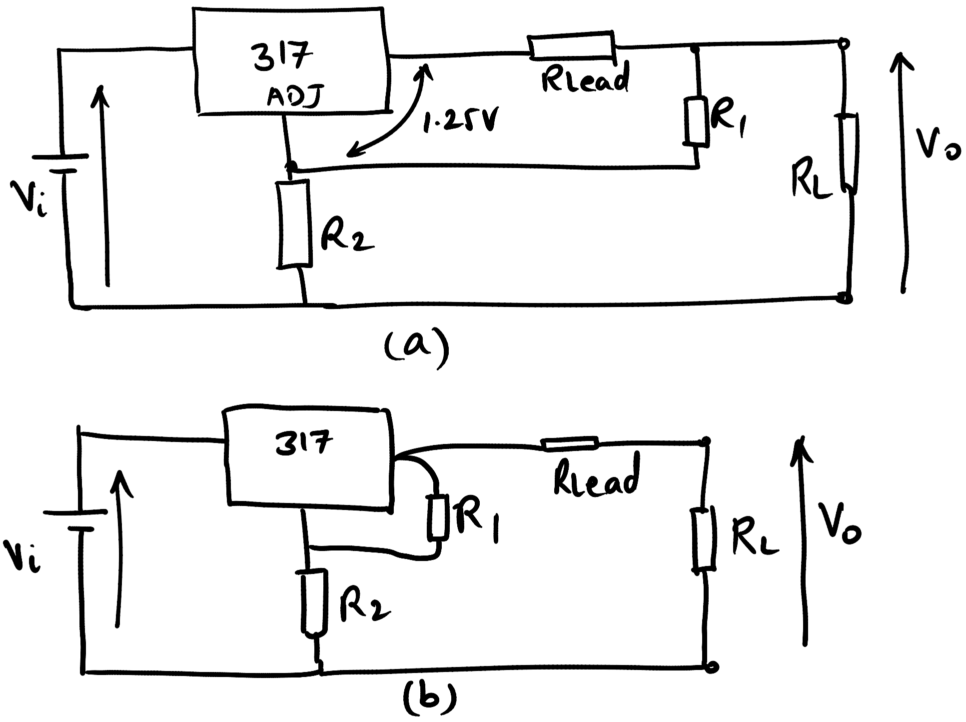
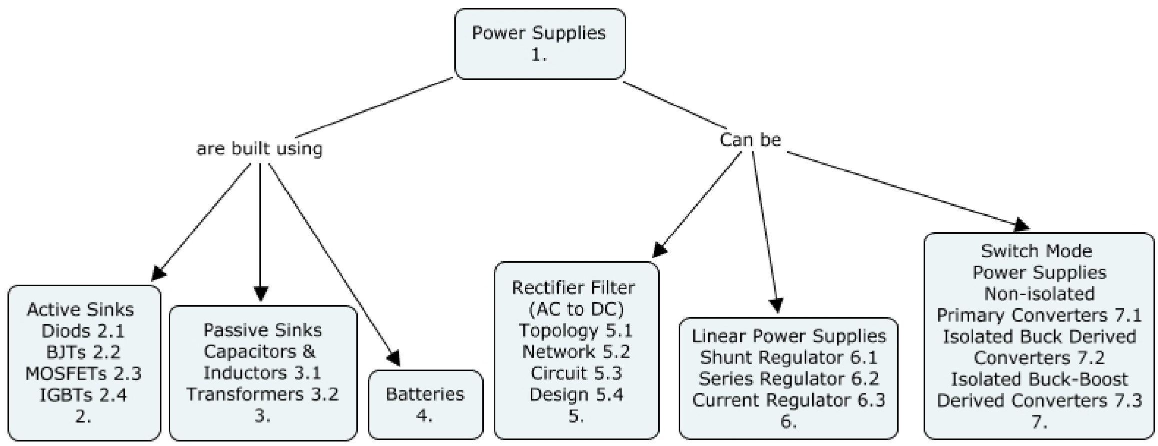


Fig. 3. Effect lead resistance in 317 IC or any variable IC regulator

Create

1. Design a generic 317 IC based regulator?
2. Design a zener shunt regulator wherein the input voltage Vi varies between 9 – 13V and the zener diode used is a 5V, 400mW device.

Concept Map of the Course



Syllabus:

Power Supplies: Active Sinks: Diodes, BJTs, MOSFETs and IGBTs. Passive Sinks: Capacitors, Inductors and Transformers Batteries: Rectifier Filter: Topology, Network, Circuit and Design Linear Power Supplies: Shunt regulators, Series regulators, Current Regulators Switch Mode Power Supplies: Non Isolated Primary converters, Isolated Buck Derived, Converters, Isolated Buck-Boost Derived Converters.

Reference Books:

1. L. Umanand, "Power Electronics: Essentials and Applications"- Wiley India, 2009.
2. Muhammad H.Rashid, "Power Electronics Circuits, Devices & Applications" - Pearson Education India Publication, New Delhi, II Edition, 2007.
3. M.D.Singh & K.B.Khanchandani, "Power Electronics", Tata Mc Graw Hill publishing company Ltd, New Delhi, 2004.
4. Ned Mohan, Tore Undeland & William Robbins, "Power Electronics: converters Applications and Design", John Willey and sons 2003.
5. P.S. Bimbra, "Power Electronics"- Khanna Publishers,1996.

Course Contents and lecture Schedule

SNo.	Topic	Lectures
1.	**Power Supplies**	2
2.	**Active Sinks**	1
2.1	Diodes	2
2.2	BJTs	2
2.3	MOSFETs	2
2.4	IGBTs	2
3.	**Passive Sinks**	**1**
3.1	Capacitors and Inductors	2
3.2	Transformers	2
4.	**Batteries**	**2**
5.	**Rectifier filter**	**1**
5.1	Topology	1
5.2	Network	2
5.3	Circuit	2
5.4	Design	3
6	**Linear Power Supplies**	**1**

6.1	Shunt Regulators	2
6.2	Series Regulators	2
6.3	Current Regulators	2
7	**Switch Mode Power Supplies**	1
7.1	Non isolated Primary converters	2
7.2	Isolated Buck Derived Converters	2
7.3	Isolated Buck- Boost converters	2

Course designers:

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Sub code	Lectures	Tutorial	Practical	Credit
DCH	3	0	-	3

DCH Embedded Systems 3:0

Preamble: This course attempts to make the students familiar with ARM processor involved in designing real-time based embedded systems. Unlike general purpose computing platforms, embedded systems must perform their tasks while minimizing tight resource constraints. ARM processors are embedded in products ranging from cell/mobile phones to automotive braking systems. The course begins by introducing ARM processor design philosophy and discussing how and why it differs from the traditional RISC philosophy and also introduces a simple embedded system based on the ARM processor. It teaches proven techniques and rules for writing C code that will compile efficiently on the ARM architecture, and it helps determine which code should be optimized. It covers the theory and practice of handling exceptions and interrupts on the ARM processor through a set of detailed examples. It discusses how to optimize primitive operations for ARM processors. This course examines how to maximize the performance of ARM for digital processing applications and how to implement its algorithms. It focus on memory issues like, examining the various cache technologies that surround the ARM cores, demonstrating routines for controlling the cache on specific cache-enabled ARM processors and also discusses the memory protection unit, and memory management unit.

Program outcomes addressed

c. An ability to apply the knowledge of mathematics, science and engineering
d. An ability to design a component to meet the desired social needs within realistic constraints.
e. An ability to develop and conduct experiment and interpret data.

Competencies

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

1. Understand the difference between general purpose computing system and embedded system.
2. Explain the concept of real-time system
3. Understand the cache architecture and memory management in ARM
4. Handle responses to interrupts and exceptions in real time.
5. Explain the implementation idea of primitives DSP application in ARM.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	20	10
2	Understand	60	60	30
3	Apply	20	20	20
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	40

Course Level Learning Objectives

Remember

1. What is an AMBA and HBA Bus?
2. What is a pipeline structure in ARM processor?
3. What is a register file?
4. Define the term Boot code.
5. What do you meant by optimized primitive?
6. What is a thumb instruction?

Understand

1. Differentiate between CISC and RISC?
2. How RISC pipeline works?
3. State the benefit of Pipieline structure.
4. Distinguish computing system and embedded system.
5. How does ARM handle the interrupts?
6. Write the importance of operating system for an embedded system.
7. Compare and explain various Loop execution (optimized) in ARM processors.
8. Explain various register allocation methods in ARM processor.
9. Explain the programming model of ARM architecture.
10. Explain the term i, boot loader ii, Firmware iii, Device drivers.
11. Explain the Flushing and Cleaning methods of Cache Memory.
12. Explain the function of memory management.

Apply

1. Develop an assembly level program for computing Fibonacci function with less memory usage.

2. Develop a C program for ARM processor for accessing an IO using polling method and interrupt driven method.

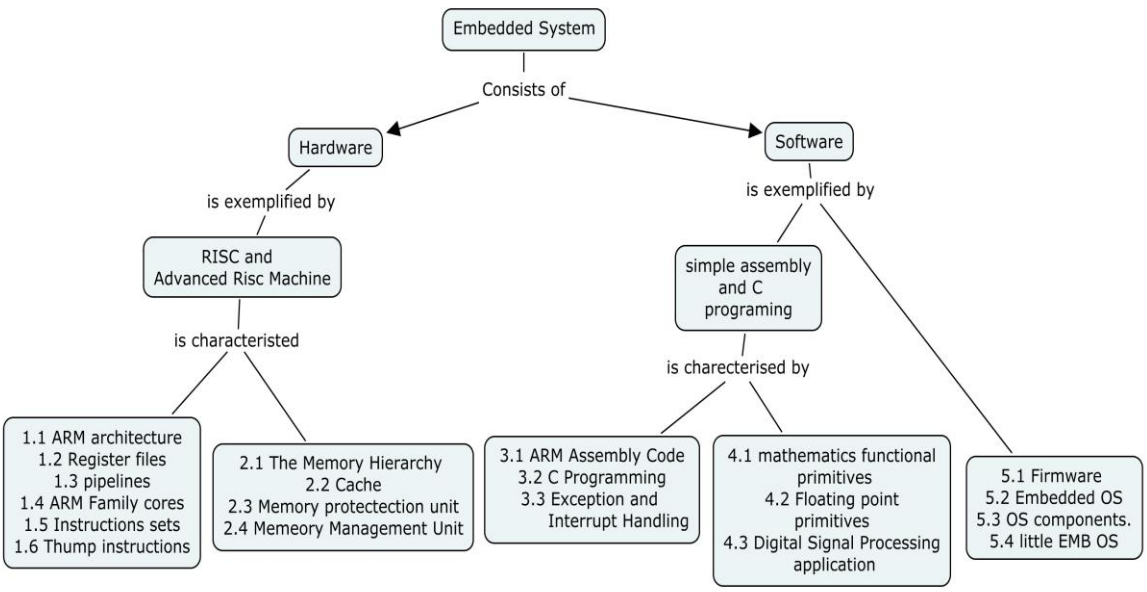
3. Write an assembly level program for transferring a file from one space to another space using memory management unit.

4. Compose a memory bank of 32K x 16 RAM with 1kx8 RAMs.
5. Develop an assembly code to run floating point primitive for IEEE754 format and in ARM7 Processor.
6. Develop an assembly code for a FIR filter Primitive in ARM7 Processor with less register usage.

Create

1. Design an embedded system which can react for opening and closing the door, upon correct key stroke entry in a security system.
2. Design a digital clock and wake timer using ARM processor with appropriate interrupt handling.
3. Design an embedded system to mange multiple task in real time.
4. Design an Embedded system for a data acquisition system with multiple tasks in real time.
5. Design an Embedded system for a vending machine.

Concept Map



Course Plan and Lecture Schedule

No.	**Topic**	**No. of Lectures**
1	**ARM processor Hardware and Software**	
1.1	ARM architecture	2
1.2	Register files, pipelines	2
1.3	ARM Family cores	2
1.4	ARM Instructions sets,	3
1.5	Thump instructions	3
2	**Memory unit**	
2.1	The Memory Hierarchy	2
2.2	Cache policies	2
2.3	Memory protection unit	2
2.4	Memory Management Unit	3
3	**ARM Coding**	
3.1	ARM Assembly level Code	2
3.2	Efficient C Programming	4
3.3	Exception and Interrupt Handling Methods	2
4	**Primitives and applications**	
4.1	Mathematics functional primitives	3
4.2	Floating point primitives	2
4.3	Digital Signal Processing application	2
5	**SOFTWARE**	
5.1	Firmware	2
5.2	Embedded OS	2
5.3	OS components	2
5.4	little EMB OS	3

Syllabus

ARM Hardware/Software: Introduction to RISC and ARM. Embedded system HW/SW. ARM Processor fundamentals. Introduction to the ARM and its thumb instruction Set. **Memory in ARM:** The Memory Hierarchy and Cache Memory. Cache architecture and its policies. Functions of Memory Protection Units and Memory Management Units. **ASM and C coding:** Exception and Interrupt Handling. Writing and Optimizing ARM Assembly Code and efficient C Programming. **Software:** Writing and optimizing of mathematics functional primitives and Floating point primitives. Digital Signal Processing application in ARM Programming. Basics of Firmware for Embedded system. Embedded operating systems and its components. Case study of a little EMB OS.

Text Books:

1. Andrew N. Sloss Dominic Symes Chris Wright. "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier, 2005.
2. Tammy Noergaard, "Embedded System Architecture" Elsevier, 2005

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
DCJ	3	-	-	3

DCJ MIMO Wireless Communication Systems 3:0

Preamble: The use of multiple antennas at the transmitter and /or the receiver in a wireless system is popularly known as Multiple Input Multiple Output (MIMO) wireless systems. It has become as a matured and promising technology for dealing with the fading and interference. MIMO technology constitutes a breakthrough in the design of wireless communication systems, and is already at the core of several wireless standards. Exploiting multi-path scattering, MIMO techniques deliver significant performance enhancements in terms of data transmission rate and interference reduction. The objective of this course is to present the techniques in physical layer aspects of MIMO wireless communication systems and determine their performance in terms of bit error rate and capacity.

Prerequisite: D62 Wireless Communication Systems, D44 Digital Communication Systems and D34 Analog Communication Systems.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies: At the end of the course, the student will be able to:

1. Describe the MIMO concept of Wireless Communication Systems
2. Characterize the MIMO wireless Channel in terms of large scale path loss and fading
3. Characterize the rapid fluctuations of wireless Channel in terms of small scale fading and multipath parameters
4. Determine the capacity, and bit error rate for a given digital modulation scheme of wireless communication system in AWGN
5. Determine the capacity, and bit error rate for a given digital modulation scheme of wireless communication system in Rayleigh fading and frequency selective fading environments

6. Architect a MIMO wireless communication system as per given specifications.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	20	20	10
2	Understand	20	20	10
3	Apply	60	60	80
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course level Learning Objectives

Remember:

1. Define Outage probability
2. What is Ergodic Capacity?
3. Give the angular domain representation of MIMO Channel.
4. Draw the V-BLAST architecture for communicating over the MIMO Channel
5. State the diversity-multiplexing tradeoff of the slow fading channel.
6. In a MISO slow fading channel, prove that the Alamouti scheme radiates energy in an isotropic manner.

Understand:

1. It is suggested that the full diversity gain can be achieved over a Rayleigh faded MISO channel by simply transmitting the same symbol at each of the transmit antenna simultaneously. Is this correct?. Justify.
2. Compare the performance of OFDM system with single carrier system, in the context of symbol duration and bandwidth.
3. What do you mean by Power limited Region and Bandwidth limited region?
4. State true or false : Justify your answer
    a. Channel knowledge at the transmitter is not required in MIMO channels to extract multiplexing gain.
    b. Channel knowledge at the transmitter is required in MIMO channels to extract diversity gain.
5. Explain the concept of waterfilling
6. Distinguish between array gain and diversity gain

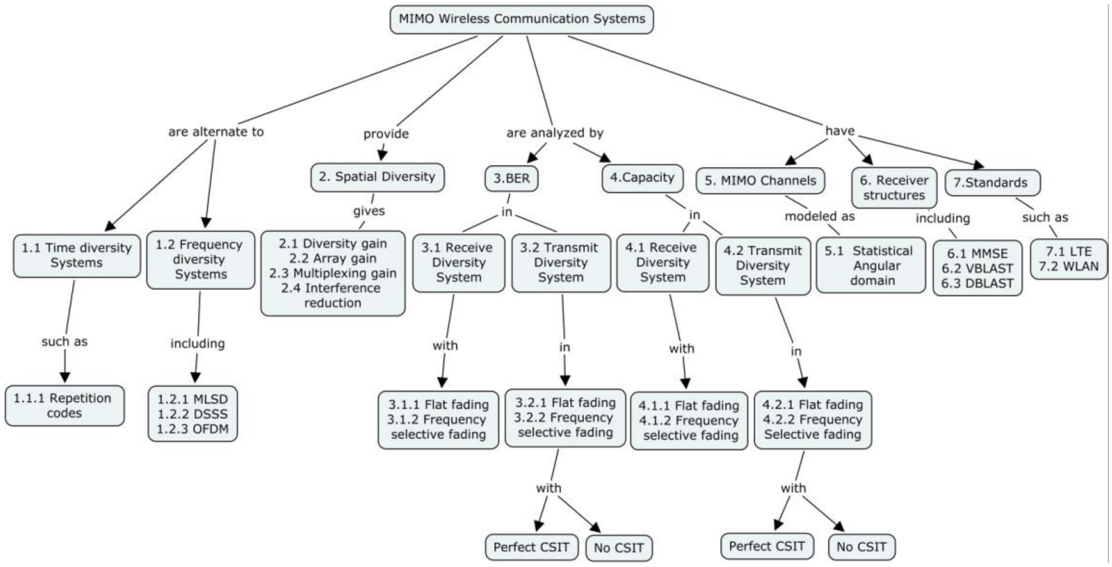
Apply:

1. Consider a SIMO system with L receive antennas. Independent CN(0, N_0) noise corrupts the signal at each of the receive antennas. The transmit

signal has a power constraint of P. Suppose the gain between the transmit antenna and each of the receive antenna is equal to unity, what is the capacity of the channel?.

2. Consider the L-parallel channel with i.i,d Rayleigh Coefficients. Determine the optimal diversity gain at a multiplexing rate of r per subchannel.
3. Compute the energy loss when using 4-PAM, compared to using QPSK, assuming that both modulation schemes convey 2 bits of information.
   a. Compute the corresponding loss when one wants to transmit k-bits of information using 2^k PAM rather than 2^k QAM. Assume that k is even.
   b. How does the loss depend on k?`
4. Consider a 2 x 2 MIMO system with Space Time coding is employed at the transmitter.
   a. Derive the expression for pairwise error probability
   b. Assuming that the channel matrix has independent and identically distributed Rayleigh components, derive an expression average probability of error.
5. Find the capacity of AWGN channel has a bandwidth of 1 MHz, signal power is 10 Watts and noise power spectral density is 10^{-9} Watts/Hz.
6. Consider a channel with delay spread. The transmitted signal after scattering arrives at the receiver at two different delays τ_1 and τ_2. We assume that the channel is time-invariant. The baseband channel impulse response is given by $h(\tau) = \gamma_1\delta(t-\tau_1) + \gamma_2\delta(t-\tau_2)$, where γ_i (*i* = 1, 2) are the complex scatterer amplitudes of the scatterers located at delays τ_i (*i* = 1, 2) respectively. Further $E(\gamma_i) = 0$ with $E\left(|\gamma_i|^2\right) = 1$.
   i. Calculate the frequency response of the channel, *H*(*f*).
   ii. Show that under uncorrelated scattering (US), $E(\gamma_1\gamma_2^*) = 0$, the channel is WSS in transmission frequency, *f*.
   iii. Estimate the coherence bandwidth of the channel for $\tau_1 = 0$ and $\tau_2 = 2\mu s$

Concept Map



Syllabus

Introduction, Time and Frequency Diversity Schemes: Time diversity Systems – Repetition coding, Frequency Diversity- Maximum Likelihood Sequence Detection (MLSD),Direct Sequence Spread Spectrum (DSSS), Orthogonal Frequency Division Multiplexing(OFDM) **Spatial Diversity:** Diversity gain, Array gain, Multiplexing gain, Interference reduction, **Bit Error Rate** (**BER) of Wireless Channels:** Transmit, Receive Diversity systems, Flat fading, Frequency selective fading channels, Transmitter channel side information, Perfect CSIT (Channel Side Information known at the Transmitter) and No CSIT Capacity of wireless channels **Capacity of Wireless Channels:** Transmit, Receive Diversity systems, Flat fading, Frequency selective fading channels, Transmitter channel side information, Perfect CSIT (Channel Side Information known at the Transmitter) and No CSIT **MIMO channels:** Angular domain representation of signals, Angular domain representation of MIMO Channels, Statistical Modeling in the angular domain **Receiver architectures:** MMSE (Minimum Mean Square Error), The V-BLAST-MIMO Architecture, D-BLAST MIMO architecture **Standards:** LTE (Long Term Evolution), WLAN (Wireless Local Area Network)

Text Book:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communications", Cambridge University Press, 2005 (First Asian Edition, 2006)

Reference Books

1. A. Paulraj, R. Nabar and D Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2003.
2. Andrea Goldsmith, " Wireless Communications", Cambridge University Press, 2005
3. E. Biglieri, R. Calderbank, A. Constantinides, A.Goldsmith, A. Paulraj and H. V. Poor, " MIMO Wireless Communications", Cambridge University Press, 2007.

Course Contents and Lecture Schedule

S.No	Topic	No of lectures
1	Introduction	1
1.1	Time and Frequency Diversity Schemes: Time diversity Systems	1
1.1.1	Repetition coding	1
1.2	Frequency Diversity Systems	1
1.2.1	Maximum Likelihood Sequence Detection (MLSD)	1
1.2.2	Direct Sequence Spread Spectrum (DSSS)	1
1.2.3	Orthogonal Frequency Division Multiplexing(OFDM)	1
2	Spatial Diversity	1
2.1	Diversity gain	1
2.2	Array gain	1
2.3	Multiplexing gain	1
2.4	Interference reduction	1
3	BER of Wireless Channels	1
3.1	Receive Diversity systems	1
3.1.1	Flat fading	1
3.1.2	Frequency selective fading	2
3.2	Transmit Diversity systems	1
3.2.1	Flat fading with and without CSIT	2
3.2.2	Frequency selective fading with and without CSIT	3
4	Capacity of Wireless Channels	1
4.1	Receive Diversity systems	1
4.1.1	Flat fading	2
4.1.2	Frequency selective fading	2
4.2	Transmit Diversity systems	1
4.2.1	Flat fading with and without CSIT	2

S.No	Topic	No of lectures
4.2.2	Frequency selective fading with and without CSIT	2
5	MIMO Channels	1
5.1	Statistical angular domain	1
6	Receiver structures	1
6.1	Minimum Mean Square Error (MMSE)	1
6.2	V-BLAST MIMO Architecture	2
6.3	D-BLAST MIMO Architecture	2
7	Standards	1
7.1	Long Term Evolution (LTE)	1
7.2	WLAN (Wireless Local Area Network)	1
	Total Number of Hours	**45**

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
DCK	3	0	--	3

DCK Communication Network Security 3:0

Preamble: This course presents different classical and modern cryptographic techniques along with their network security applications like IP security, WEB security and System security.

Prerequisite: "D56: Data Communication Networks".

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

c. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

e. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems

Competencies: At the end of the course, the student will be able to

1. Identify the threats and security attacks in the networks and corresponding services and mechanisms
2. Describe the mathematical concept and algorithms behind conventional encryption technique, classical encryption technique and modern encryption technique
3. Describe Asymmetric encryption algorithm and Diffie-Hellman algorithm
4. Identify Different key management and distribution technique in symmetric and Asymmetric algorithm.
5. Identify network security applications like IP security, WEB security and System security.
6. Provide a practical survey of both principles and practice of cryptography and network security technology.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	40	30	20
2	Understand	40	30	40
3	Apply	20	20	20
4	Analyze	0	20	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. Encrypt the term "EXAM" using playfair cipher
2. Define discrete logarithm problem.
3. What is meant by the term Hash function?
4. List four general categories of schemes for the distribution of public keys
5. What is the purpose of Dual signature?
6. What is digital immune system?

Understand

1. Elaborate Key management operation in IPsec
2. Explain about payment processing in SET
3. Discuss about the web security threats and the methods used to overcome the threats
4. Explain Statistical anomaly detection and rule based detection techniques
5. Discuss in detail about different types of malicious programs.
6. Distinguish MAC and Hash function in detail
7. Differentiate conventional encryption with public key encryption

Apply

1. Encrypt and decrypt the term "Final Exam" using the Hill cipher with the key $k = \begin{bmatrix} 0 & 3 & 0 \\ 0 & 0 & 21 \\ 15 & 0 & 0 \end{bmatrix}$ such that $kk^{-1}=I$.
2. Determine 11^{23} mod 187.
3. In an RSA system, the public key of a given user is e=31, n=3599. What is the Private key of this user. When M=48, find C and verify it.
4. Users A and B use the Diffie Hellman Key exhange technique a common prime q=71 and a primitive root α =7
   a. If user A has private key X_A=5, what is A's public key Y_A?
   b. If user B has private key X_B=12, what is B's public key Y_B?
   c. what is the shared secret key
   d. If user E acts as a intruder (Man-in the-middle attack) between A and B, Compute the keys from E to A and B.
5. Using play-fair cipher encrypt the term "buffallo" using the keyword "BALLOON"

6.Encrypt the given plaint text 1011 0111 using S –DES for IP=[2 6 3 1 4 8 5 7], k1=[10001111], k2=[11110000] , $s_0 = \begin{pmatrix} 1 & 0 & 3 & 2 \\ 3 & 2 & 1 & 0 \\ 0 & 2 & 1 & 3 \\ 3 & 1 & 3 & 2 \end{pmatrix}$

$s_1 = \begin{pmatrix} 0 & 1 & 2 & 3 \\ 2 & 0 & 1 & 3 \\ 3 & 0 & 1 & 0 \\ 2 & 1 & 0 & 3 \end{pmatrix}$ and p4=[2 4 3 1] and verify using decryption

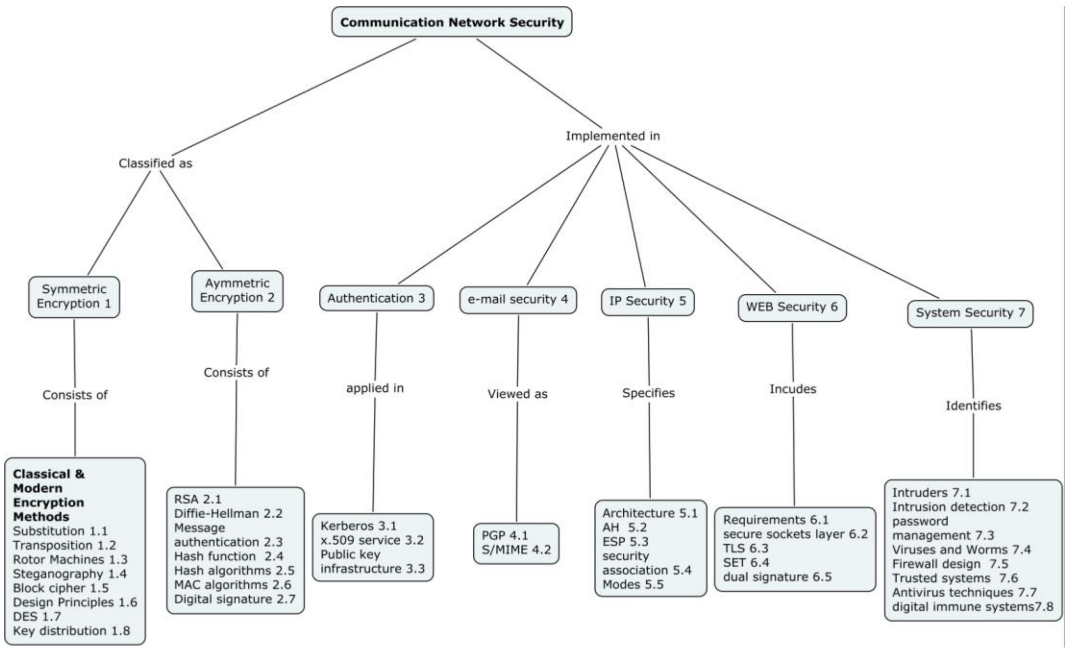
Analyze

1. The plaintext 'letusmeetnow' and the corresponding 'HBCDFNOPIKLB'are given. The algorithm used is Hill cipher, but the key size is unknown. Identify the key matrix.
2. Eve secretly gets access to Alice 's computer and using her ciphertext 'ABCDEFGHIJ'. The screen shows ' CABDEHFGIJ'. If Eve knows that Alice is using a keyed transposition cipher,
   i) Identify the type of attack is Eve launching.
   ii) Identify the size of the permutation key.
3. Identify the demerits of S-DES and motivation of feistel block cipher with its neat diagram.
4. Distinguish Statistical anomaly detection and rule based detection techniques
5. Identify the web security threats and the methods used to overcome the threats
6. When the PT-109 American patrol boat, under the command of Lieutenant John F Kennedy was sunk by a Japanese destroyer, a message was received at an Australian wireless station in play fair code.

   KXJEY UREBE ZWEHE WRYTU HEYFS
   KREHE GOYFI WTTTU OLKSY CAJPO
   BOTEI ZONTX BYBNT GONEY CUZWR
   GDSON SXBOU YWRHE BAAHY USEDQ

The key used was "ROYAL NEWZEALAND NAVY". Decrypt the message.

Concept Map



Syllabus:

Conventional Encryption: Introduction – Conventional Encryption model – Data Encryption Standard – block cipher – Encryption algorithms – confidentiality – Key distribution. **Public Key Encryption and Hashing**: Principles of Public key cryptosystems – RSA algorithm – Diffie-Hellman Key Exchange – Message authentication and Hash function – Hash MAC algorithms – Digital signatures. **Authentication applications**- Kerberos, x.509 Authentication service, Public key infrastructure. **Electronic Mail Security:**- Pretty Good Privacy, S/MIME. **IP and WEB Security**: IP security overview – IP security Architecture, authentication Header – Security payload – security association – key management. Web security requirement – secure sockets layer – transport layer security –secure electronic transaction – dual signature. **System Security:** Intruders – Intrusion detection-password management -Viruses – Viruses and related threats-Worms – Firewall design – Trusted systems – Antivirus techniques – digital immune systems.

Text Book

1. William Stallings. "Cryptography and Network Security", 4th Edition, Prentice Hall of India, New Delhi, 2004.

References:

1. C. Kaufmann, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", Prentice Hall PTR, 2002.
2. W.R. Cheswick, S.M. Bellovin and A.D. Rubin, "Firewalls and Internet Security", Addison- Wesley, 2003.

Course Contents and Lectures schedule

S. No.	Topics	No of Lectures
1	**Conventional Encryption**	
1.1	Introduction – Conventional Encryption model	2
1.2	Data Encryption Standard – block cipher	2
1.3	Different Encryption algorithms	2
1.4	Confidentiality	2
1.5	Key distribution	1
2	**Public Key Encryption and Hashing**:	
2.1	Principles of Public key cryptosystems – RSA algorithm	2
2.2	Diffie-Hellman Key Exchange	2
2.3	Message authentication and Hash function	2
2.4	Hash MAC algorithms	2
2.5	Digital signatures.	2
3	**Network security applications**	
3.1	Pretty Good Privacy,	2
3.2	S/MIME	2
4.1	IP and WEB Security-introduction	2
4.2	IP security overview – IP security Architecture	2
4.3	Authentication Header – Security Payload	2
4.4	Security association –key management.	2
4.5	Web security requirement	
4.6	Secure sockets layer – transport layer security	2
4.7	Secure electronic transaction – dual signature	2
5	**System Security**	
5.1	Intruders – Intrusion detection-	2
5.2	Password management	2

S. No.	Topics	No of Lectures
5.3	Viruses – Viruses and Related threats-Worms	2
5.4	Firewall design – Trusted systems	2
5.5	Antivirus techniques – digital immune Systems.	2
	Total Number of Hours	**45**

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
DCL	3	-	-	3

DCL Real Time Operating Systems 3:0

Preamble: A real-time operating system (RTOS) is an operating system that guarantees a certain capability within a specified time constraint. Real-time operating systems are created for a special application. Some of existing general purpose operating systems claims to be real-time operating systems. In general, real-time operating systems are required to have multitasking, prioritized process threads and sufficient number of interrupt levers. Real-time operating systems are often required in small embedded operating systems that are packaged as part of micro-devices. The kernel programs can be considered to meet the requirements of a real-time operating system. However, since other components, such as device drivers, are also usually needed for a particular solution, a real-time operating system is usually larger than just the kernel. The modules are organized as follows: The first two modules will cover about the fundamentals of operating system. Design consideration of programs is analyzed in the third module. Fourth module consists of case study and application. Validation and testing is the end of the modules.

Program outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies: At the end of the course, the student will be able to

1. Understand the difference between general purpose computing operating system and a real-time operating system.
2. Understand the concept and structure of real-time operating system.
3. Understand the operating system components and its functions.
4. Apply the concepts of small operating system with real time aspect for a system.
5. Investigate the structure of real-time operating system and confirm its function through testing.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3 / End semester examination
1	Remember	20	20	10
2	Understand	60	60	50
3	Apply	20	20	30
4	Analyze	0	0	10
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

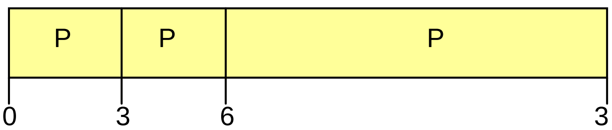
1. Define a real-time system.
2. What is meant by interrupt latency?
3. What is meant by time relative buffering?
4. What is meant by scheduling?
5. What is need of quality assurance?
6. Name the properties of real time clock.

Understand

1. How interpreters are functioning?
2. How co-routine function performs?
3. What is a system call? Where it is implemented?.
4. How thrashing affects the performance of the OS?
5. Draw the state transition diagram of task-control block model system and explain the task management.
6. List the essential functions of RTOS.

Apply

1. Find out the average waiting time for the following processes

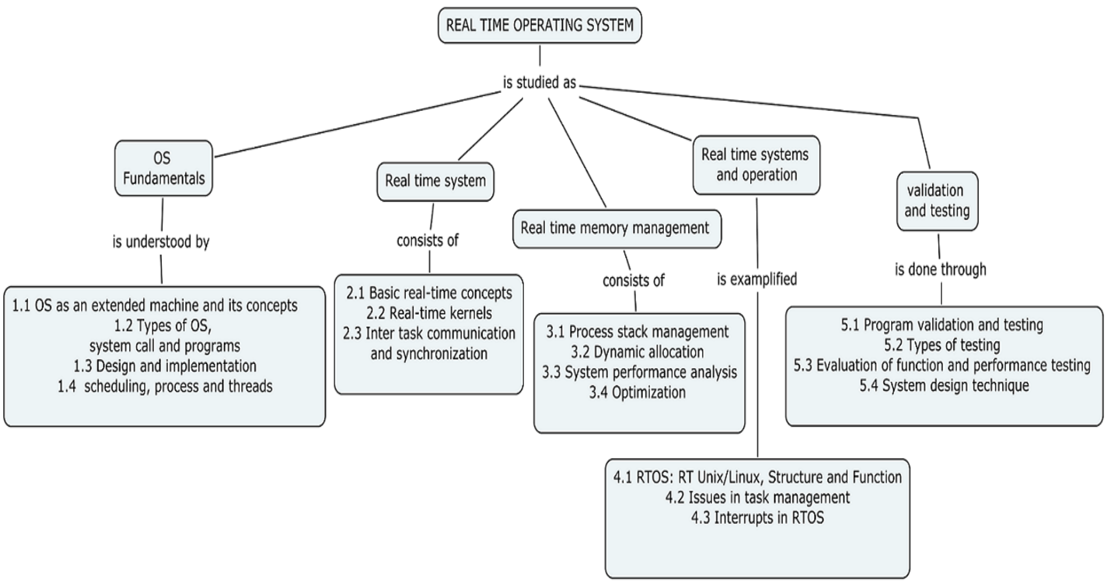


2. Develop c code to implement a semaphore
3. Develop a c code to implement a ring buffer
4. Write program codes to demonstrate the function of inter process communication.
5. Develop program code using c to implement a process control block
6. How semaphores are applied in OS function?

Analyze

1. Consider a real-time weapon control system aboard an aircraft. Analyze which of the following events would be considered synchronous and which would be considered as a synchronous.
   (a) A 10-millisecond clock interrupt.
   (b) A divide-by-zero error.
   (c) A built-in-test software failure.
   (d) A signal indicating the pilot has pressed the "fire rocket" button.
   (e) A signal indicating "low on fuel".
2. Compare the functions of base class to a derived class.
3. Why is not wise to disable interrupts before the while statement in the binary semaphore, P?
4. Why context switching is needed in OS function?
5. Investigate the critical section function along with different threads of a Real Time Operating System.
6. Examine the RTOS function in dead lock situation between multiple tasks

Concept Map



Syllabus

OS fundamentals and functions: OS as an extended machine and its concepts, Types of OS, system call and programs, System structure: Design and implementation. **Real-time systems:** Concepts and scheduling, Co-operative process and IPC, Threads overview, Multithreading models. **Real time memory management:** Process stack management, Dynamic allocation, and System performance analysis **Real-Time operating systems** Real time OS: RT Unix/Linux, Structure and Function, Issues in task management and Interrupts in

RTOS. **Validation and testing:** Program validation and testing, Types of testing, Evaluation of function and performance testing, System design technique.

Textbooks

1. Silberschatz, Galvin, Gagne, "Operating Systems Concepts", Sixth edition – John Wiley & Sons – Indian edition –2002 (1)
2. Philip A. Laplante, "Real time systems Analysis and Design – An Engineer's Handbook", IEEE computer society press PHI, 2nd Ed. 1997. (2,3,4)
3. Allan. V. Shaw, "Real Time systems and software", John Wiley & Sons(4,5)

Reference Book

1. Karl Hamcher, Zvonko Vranesic, Safwat Zaky, "Computer Organization", fifth ed. McGraw Hill -2002 , chapter 3,4,9 and 10. (Course material for ARM processor only.)
2. Frank Vahid and Tony Givargis, "Embedded system Design–A unified Hardware/software introduction", John Wiley & sons India 2002 – Chapter 6,7& 8.
3. Rajkamal, Embedded systems, "Architecture, programming and Design", TMH, 2003.
4. Stephen B.Furber, "ARM system architecture", Addison Wesley 1996.
5. Andrew S. Tanenbaum, "Modern Operating Systems", Second Edition, Prentice Hall of India - Indian Edition – 1995.
6. D.M.Dhamdhere, "Systems Programming and Operating Systems", Tata McGraw Hill – Second Revised Edition 1997 (1.1)
7. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", Elsevier Inc ,2001,(4,5)
8. C.M. Krishna, Kang G. Shin, "Real–Time Systems", McGraw – Hill International Editions, 1997.
9. Raymond J.A.Bhur, Donald L.Bailey, "An Introduction to Real Time Systems", PHI 1999
10. R.J.A Buhur, D.L Bailey, "An Introduction to Real – Time Systems", Prentice – Hall International, 1999.

Course Contents and Lecture Schedule:

S. No.	Topic	No. of Lectures
1	**OS fundamentals and functions**	
1.1	OS as an extended machine and its concepts	2
1.2	Types of OS, system call and programs	2
1.3	System structure: Design and implementation	2
1.4	Concepts of scheduling, process and threads	2
2	**Real-time systems**	
2.1	Basic real-time concepts	2
2.2	Real-time kernels	3
2.3	Inter task communication and synchronization	3
3	**Real time memory management**	
3.1	Process stack management	2
3.2	Dynamic allocation	2
3.3	System performance analysis	2
3.4	Optimization	2
4	**Real-Time operating systems**	
4.1	Real time OS: RT Unix/Linux, Structure and Function	4
4.2	Issues in task management	2
4.3	Interrupts in RTOS	2
5	**Validation and testing**	
5.1	Program validation and testing	2
5.2	Types of testing	2
5.3	Evaluation of function and performance testing	2
5.4	System design technique	2
	Total	**40**

Course Designers:

1. L.R. Karl Marx lrkarlmarx@tce.edu
2. K. Hariharan khh@tce.edu

Sub code	Lectures	Tutorial	Practical	Credit
DCM	3	-	-	3

DCM Low Power VLSI Systems 3:0

Preamble: The course presents the basic principles and concepts of low-power CMOS VLSI, design and optimization of low-power electronic systems using various tools and techniques**.**

Prerequisite: 'D23 Basics of Digital Systems', 'D32: Analog Circuits and Systems', 'D42: Designing with PLDs and FPGAs' and 'D52: CMOS VLSI Systems.

Program Outcomes addressed:

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.
k. Graduate who can participate and succeed in competitive examinations.

Competencies: At the end of the course, the student will be able to

7. Understand the power dissipation in CMOS VLSI circuits.
8. Optimize power by designing low-power CMOS VLSI arithmetic circuits including adders and multipliers.
9. Design low-power CMOS VLSI circuits including memories, clock-interconnect and layout design using various techniques.
10. Determine logic level power requirement and analyze power using simulation and probability.
11. Synthesize and design software for low-power CMOS VLSI Circuits.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/ End-semester examination
1	Remember	30	20	0
2	Understand	30	20	10
3	Apply	40	20	30
4	Analyze	0	10	20
5	Evaluate	0	10	10
6	Create	0	20	30

Course Level Learning Objectives

Remember

1. What are the differences between partially-depleted and fully-depleted SOI CMOS devices?
2. What are the tradeoffs of using shallow trench isolation (STI) and LOCOS for CMOS devices?
3. What are the challenges in realizing a CMOS VLSI technology with a channel length smaller than 0.1μm?
4. What is the influence of the velocity saturation on the performance of an MOS device? What is the effect of velocity overshoot?
5. What are the advantages of the SOI DRAM as compared to the bulk CMOS DRAM? What are the disadvantages?
6. What are the programming/erase mechanisms in the flash memory cell? What are the disadvantages of flash memory?
7. What is the difference between the FRAM and other non-volatile memory? What are the advantages?
8. What are the methods to reduce noise problems when designing dynamic logic circuits? What are the tradeoffs?

Understand

1. Compare the advantages between CMOS and BiCMOS technologies. Why is CMOS technology the number one technology for VLSI?
2. Compare the tradeoffs between bulk and SOI CMOS technologies.
3. Why should the sub-threshold slope in terms of mV/dec of an MOS device be as small as possible? How is the sub-threshold slope for an MOS device reduced?
4. Why is the noise immunity of CMOS dynamic logic circuits worse as compared to the static logic circuit? Is there any method to raise the noise immunity? At what cost?
5. What are the advantages of multiple output domino logic (MODL)? What are the possible problems? How can they be avoided?
6. What factors affect the initial voltage difference in the DRAM bit lines during the read cycle?
7. When the supply voltage is lowered, what is the influence in the initial voltage difference in the bit lines during the read cycle?

Apply

1. Calculate the threshold voltage of an NMOS device with an *N*+ polysilicon gate, a channel length of 0.25μm, a gate oxide of 55Å, a junction depth of 0.15μm, and a doping density of 10^{18}cm^{-3}

2. Determine V_{OH}, V_{OL}, V_{IH}, V_{IL} for the NMOS inverter with a depletion load with its gate connected to source. Suppose $k_i = 25\mu A/V^2$ for the driver NMOS device. $k_1 = 6.25\mu A/V^2$ for the depletion load NMOS device. The threshold voltage of the depletion load NMOS device is –3V and 0.8V for the enhancement-mode device. $V_{DD} = 5V$.
3. Compute the output switching activity α_{O1}, α_{O2} and α_F of the chain-type 4-input AND gate. Consider the cases with $P(A = 1) = P(B = 1) = P(C = 1) = P(D = 1) = 0.75$ and 0.25 respectively. Analyze its switching activity.

Analyze

1. Using and domino dynamic logic circuits, design a logic function $F = A \oplus B \oplus C$ in one stage and two cascading stages. Analyse and discuss the transient performance of the circuit for load capacitances of 0.01pF, 0. 1pF, and 0.5pF, and at supply voltages of 5V, 3.3V, 2.5V, and 1.5V.
2. Consider domino dynamic logic circuits for the logic function $F = A.\ B.\ C.$ Analyse and discuss the transient performance of the circuit for load capacitances of 0. 1pF, and 0.5pF, and at supply voltages of 5V, 3.3V and 2V.
3. Consider the 6-input AND gate. $W(MN3) = 5\mu m$. $W(MNi) = W(MN3)\,(1 - \alpha(i - 3))$, i = 0 – 6. Compare the differences in the propagation delay for α = –0.05, 0, 0.05, 0.1, 0.2.
4. Consider the 6-input AND gate. $W(MN3) = 4\mu m$. $W(MNi) = W(MN3)\,(1 - \alpha(i - 3))$, i = 0 – 6. Compare the differences in influence of the worst-case charge-sharing problem for α = –0.05, 0, 0.05, 0.1, 0.2.
5. Design $F = AB + BC + CA$ using DCVS and DCVSPG. What are the differences between the DCVS circuit and the DCVSPG circuit? Compare the pull-up and pull-down transients of the DCVS circuit with those of the DCVSPG circuit. Compare the power dissipation of the DCVS with that of the DCVSPG circuit.

Evaluate

1. Use static CMOS logic circuits and complementary pass-transistor logic (CPL) to design the parallel adder. Which approach has the best speed performance (smallest propagation delay)? For the design with the best speed performance, is its throughput also the highest?
2. Compare the performance of the multipliers using Wallace tree reduction with 3-to-2 and 4-to-2 compressor, modified Booth encoder/decoder, and combining modified Booth encoder/decoder with Wallace tree reduction.

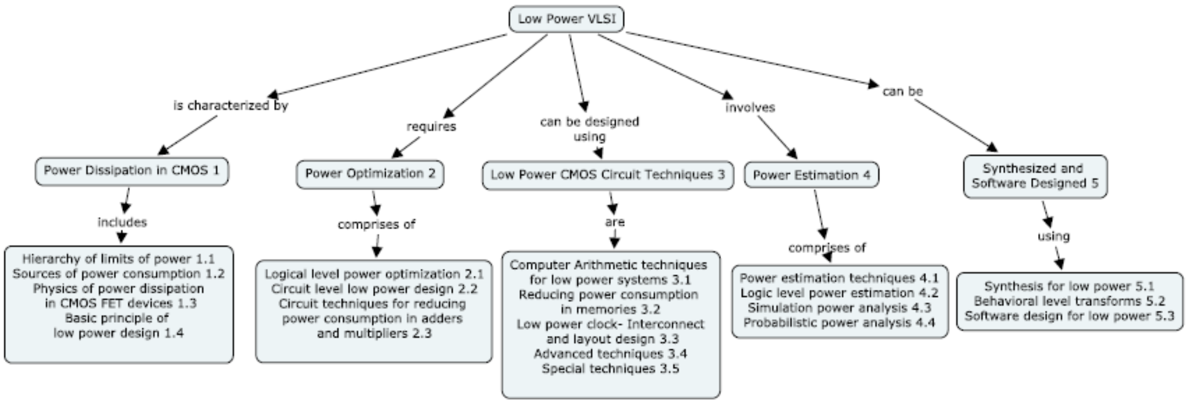
Create

1. Design a logic function $F = AB + BC + CA$ using 2-input NAND and NOR gates. If an n-well CMOS technology is used, which approach should be used to

reduce the body effect on degrading the circuit performance? If p-well CMOS technology is used, which approach should be used?

2. Use the pass-transistor logic circuits to design $F = AB + \overline{B}C + \overline{A} \cdot \overline{B}$
3. Design a logic function $F = AB + AC + \overline{A}D\overline{E} + BE$ using CPL and DPTL and LEAP. Use binary decision diagram (BDD) to design the above logic function.

Concept Map



Syllabus:

Power Dissipation in CMOS: Hierarchy of limits of power, Sources of power consumption, Physics of power dissipation in CMOS FET devices, Basic principle of low power design. **Power Optimization:** Logical level power optimization, Circuit level low power design, Circuit techniques for reducing power consumption in adders and multipliers. **Low Power CMOS Circuits:** Computer Arithmetic techniques for low power systems, Reducing power consumption in memories, Low power clock- Interconnect and layout design, Advanced techniques, Special techniques. **Power Estimation:** Power estimation techniques, Logic level power estimation, Simulation power analysis, Probabilistic power analysis. **Synthesis and Software Design for Low Power:** Synthesis for low power, Behavioural level transforms, Software design for low power.

Text Book:

1. K. Roy and S.C. Prasad, "Low Power CMOS VLSI Circuit Design", Wiley, 2000.
2. Gary Yeap, "Practical Low Power Digital VLSI Design", Kluwer, 1998.

Reference Books:

2. A.P. Chandrakasan and R.W. Broadersen, "Low Power Digital CMOS Design", Kluwer, 1995.
3. Abdellatif Bellaouar, Mohamed. I. Elmasry, "Low Power Digital VLSI designs" Kluwer, 1995.

4. Dimitrios Soudris, Chirstian Pignet, Costas Goutis, "Designing CMOS Circuits for Low Power", Kluwer, 2002.
5. J.B. Kuo and J.H Lou, "Low voltage CMOS VLSI Circuits", Wiley, 1999.
6. A. Wang, B. H. Calhoun and A. P. Chandrakasan, "Sub-threshold Design for Ultra Low-Power Systems", Springer, 2006.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Power Dissipation in CMOS**	
1.1	Hierarchy of limits of power	1
1.2	Sources of power consumption	2
1.3	Physics of power dissipation in CMOS FET devices	2
1.4	Basic principle of low power design	2
2	**Power Optimization**	
2.1	Logical level power optimization	3
2.2	Circuit level low power design	3
2.3	Circuit techniques for reducing power consumption in adders and multipliers	3
3.	**Design of Low Power CMOS Circuits**	
3.1	Computer Arithmetic techniques for low power systems	2
3.2	Reducing power consumption in memories	2
3.3	Low power clock- Interconnect and layout design	2
3.4	Advanced techniques	2
3.5	Special techniques	2
4	**Power Estimation**	
4.1	Power estimation techniques	2
4.2	Logic level power estimation	2
4.3	Simulation power analysis	2
4.4	Probabilistic power analysis	2
5	**Synthesis and Software Design for Low Power**	
5.1	Synthesis for low power	2
5.2	Behavioural level transforms	2
5.3	Software design for low power	2
	Total Number of Hours	**40**

Course Designers:

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Sub code	Lectures	Tutorial	Practical	Credit
DCN	3	-	-	3

DCN DSP with FPGA 3:0

Preamble: This course provides the students, the knowledge about implementation of Digital Signal Processing (DSP) blocks on Filed programmable Gate Arrays (FPGA). It considers computer arithmetic aspects and algorithms to implement DSP blocks efficiently on FPGA.

Prerequisite: 'D23 Basics of Digital Systems', 'D42 - Designing with PLDs and FPGAs' and 'D54 Digital Signal Processing'.

Program Outcomes addressed:

e. Graduates will demonstrate knowledge of mathematics, science and engineering.
f. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
h. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
i. Graduate who can participate and succeed in competitive examinations.

Competencies: At the end of the course, the student will be able to

7. Explain the operation of the devices and tools used to design state-of-the-art DSP systems.
8. Represent a given decimal number in fixed or floating point number systems, including canonic signed digit, logarithmic, residue number system (RNS).
9. Compute nontrivial (transcendental) algebraic functions using CORDIC algorithm
10. Explain the number theoretic transforms which are used in fast convolution algorithms
11. Write a VHDL/VerilogHDL program for FIR Filter using distributed arithmetic
12. Design and implement IIR filter with pipelining and/or parallel processing
13. Explain the different types of FFT algorithms including Cooley-Tukey, Winograd and Good-Thomas.
14. Implement FFT algorithms using VHDL/VerilogHDL
15. Design and implement a Communication system block such as Viterbi decoder, Linear Block Code, universal modulator.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/ End-semester examination
1	Remember	20	20	20
2	Understand	40	40	30
3	Apply	40	40	30
4	Analyze	0	0	0
5	Evaluate	0	0	0
4	Create	0	0	20

Course Level Learning Objectives

Remember:

8 List out the sequence of steps involved to design an FPGA

9 Define LNS

10 Mention the advantages of an FPGA to meet the requirements of DSP technology.

11 State Bluestein chirp-z algorithm

12 Define Clock skew

13 List the properties of FIR filter

Understand:

8 Draw the design flow of FPGA

9 Convert the given decimal number 15 into equivalent optimal CSD

10 Explain the function of pipelined adder with neat diagram

11 Illustrate DA algorithm in VHDL coding

12 Explain in detail about the designing of FIR filter

13 Give equivalent CSD coding for the decimal number 15.

Apply:

7 Implement universal modulator using CORDIC algorithm

8 Compute the number of multiplications and additions required to implement 12 point FFT using Cooley-Tucky.

9 Calculate the Eigen value and Eigen vectors for the given network

10 Implement the FIR filter using DA algorithm

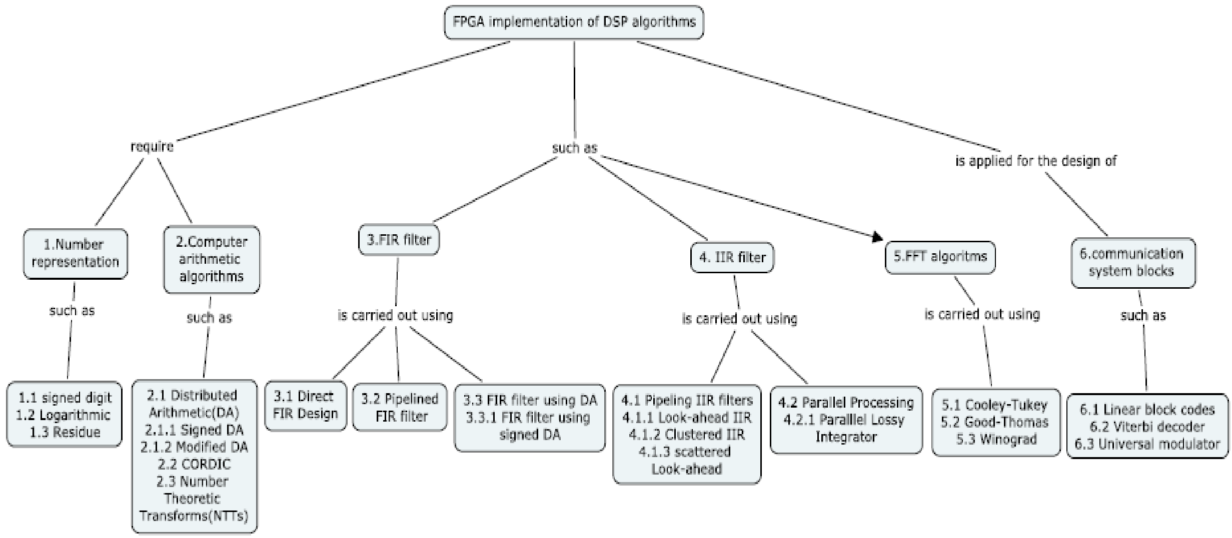
11 Find the transfer function of second order IIR filter having poles at 0.5 and 0.25 using 2 pipelined stages by applying scattered Look-ahead method.

12 Find the expression of DA algorithm to implement convolution sum on FPGA.

Create

1. Write an VHDL coding to implement filter directly with coefficients {-1,3.75, 3.75, -1} and make modifications in that coding to perform optimization with respect to speed or size or both of these parameters.
2. Design and implement architecture to convert any polar coordinate into rectangular coordinate.
3. Design an filter with coefficients {1, 3, 7} which avoids the use of general purpose multipliers and reduce the number of MAC cycles.
4. Write an VHDL coding for an circuit that generates Amplitude Modulated or Frequency modulated or Phase modulated signal.
5. Write VHDL coding for an reconfigurable architecture to find Fast Fourier Transform for N=2 point, 4 point or 8 point.

Concept map



Syllabus

Introduction and Computer Arithmetic: FPGA Technology – DSP Technology Requirements – Design Implementation – Number Representation- Binary Adders- Binary Multipliers- Multiply Accumulator and Sum of Products – Computation of Special Functions using CORDIC. **Finite Impulse Response (FIR) Digital Filters:** Digital Filters – FIR Theory – Designing FIR Filters – Constant Coefficient FIR Design **Infinite Impulse Response (IIR) Digital Filters:** – IIR Theory – IIR Coefficient computation – IIR Filter Implementation – Fast IIR Filter. **Fourier Transforms:** The Discrete Fourier Transform Algorithms – Fast Fourier Transform Algorithms – Fourier Related Transforms: Computing the DCT using the DFT – Fast Direct DCT Implementations. **Applications:** Rectangular and Number theoretic Transforms – Error Control and Cryptography: Block Codes, Convolutional Codes, Cryptography Algorithms for FPGAs -

Modulation and Demodulation: Incoherent Demodulation, Coherent Demodulation.

Text Book:

1. U.Meyer Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, June 2004

Reference Books:

1. Keshab K. Parhi, "VLSI Digital Signal Processing systems, Design and implementation", Wiley, Inter Science, 1999
2. John G. Proakis, "Digital Communications," Fourth Ed. McGraw Hill International Edition, 2000.
3. Michael John Sebastian Smith, "Applications Specific Integrated Circuits", Pearson Education, 2000
4. Sophocles J. Orfanidis, "Introduction to Signal Processing", Prentice Hall, 1996

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1.	**Number representation**	
1.1	signed digit Number system	2
1.2	Logarithmic Number system	1
1.3	Residue Number system	2
2	**Computer arithmetic algorithms**	
2.1	Distributed Arithmetic(DA)	2
2.1.1	Signed DA	1
2.1.2	Modified DA	1
2.2	CORDIC	2
2.3	Number Theoretic transforms	2
3	**FIR filter**	
3.1	Direct FIR design	2
3.2	Pipelined FIR filter	1
3.3	FIR filter using DA	2
3.3.1	FIR filter using signed DA	1
4	**IIR filter**	
4.1	Pipelining IIR filters	2
4.1.1	Look-ahead IIR	1

No.	Topic	No. of Lectures
4.1.2	Clustered IIR	2
4.1.3	scattered Look-ahead	1
4.2	Parallel Processing	2
4.2.1	Parallel Lossy Integrator	1
5	**FFT algorithms**	
5.1	Cooley-Tukey	2
5.2	Good-Thomas	2
5.3	Winograd	2
6	**communication system blocks**	
6.1	Linear block codes	2
6.2	Viterbi decoder	2
6.3	Universal modulator	2
	Total Number of Hours	**40**

Course Designers

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2. K.Kalyani kalyani@tce.edu

Sub Code	Lectures	Tutorial	Practical	Credit
DCO	3	-	-	3

DCO Data Compression 3:0

Preamble: We live in a world where data compression is a key part of almost every aspect of computer and communications technology. No matter how much storage we have in our computers we are always concerned with space optimization and the algorithmic aspects of the efficiency we struggle to achieve. We are always looking for techniques to achieve better transmission rates. Data compression is grounded in information theory, and there are many fundamental algorithms that we must deal with daily in our information transmission and storage tasks. The objective of this course is to introduce the lossy and lossless compression techniques in text, audio, image and video signals. The course will start with the basic theory behind these methods followed by techniques that are used to augment the performance of the compression algorithms. Image/Video compression standards like JPEG, MPEG and H.263 will also be discussed. The course will contain both mathematical/analytical components.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies: At the end of the course the student should be able to

1. Define Entropy, conditional entropy, information, channels
2. Understand Data models: static and adaptive
3. Understand the concepts of Arithmetic coding, Dictionary techniques, Context modeling
4. Apply the concept of Generating the binary code for the sequence.
5. Understand modeling and coding, lossy and lossless compression
6. Apply various lossy coding techniques for speech, audio, image and video compression
7. Apply various lossless coding techniques for text and images
8. Analyse advantages and disadvantages of various codes
9. Analyse the suitable codes for various applications like text,speech and images

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	20	20	20
2	Understand	20	20	20
3	Apply	40	40	40
4	Analysis	20	20	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning Objectives

Remember

1. What do you mean by lossy and lossless compression?
2. Define average length of the code
3. What is good code?
4. Define modeling?
5. State entropy
6. Write notes on symbol region decoding and half tone region decoding

Understand

1. How do you get the diagram coding?
2. Describe briefly about Delta modulation
3. Why Huffman code is called optimum code?
4. Explain unique code
5. Discuss redundancies
6. Why do we go for extended Huffman code?
7. Consider a source alphabet with probabilities A={a1,a2,a3,a4,a5} with P(a1)= P(a3) = P(a4)= 0.2 P(a2)= 0.3 and P(a5) =0.1 .Will the Huffman And minimum variance Huffman code have the same average length.
8. Compare MH,MR,MMR
9. Write about sibling Properties?
10. Discuss about Fascimile encoding technique.
11. Explain how compression is obtained with Adaptive DPCM
12. Discuss about Wavelet coding.
13. Explain how JPEG image compression is obtained using transform coding
14 . Explain about Code Excited Linear Prediction.

Apply

1. Design a Huffman code and find average length for a source that puts out letters from an alphabet A={a1,a2,a3,a4,a5} with P(a1)= P(a3) = P(a4)= 0.1 P(a2)= 0.3 and P(a5) =0.4.
2. Find adaptive Huffman code for the same output source with the above Probabilities
3. Generate arithmetic code and Decode with scaling for the sequence 1332 with cdf F_x (1) = 0.8 F_x (2) = 0.82 and F_x (3) = 1.
4. Generate binary code using integer arithmetic code for the sequence 1321 with cdf F_x (1) = 0.6 F_x (2) = 0.72 and F_x (3) = 1.
5. Generate LZ77 code for the sequence "abbreviationabbreabbre" with the size of look ahead buffer 7 and search buffer 10.
6. Find Walsh hadamard transform for the given 4x4 image

2	3	4	2
7	2	0	3
1	0	2	3
2	3	2	1

7. Find DCT and inverse DCT for the following 2X2 matrix

2	3
2	1

Analysis

1. A sequence is encoded using LZW algorithm and the initial dictionary is

Index	Entry
1	A
2	$
3	H
4	I
5	S
6	T

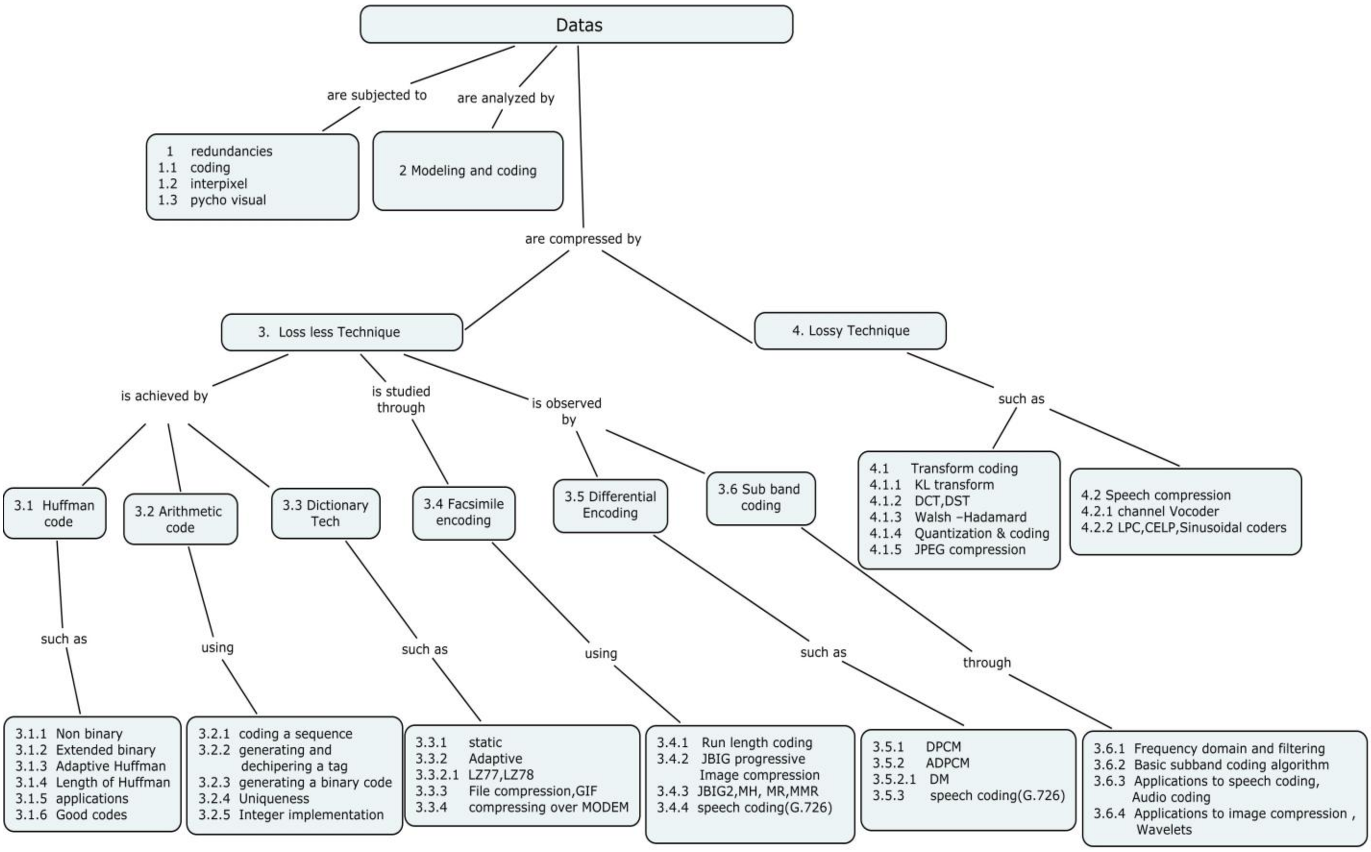
The output of the LZW encoder is the following sequence. 6 3 4 5 2 3 1 6 2 9 11 16 12 14 4 20 10 8 23 Decode this sequence? Encode the decoded sequence using the same initial dictionary. Does your answer match the sequence given above?

2. Consider the following image

10	10	15	5	7
5	3	10	10	15
15	15	2	4	10
5	5	6	10	30

Obtain 2-D DWHT by first taking the 1-D transform of the rows then taking the column by column transform of the resulting transform. Obtain 2-D DWHT by first taking the 1-D transform of the columns then taking the row by row transform of the resulting transform. Compare and comment on the results.

Concept Map



Syllabus

Introduction: Coding, Inter pixel ,Psycho visual redundancy, Lossless, Lossy compression, Measure of performance-Modeling and coding- Huffman coding- Good codes- The Huffman coding algorithm, Minimum variance Huffman codes length of Huffman codes- Extended Huffman codes- Non binary Huffman codes, Adaptive Huffman coding –Applications of Huffman coding , Lossless image compression, Text & Audio compression, **Arithmetic coding:** Introduction- **C**oding a sequence-Generating and deciphering the tag- Generating a binary , Uniqueness of arithmetic code –algorithm, Integer implementation- Comparison of Huffman and arithmetic coding, Applications of Bi-level image compression (JBIG standard) compression, **JBIG2-Image compression, Dictionary Techniques and Lossless image compression**: Static dictionary-Adaptive dictionary, LZ77, LZ78 approach-applications, File compression- Graphics Interchange format-compressing over modem (V.42 bis) Facsimile Encoding-Run length coding-Comparison of MH,MR,MMR and JBIG- Progressive image transmission – Linear prediction, Context, Multi resolution models-Modeling prediction errors, **Differential & Sub band coding:** Basic algorithm**,** Prediction in DPCM-Adaptive DPCM- Delta modulation, -Speech coding (G726), Frequency domain and filtering -The basic sub band coding Algorithm- Application to Speech Coding-G.722- Audio coding (MPEG Audio) - Application to Image Compression – Wavelets and image compression, **Transform Coding and Analysis and Synthesis Scheme:** Introduction –Transform- KL transform –Discrete cosine, Sine, Walsh –Hadamard transform, Quantization, Coding of transform coefficients- JPEG Image Compression – Application to Audio compression-Speech compression- Channel Vocoder- Linear predictive coder-Coder-Code Excited linear prediction-Sinusoidal coders-Silence compression

Text book:

1. Khalid Sayood, "Introduction to Data Compression", Morgan Kauffmann Publishers, Inc. California, 2001.

Reference books:

1. Mark Nelson, Jean Louf Goilly, "The Data compression Book", BPB Publications,1996
2. Rafel C.Gonzalez, "Digital Image processing", Addison Wesley, 2003.

Course Contents and Lecture Schedule

S. No.	Topic	No. of Lectures
1.	**Redundancies**	
1.1	Coding redundancy	1
1.2	Interpixel redundancy	1
1.3	Psychovisual redundancy	1
2.	**Modeling and Coding**	1
3.	**Loss less compression**	
3.1	Huffman codes	1
3.1.1	Non binary Huffman codes	1
3.1.2	Extended binary code	1
3.1.3	Adaptive Huffman code	1
3.1.4	Length of Huffman code	1
3.1.5	Applications of Huffman code	1
3.1.6	Good codes	1
3.2	**Arithmetic codes**	
3.2.1	Introduction-**C**oding a sequence	2
3.2.2	Generating and deciphering the tag	1

3.2.3	Generating a binary code	1
3.2.4	Uniqueness of arithmetic code	1
3.2.5	Integer implementation	1
3.3	**Dictionary Techniques**	
3.3.1	Static Dictionary	1
3.3.2	Adaptive Dictionary	1
3.3.2.1	LZ77, LZ78 approach	1
3.3.3	File compression, Graphics Interchange format	1
3.3.4	compressing over modem (V.42 bis)	1
3.4	**Facsimile encoding**	1
3.4.1	Run length coding	1
3.4.2	JBIG progressive Image compression	1
3.4.3	JBIG2, MH, MR, MMR	2
3.5	**Differential Encoding**	
3.5.1	DPCM	1
3.5.2	ADPCM	1
3.5.2.1	DM	1
3.5.3	Speech coding (G.726)	1
3.6	Sub band coding	1
3.6.1	Frequency domain and filtering	1
3.6.2	Basic sub band coding algorithm	1
3.6.3	Applications to speech coding, Audio coding	2
3.6.4	Applications to image compression , wavelets	2
4.0	**Lossy compression**	
4.1	Transform coding	1
4.1.1	KL transform	1
4.1.2	Discrete cosine Transform,DST	1
4.1.3	Walsh-Hadamard Transform	1
4.1.4	Quantization & Coding	1
4.1.5	JPEG compression	1
4.2	Speech compression	1
4.2.1	Channel Vocoder	1
4.2.2	LPC,CELP,sinusoidal coders	2
	Total Number of Hours	**48**

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
DCP	3	-	-	3

DCP Microelectronics 3:0

Preamble: This course will be followed by a elective course: ASIC Design. The course is to bring an insight into the deep submicron technology that is governing the recent IC Industries. This is carried out by discussing the design of various device parameters individually and then discussing the relative importance of the individual device parameters and determining the performance of small dimension modern transistors. The power consumption and packaging issues of the microeclectronic circuits have been analyzed.

Prerequisite: 'D23 – Basics of Digital Systems', 'D32: Analog Circuits and Systems', 'D42: Designing with PLDs and FPGAs' and 'D52: CMOS VLSI design'

Program Outcomes addressed:

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies: At the end of the course, the student will be able to

1. Understand the basic concepts of Semiconductor device physics and the evolution of deep submicron technology.
2. Explain the concepts of MOSFET scaling, short channel effects and modeling its parameters.
3. Describe the physical effects of the scaling of MOSFET device.
4. Solve the power consumption issues and the reduction techniques at various abstraction levels.
5. Describe the packaging issues associated with the microelectronic circuits.
6. Explain the other field effect transistors used for constructing Microelectronic circuits.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	0	10
2	Understand	20	20	20
3	Apply	30	40	30
4	Analyze	30	30	30
5	Evaluate	0	10	10
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. What are the Different operating regions of the MOSFET?
2. Define Short channel effect
3. What do you mean by intrinsic MOSFET Capacitance?
4. Define subthreshold leakage current.
5. What is meant by adiabatic logic?
6. What is the role of package in signal integrity?

Understand

1. What is the role of capacitance in inteconnect delay modeling?
2. How the parasitic resistance and capacitance affects the MOSFET characteristics?
3. Define effective Channel Length.
4. What do you mean by return path discontinuity?
5. List other Hetero-juction MOSFETs.
6. What do you mean by EMI/EMC compliance?

Apply

1. Calculate the flat-band voltage of a silicon nMOS capacitor with a substrate doping $N_a = 10^{17}$ cm^{-3} and an aluminum gate (Φ_m = 4.1 V). Assume there is no fixed charge in the oxide or at the oxide-silicon interface.
2. Draw the five resistor network indicating the substrate resistance in submicrometer MOSFET model.
3. Calculate the oxide capacitance, the flat-band capacitance and the high frequency capacitance in inversion of a silicon nMOS capacitor with a substrate doping $N_a = 10^{17}$ cm^{-3}, a 20 nm thick oxide ($\varepsilon_{ox} = 3.9\ \varepsilon_0$) and an aluminium gate (Φ_m = 4.1 V).

4. Draw the two port network and derive the expression for the noise parameters .Given R_{va}=400 ohms, G_{in}=23, B_c=0.06, G_c=230, find the values of noise parameters.
5. Draw the small signal model for noise parameters for induced gate noise and its correlation to the drain noise.

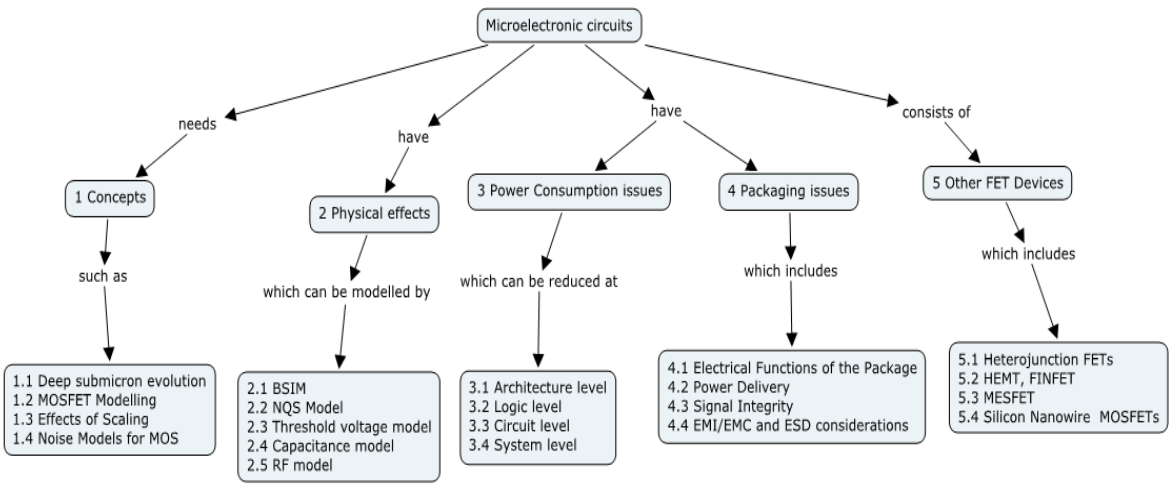
Analyse

1. Differentiate between switching current and leakage current.
2. Consider the following combinational circuit F= AB+C . Identify the topology of circuit of connecting MOS devices to get minimum power consumption.
3. Consider the capacitance model for the BSIM and find the parameter which corresponds to the delay calculation.
4. Distinguish between micro model and macro model of a device.

Evaluate

1. Consider the CMOS circuit for the logic F= B+AC+AD. Show that the assignment of input to the various transistors changes the power consumed by the circuit.
2. For the combinational logic F= B+AC+AD. Generate the input vector sequence for which the circuit shows maximum power dissipation.

Concept Map



Syllabus

Concepts: Deep submicron evolution, MOSFET Modeling, Effects of Scaling, Noise Models of MOS **Physical effects:** BSIM, NQS Model, Threshold Voltage Model, Capacitance Model, RF Model **Power Consumption Issues:** Architecture Level, Logic Level, Circuit Level, System Level **Packaging Issues:** Electrical Functions of the Package, Power Delivery, Signal Integrity, EMI/EMC and ESD Considerations **Other FET Devices:** Heterojunction FETs, HEMTs, FINFET, MESFET structure, Silicon Nanowire MOSFETs

Text Book:

1. Yuan Taur, tak H.Ning, "Fundamentals of Modern VLSI Devices" Cambridge University press,1998.
2. Nandita Dasgupta, Amitava Dasgupta, " Semiconductor device Modeling" PHI, 2004

Reference Books:

1. Mark.S.Lundstrom, Jing Guo, " Nano Scale Transistors" , Springer, 2006

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Concepts:**	
1.1	Deep submicron evolution	1
1.2	MOSFET Modeling	3
1.3	Effects of Scaling	3
1.4	Noise Models of MOS	3
2	**Physical effects:**	
2.1	BSIM	1
2.2	NQS Model	1
2.3	Threshold Voltage Model	2
2.4	Capacitance Model	2
2.5	RF Model	2
3	**Power Consumption Issues:**	
3.1	Architecture Level	2
3.2	Logic Level	2
3.3	Circuit Level	2
3.4	System Level	2
4	**Packaging Isssues:**	

4.1	Electrical Functions of the Package	2
4.2	Power Delivery	2
4.3	Signal Integrity	2
4.4	EMI/EMC and ESD Considerations	2
5	**Other FET Devices:**	
5.1	Heterojunction FETs	2
5.2	HEMTs, FINFET	2
5.3	MESFET structure	1
5.4	Silicon Nanowire MOSFETs	1
	Total Number of Hours	**40**

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
DCQ	3	0	-	3

DCQ Digital Video Systems 3:0

Preamble: The purpose of this course is to provide an insight to the fundamental theory and techniques for efficient representation, processing and display of video signals and the applications of digital video systems. Topics to be covered include: introduction to video systems, properties of the human visual system, video sampling, video sampling rate conversion, video modeling, motion estimation, fundamentals of video compression techniques, Video display (LCD, LED with High definition) and applications such as video conferencing and surveillance.

Prerequisite: D63- Digital Image Processing

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
e. Graduates will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.
k. Graduate who can participate and succeed in competitive examinations.

Competencies: At the end of the course the student should be able to

1. Understand of what videos are and how they are modeled.
2. Understand how digital video products have developed over time and how the video and compression standards and recommendations have been used in the past to help build these systems as well as into the future.
3. Understand various existing and emerging video processing standards.
4. Apply the different imaging and video compression standards to acquire and process their own digital video data to a diverse set of example applications
5. Analyze what the components are that make up a digital video system and how they are used.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/ End Semester Examination
1	Remember	20	20	20
2	Understand	40	40	20
3	Apply	40	40	40
4	Analyze	0	0	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning Objectives

Remember

1. What are the pros and cons of using component vs. composite format?
2. What is the perceived color if you mix red, green, and blue dyes in equal proportion?
3. What are the necessary sampling rates for video?
4. Which sampling lattice is the most efficient under a given total sampling rate?
5. What are the main advantages of the multi-resolution estimation method, compared to an approach using a single resolution?
6. What are the tools that improve the coding efficiency of H.263 over H.261?

Understand

1. Describe the mechanism by which the human perceive color.
2. Describe the pros and cons of different motion representation methods (pixel based, block-based, mesh-based and global).
3. What are the most compute intensive parts of an H.261 video encoder?
4. What are the most compute intensive parts of a decoder? Why?
5. Explain the concept of profiles and levels in MPEG-2.
6. What is drift? When does it occur?
7. Show that, under perspective projection, the projected 2D motion of a planar patch undergoing rigid motion can be described by a projective mapping.

Apply

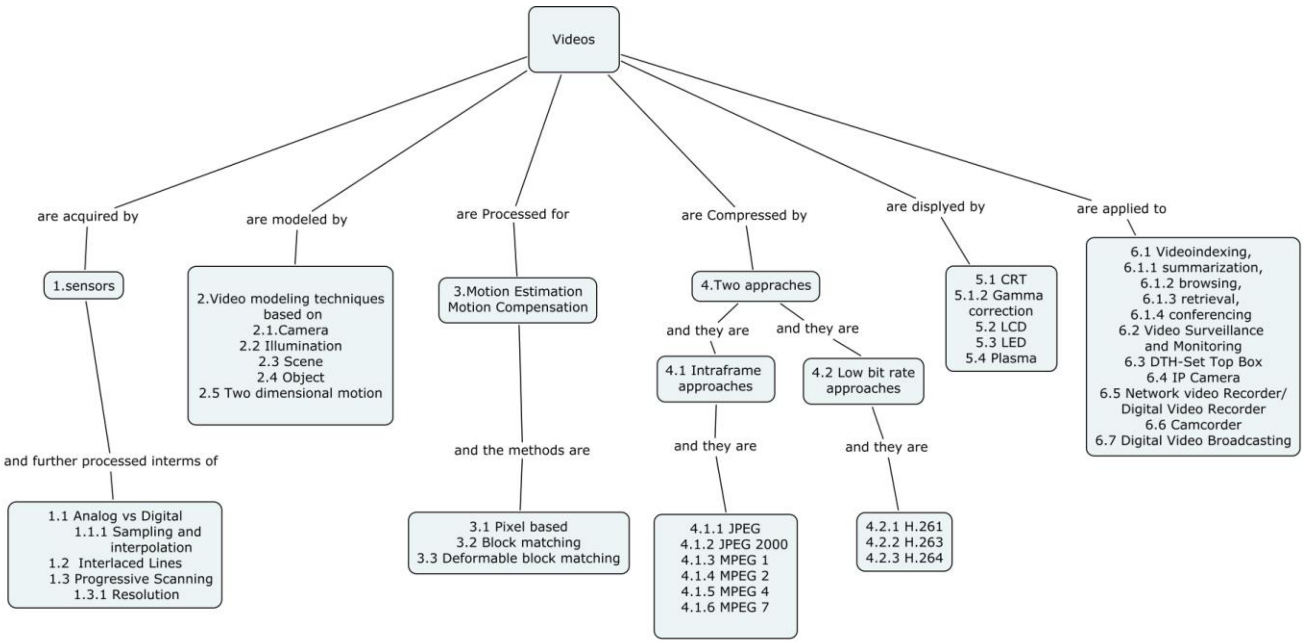
1. Suppose that you are given the motion vectors dk at K > 3 points xk in an image, and that you want to use the affine mapping to approximate the overall motion. How do you determine the affine parameters?
2. Which of the MPEG-2 profiles are used in commercial products? Why do the others exist?

3. For the following colors in the digital RGB coordinate, determine their values in the YCbCr coordinate.
    a. (255,255, 255); (b) (0, 255, 0); (c) (255,255,0); (d) (0, 255, 255).
4. For the following colors in the RGB coordinate, determine their values in the YIQ and YUV coordinates, respectively.
    (a) (1,1,1); (b) (0,1,0); (c) (1,1,0); (d) (0, 1,1).
5. Why does a computer monitor use a higher temporal refresh rate and more line numbers than does a typical TV monitor?
6. Why is the dentition of FAP's as done in MPEG-4 important for content creation?

Analyze

1. Under orthographic projection, how the projected 2D motion of a planar atch undergoing translation, rotation and scaling (because of camera zoom)can be described by an affine function. Analyze it.
2. What is the difficulty with video indexing and retrieval? How can a standardized content description interface such as MPEG-7 simplify video retrieval?
3. How does the segment-tree in MPEG-7 describe the syntactic structure of a video sequence? How does the event-tree in MPEG-7 describe the semantic structure of a video sequence? What are their relations?
4. Analyze the video surveillance hardware for different applications?
5. Analyze the considerations you would use to determine the frame rate and line number when designing a video capture/display system? Are the parameters chosen for NTSC color TV broadcasting appropriate?
6. How is synchronization achieved between a speech synthesizer and a talking ace?

Concept Map



Syllabus

Digital video Formation- Introduction to digital video and digital video processing, Video capture,Analog to Digital, Analog versus Digital- Video sampling and interpolation- Interlaced scanning- Progressive scanning-Resolution- **Video modelling techniques-** Based on Camera-scene-illumination-object- Two dimensional motion- **Video processing operations-** Motion detection and Estimation- Pixel based approaches- Block matching approaches- Deformable block matching approaches- Motion compensation for videos- Video Segmentation- **Fundamentals of video compression techniques-**Intra frame coding approaches- JPEG Compression, New standards JPEG2000- MPEG-1 and MPEG-2 video compression standards-MPEG-4 and MPEG-7- Low bit rate approaches such as H.261 and H.263-H.264- **Video Display-**CRT**-** Gamma correction- High definition television (LCD, LED and plasma Display)- **Applications-** Video indexing, summarization, browsing, retrieval, conferencing systems- Video Surveillance Systems-Set Top Box (STB) -Direct to Home (DTH) -IP Camera, Camcorder- Network Video Recorder/ Digital Video Recorder- Digital video Broadcasting

Text book:

1. Essential Guide to Video Processing by Al Bovik, Academic Press, 2009, ISBN 978-0-12-37445.
2. Video Processing & Communications, by Yao Wang, Jom Ostermann, & Ya-Oin Zhang. Prentice Hall, 2002, ISBN 0-13-017547-1.

Reference books:

1. Digital Video Processing, by A. Murat Tekalp, Prentice Hall, 1995, ISBN: 0-13-190075-7.
2. Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards, by Yun Q. Shi & Huifang Sun. CRC Press, 2000, ISBN: 0-8493-3491-8.
3. Fundamentals of Digital Image Processing, by Anil K. Jain, Prentice Hall, 1989, ISBN: 0013-336165-9.
4. Computer Imaging: Digital Image Analysis and Processing, by Scott E Umbaugh, CRC Press,2005, ISBN: 0-8493-2919-1.
5. Video Engineering, by Inglis & Luther, 2nd edition, McGraw Hill, 1996. (covers fundamentals of analog & digital video systems, including HDTV, CATV, Terrestrial & satellite video broadcast technologies.) [SUT: TK 6630 .I54 1996]
6. Video Dialtone Technology, by Minoli, McGraw Hill, 1995. (covers digital video over ADSL, HFC, FTTC & ATM technologies, including interactive TV & video-on-demand.)
7. Handbook of Image & Video Processing, by Al Bovik, Academic Press, 2000, ISBN: 0121197905.
8. Digital Video Compression (with CD-ROM), by Peter Symes. Bk &CD-Rom edition, 2003, ISBN: 0071424873.
9. H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia, by Iain E. G. Richardson & Iain E. G. Richardson. John Wiley & Sons, 12, 2003, ISBN: 0470848375.

Course Contents and Lecture Schedule

S.No.	**Topic**	**No. of Lectures**
1.	**Digital video Formation**	
1.1	Introduction to digital video and digital video processing, Video capture,Analog to Digital, Analog versus Digital	2
1.1.1	Video sampling and interpolation	1
1.2	Interlaced scanning	2
1.3	Progressive scanning	1
1.3.1	Resolution	1
2.	**Video modelling techniques**	
2.1	Based on Camera	1

S.No.	Topic	No. of Lectures
2.2	Illumination	1
2.3	Scene	1
2.4	Object	1
2.5	Two dimensional motion	1
3.	**Video processing operations**	
3.1	Motion detection and Estimation	2
3.1.1	Pixel based approaches	2
3.1.2	Block matching approaches	1
3.1.3	Deformable block matching approaches	1
3.2	Motion compensation for videos	1
3.3	Video Segmentation	1
4.	**Fundamentals of video compression techniques**	
4.1	Intra frame coding approaches	1
4.1.1	JPEG Compression, New standards JPEG2000	1
4.1.2	MPEG-1 and MPEG-2 video compression standards	2
4.1.6	MPEG-4 and MPEG-7	2
4.2	Low bit rate approaches such as H.261 and H.263	2
4.2.1	H.264	1
5.	**Video Display**	
5.1	CRT	1
5.1.1	Gamma correction	1
5.2	High definition television (LCD, LED and plasma Display)	2
6	**Applications**	
6.1	Video indexing, summarization, browsing, retrieval, conferencing systems.	1
6.2	Video Surveillance Systems	1
6.4	Set Top Box (STB) –Direct to Home (DTH)	1
6.5	IP Camera, Camcorder	1
6.6	Network Video Recorder/ Digital Video Recorder	1
6.7	Digital video Broadcasting	1
	Total	**42**

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
DCR	3	-	-	3

DCR Satellite Image Analysis 3:0

Preamble:

This course aims at processing satellite images to analyze and extract information from them, using signal and image processing operations.

Prerequisite: "D63: Digital Image Processing".

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, signal and image processing.

b. Graduates will demonstrate ability to process and analyze images with different characteristics.

d. Graduates will demonstrate an ability to process 2D and 3D signals as per needs and image type.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze satellite images.

Competencies: At the end of the course, the student will be able to

1. Determine the quality of the image using noise model statistics.
2. Improve the quality of a distorted image by geo-referencing.
3. Describe and determine the performance of different stretching techniques for enhancement.
4. Describe the role of spectral, spatial and scale space transforms on Satellite images.
5. Analyse the performance of supervised and unsupervised training for different sensor data.
6. Characterize the influence of feature extraction, in terms of accuracy on classified images.
7. Determine the performance of different feature extraction methods
8. Integrate two different sensor satellite data
9. Remove the data redundancies by suitable compression technique to transmit the satellite image efficiently

Tools

MATLAB, ENVI Softwares

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	20	20	20
2	Understand	40	40	20
3	Apply	40	40	40
4	Analysis	0	0	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning Objectives

Remember

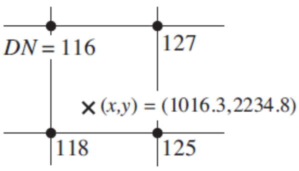
1. What is meant by geometric correction?
2. List the properties of Fourier transform.
3. Write the law's 2D masks to ridges and waves.
4. What is meant by Scale space fusion?
5. Explain the terms; Fractal dimension, Lacunarity.
6. What are different types of Vegetation Indexes?

Understand

1. Prove the rotation invariance property of Fourier transform.
2. Explain how wetness and dryness are analyzed using tasseled cap transformation?
3. The cross-correlation coefficient is commonly used to register image patches. Which environmental and calibration factors in remote-sensing imagery are removed by this normalization?
4. Differentiate supervised and unsupervised classification.
5. Which spectral bands are used in multi spectral ratio to analyse vegetation.
6. How wavelets are used for Image Compression?

Apply

1. Given the *DN* values of four neighboring pixels, find the *DN* of the resampled pixel at X using bilinear resampling:



2. The following table shows the histogram of a poor contrast grey scale Image:

Grey level i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n_i	15	0	0	0	0	70	110	45	70	35	0	0	0	0	0	15

Modify the same image as a high contrast one.

3. The following table gives the number of pixels at each of the grey levels in an image with those grey values only:

0	1	2	3	4	5	6	7
3244	3899	4559	2573	1428	530	101	50

Draw the histogram corresponding to these grey levels, and then perform histogram equalization and draw the resulting histogram.

4. Determine the Fourier transform of a 5 X 5 image f(x,y) with constant matrix f(x,y)=1.

5.Classify the following image into 3 classes using K- means clustering.

12	6	5	13	14	14	16	15
11	10	8	5	8	11	14	14
9	8	3	4	7	12	18	19
10	7	4	2	10	12	13	17
16	9	13	13	16	19	19	17
12	10	14	15	18	18	16	14
11	8	10	12	14	13	14	15
8	6	3	7	9	11	12	12

Analyze

1.Given a multispectral image with a *DN* covariance matrix,

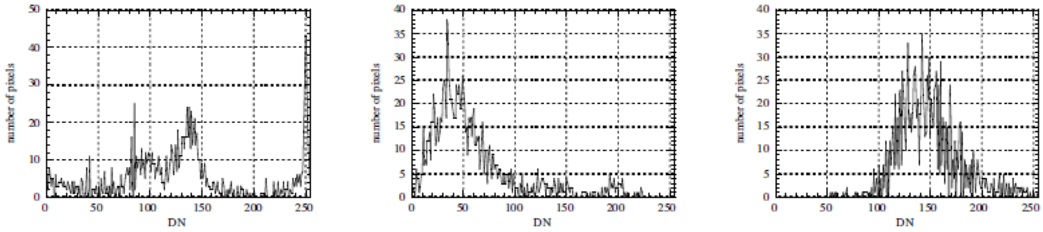
$$C = \begin{bmatrix} 1900 & 1200 & 700 \\ 1200 & 800 & 500 \\ 700 & 500 & 300 \end{bmatrix}.$$

What is the correlation matrix? Now, suppose you do a calibration of the data to at-sensor radiance *L* as follows,

$$\begin{aligned} L_1 &= 2 \times DN_1 + 11 \\ L_2 &= 3 \times DN_2 + 4 \\ L_3 &= 5 \times DN_3 + 2 \end{aligned}$$

What are the covariance and correlation matrices of the calibrated data? Will the PCT of the calibrated data be the same as the PCT of the *DN* data? Will the standardized PCT be the same?

2. Given the following histograms of the (actual) HSI components of a three-band image, specify three *DN* transformations that will make the saturation of every pixel equal to 200, linearly stretch the intensity to increase the contrast, and leave the hue unchanged.



hue *saturation* *intensity*

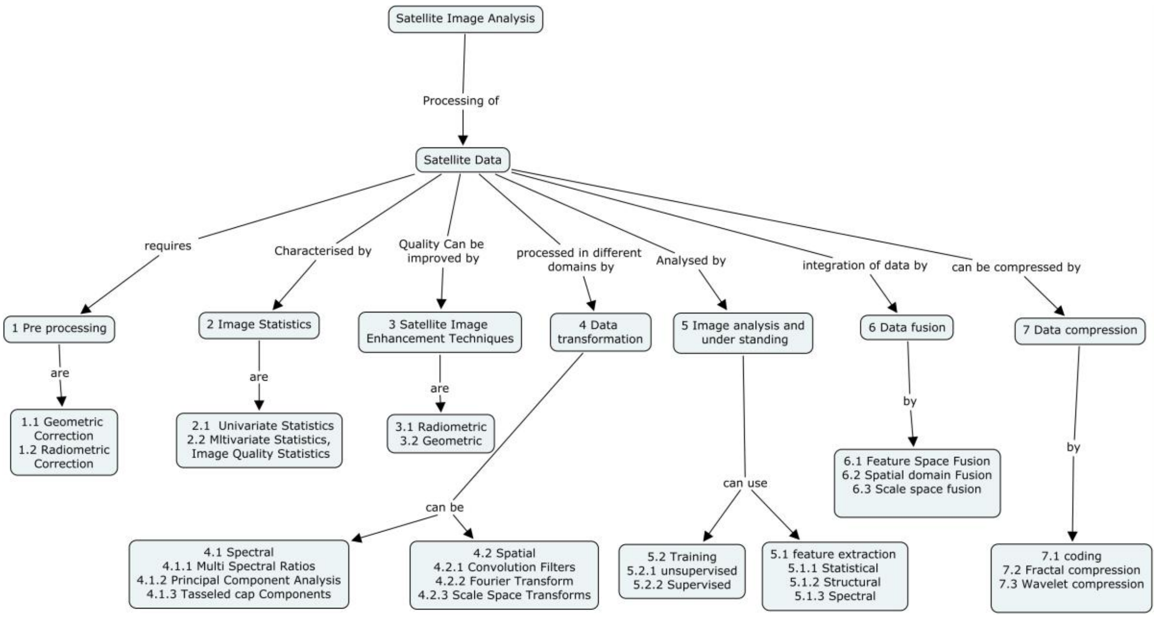
3.Suppose you calculate the local mean and standard deviation in a 3 X 3 pixel window, moved across an image. What is the statistical uncertainty in the mean values? What if the window is 5 X 5 pixels?

4. For a 4 bit input matrix obtain the Co-occurrence matrix and Analyze it by computing any six Haralick's statistical texture features .

10	10	12	0	0
5	0	10	10	12
1	1	2	0	10
5	5	0	10	12

5. In a multi spectral image of size 512 X 512, each pixel is associated with 7 bytes of colour information; How many bytes are required to store that image?

Concept Map:



Syllabus

Satellite Data: Satellite Image Characteristics, Preprocessing- Geometric Correction, Radiometric Correction, **Image Statistics**: Univariate Statistics, Multivariate Image Statistics, Image Quality statistics, **Satellite Image Enhancement:** Radiometric Enhancement- Histogram Based Enhancements, Density Slicing, Stretching, Geometric Enhancement- Neighborhood Operations, Template Operators, **Data Transformation**: Spectral Transforms - Multispectral Ratios - Vegetation Indexes, Principal Components, Tasseled-Cap Components, Color-Space Transforms, Spatial Transforms – Convolution, Fourier Transform, Scale Space Transforms, **Image Analysis And Understanding:** Feature Extraction- Statistical, Structural, Spectral, Training –Supervised, Unsupervised, Hybrid Training, **Data Fusion**: Feature Space fusion, Spatial domain fusion, Scale space fusion, **Data Compression:** Compression by coding, Fractal Compression, Wavelet Compression.

Text Book:

1. Robert A. Schowengerdt, Remote Sensing Models & Methods For Image Processing, III Edition, 2004.
2. J. A. Richards "Remote Sensing Digital Image Analysis: An Introduction", Second Revised Edition, 1993.

Reference Books:

1. Thomas M.Lillesand, Ralph W.Kiefer, "Remote Sensing And Image Interpretation", Fifth Edition, 2004.
2. John R. Jensen, "Remote Sensing Of The Environment – An Earth Resource Perspective", Pearson Education Series, 2003.
3. Rafael C.Gonzalez, Richard E.Woods, "Digital Image Processing" (3rd Edition) Rafael C.Gonzalez, Richard E.Woods, Prentice Hall, 2007.

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lectures
1.	**Satellite Data**	
1.1	Satellite Image Characteristics	1
1.2	Geometric Correction	1
1.3	Radiometric Correction	1
2.	**Image Statistics**	
2.1	Univariate Statistics	1
2.2	Multivariate Statistics, image quality statistics	1
3.	**Satellite Image Enhancement**	
3.1	Radiometric Enhancement	1
3.1.1	Histogram Based Enhancements, Density slicing	1
3.1.2	Stretching	1
3.2	Geometric Enhancement	1
3.2.1	Neighborhood Operations, Template operators	1

S.No.	Topic	No. of Lectures
4.	**Data Transformation**	
4.1	Spectral Transforms	1
4.1.1	Multispectral Ratios	1
4.1.2	Vegetation Indexes	1
4.1.3	Principal Components	1
4.1.4	Tasseled-Cap Components	1
4.1.5	Color-Space Transforms	1
4.2	Spatial Transforms	1
4.2.1	Convolution	1
4.2.2	Fourier Transform	1
4.2.3	Scale Space Transforms	3
5.	**Image Analysis And Understanding**	
5.1	Feature Extraction	1
5.1.1	Statistical	1
5.1.2	Structural	1
5.1.3	Spectral	2
5.2	Training	1
5.2.1	Supervised	2
5.2.2	Unsupervised	1
5.2.3	Hybrid Training	1
6.	**Data Fusion**	
6.1	Feature Space fusion	1
6.2	Spatial domain fusion	1
6.3	Scale space fusion	2
7.	**Data Compression**	
7.1	Compression by coding	1
7.2	Fractal Compression	1
7.3	Wavelet Compression	2
	Total Number of Hours	**40**

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
DCS	3	-	-	3

DCS Optimum Signal Processing 3:0

Preamble:

This course describes the optimal signal algorithms to extract the desired signal from observed noisy signal. The objective is to present Wiener filtering concept as the basic unifying theme. It ties together various signal processing algorithms that are used for applications such as backward and forward predictors, spectral estimators, noise reduction filters and adaptive filters for channel equalization and echo cancellation.

Prerequisite: ‘D33: Signal Processing” and “D54 Digital Signal Processing”.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

f. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies: At the end of the course, the student will be able to:

8. Determine the output of a LTI system excited by a random process.
9. Model a discrete time random signal as output of linear shift invariant filter.
10. Determine the wiener filter coefficients from the auto correlation and cross correlation of random sequences.
11. Find the coefficients of forward and backward filters for prediction of a random sequence.
12. Determine the filter coefficients and minimum error of an LMS adaptive filter.
13. Estimate the frequency content and angle of arrival of a sinusoid corrupted with white noise.
14. Apply adaptive wiener filter for channel equalization and echo cancellation.

Tools

MATLAB

Assessment Pattern

S.No	Bloom's Category	Test 1	Test 2	Test 3/ End-semester examination
1	Remember	20	20	10
2	Understand	20	20	10
3	Apply	60	60	80
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course level Learning Objectives

Remember

7. State minimal delay property.
8. State spectral factorization theorem.
9. State the principle of orthogonality.
10. Give the update equation of LMS algorithm.
11. Prove that $\sum_{m=-N}^{N} r_{xx}(m)e^{-j2\pi fm} = \frac{1}{N}\left|\sum_{n=0}^{N-1} x(n)e^{-j2\pi fn}\right|^2$.
12. What is cross correlation loop (CCL)? Derive the optimal value for the filter coefficient.

Understand

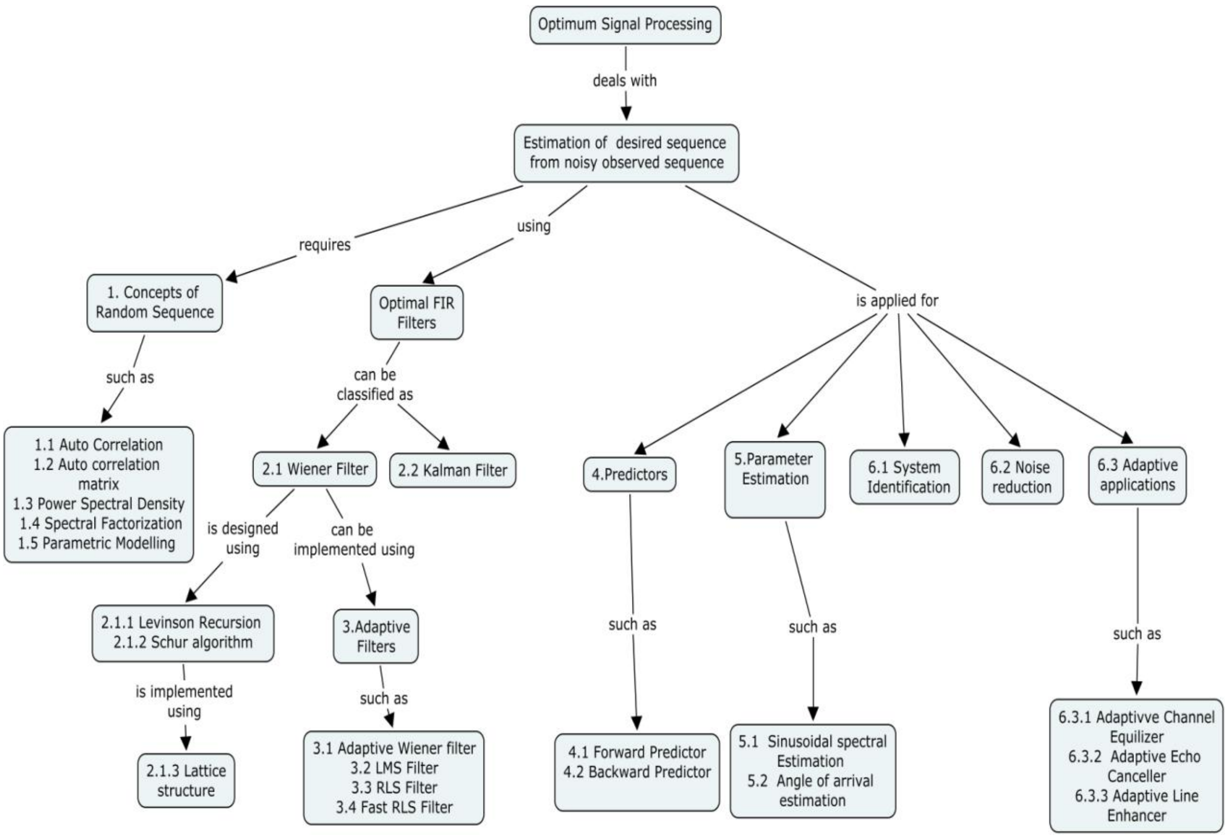
7. How can a system be identified using the cross correlation method.
8. Given a finite set of autocorrelation sequence $\{R(0) \quad R(1) \quad .... \quad ... \quad R(p)\}$, how do you estimate $R(p+1)$.
9. If a cross correlation loop is solved in an adaptive manner, what is the condition to be satisfied for the step size parameter?
10. Distinguish between 'smoothing', predicting' and 'filtering' problems.
11. Compare the computational complexity between direct form realization and lattice realization.
12. Compare the performance of LMS and RLS algorithm.
13. How is adaptive signal processing algorithm applied for adaptive linear combiner?

Apply

16. The autocorrelation sequence of a discrete time stochastic process is $\phi(k) = (0.5)^{|k|}$. Determine its power density spectrum.

17. A stationary random signal has autocorrelation function $r_{xx}(k) = 0.25^{|k|}$, for all 'k'. The observation signal is $y_n = x_n + v_n$, where v_n is zero mean, white noise sequence of variance 1, uncorrelated from x_n. Determine the optimal FIR Wiener filter of order M=1, for estimating x_n from y_n
18. Suppose that $S_{yy}(z) = \dfrac{(1-0.25z^{-2})(1-0.25z^{2})}{(1-0.8z^{-1})(1-0.8z)}$, determine the best predictor $\hat{y}_{n/n-1}$. Where $S_{yy}(z)$ is the power spectral density of random sequence y_n.
19. Let $x(n)$ be a zero mean white noise sequence of unit variance. Compute the output correlation $R_{yy}(k)$, for all k of the system. $y(n) = 0.25y(n-1) + x(n)$.
20. Let $y_n = A_1 \exp(j(\omega_1 n + \phi_1))$ be a complex sinusoid with amplitude A_1 and frequency ω_1. The randomness y_n arises only from the phase ϕ_1 which is assumed to be a random variable uniformly distributed over the interval $0 \le \phi_1 \le 2\pi$. Compute the autocorrelation function of y_n.
21. Given the autocorrelation sequence $R_{yy}(0) = 1, R_{yy}(1) = 0.5, R_{yy}(2) = 0.25$, find the reflection coefficients Γ_1, Γ_2, the model parameters and modeling errors.

Concept Map:



Syllabus

Introduction to Random signals: Random sequence, Autocorrelation, Autocorrelation matrix, Power spectral density, Spectral Factorization, Parametric modeling. **Filtering:** Wiener filter, Principle of orthogonality, Normal equations, Levinson algorithm, Schur algorithm, Lattice realization, Kalman filter. **Adaptive Filtering:** Adaptive wiener filter, LMS algorithm, RLS algorithm, Fast RLS algorithm. **Prediction:** Forward and backward predictors. **Parameter Estimation:** Sinusoidal spectral estimation and Angle of arrival estimation – Window method, Eigen Vector method, MUSIC method . **Other Applications:** System Identification, Noise reduction, Adaptive Channel Equalizer, Adaptive Echo Canceller, Adaptive Line Enhancer.

Text Book

3. Sophocles J.Orfanidis , Optimum Signal Processing: An Introduction , Tata Mc-Graw Hill , 2007.

Reference Books

2. Manson Hayes, Statistical Signal Processing, John Wiley & Sons, 1996.
3. Paulo S.R.Diniz , Adaptive Filtering: Algorithms and Practical Implementation , Kluwer Academic Publishers, 2002
4. Simon Haykin, Adaptive Filter Theory, Pearson Education,2002.

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lectures
1.	**Introduction to Random signals:**	
1.1	Random sequence	1
1.2	Autocorrelation, Autocorrelation matrix	1
1.3	Properties of Autocorrelation matrix	1
1.4	Power spectral density	1
1.5	Spectral Factorization	2
1.4	Parametric modeling of random sequence	2
2	**Filtering**	
2.1	Wiener filter	1
2.2	Principle of orthogonality, Normal equations	2
2.3	Levinson algorithm	2
2.4	Schur algorithm	2
2.5	Lattice realization	2
2.6	Kalman Filter	2
3	**Adaptive Filtering**	
3.1	Adaptive wiener filter	2

3.2	LMS algorithm	2
3.3	RLS algorithm	2
3.4	Fast RLS algorithm	2
4	**Prediction**	
4.1	Forward Predictor	2
4.2	Backward predictor	2
5	**Parameter Estimation**	
5.1	Sinusoidal spectral estimation and Angle of arrival estimation	1
5.2	Window method	2
5.3	Eigen Vector method	2
5.4	MUSIC method	2
6	**Other Applications**	
6.1	System Identification	1
6.2	Noise reduction	1
6.3	Adaptive Channel Equalizer	1
6.4	Adaptive Echo Canceller	1
6.5	Adaptive Line Enhancer	1
	Total Number of Hours	**43**

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
DCT	3	-	-	3

DCT Radio frequency Integrated Circuits 3:0

Preamble: The rapid expansion of untethered (wireless) communications services - paging, RF identification (RFID), analog and digital cellular telephony, Personal Communications Services (PCS), etc. - over the last ten years has led to an explosion in the development of integrated circuit approaches in the RF/microwave area. This course on RFIC design represents a much-needed bridge between wireless communications systems and state-of-the-art integrate circuit technology. Students concentrating in wireless communications, microelectronics can all benefit from such a course. The growing regional communications and electronics industry would also benefit from a RF integrated circuit curriculum. The course will focus on the RF front-ends for integrated transceivers for wireless communications standards, active/passive device technologies for RFIC implementations, low noise amplifiers; mixers, power amplifiers ,Modern RFIC chip sets for current wireless communications standards, usage of modern RF/microwave CAD software.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations

Competencies:

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

1. Understand transceiver architectures relevant to current wireless communications standards
2. Understand active and passive device technologies relevant to RFICs
3. Calculate noise ,linearity, and dynamic range performance metrics for RF devices and circuits
4. Design of on chip inductors, capacitors and transformers
5. Design of RF functional blocks such as low-noise amplifiers, mixers and Power amplifiers

6. Utilization of RF/microwave CAD software

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	20	20	10
2	Understand	20	20	10
3	Apply	40	40	60
4	Analysis	0	0	0
5	Evaluate	0	0	0
6	Create	20	20	20

Course Level Learning Objectives

Remember

1. Differentiate low frequency analog design and radio frequency integrated circuit design.
2. Convert 2.5nW power into dBm
3. Define noise figure
4. Correlate third order intersects point and 1dB compression point.
5. What is metal migration?
6. Define skin depth.

Understand

1. Calculate the inductance per unit length for traces with a h/w of 0.5, 1, and 2.
2. Why packaging is essential?
3. Differentiate various packaging techniques.
4. Mention few guidelines for designing bipolar transistor?
5. Compare cadence software with other high frequency simulation tools.
6. What is meant by blocking?

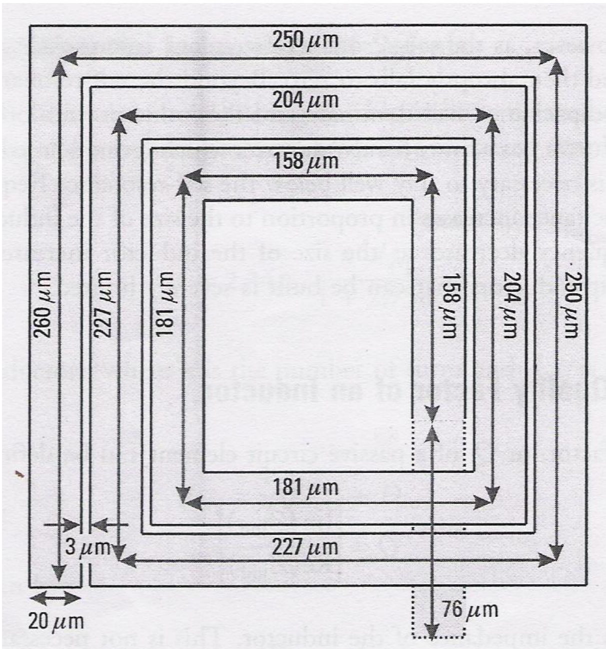
Apply

1. A rectangular aluminum line has a width of 20 μm, a thickness of 3 μm, and a length of 100 μm. Compute the resistance of the line at dc and at 5 GHz assuming that all the current flows in an area one skin depth from the surface. Assume that aluminum has a resistively of 3 $\mu\Omega$ cm.
2. Calculate bottom plate capacitance and fringing capacitance for a 1 poly, 2 metal processes with distance to substrate and conductor thickness as

given in the first two rows of Table. Calculate for metal widths of 1 μm and 50 μm.

	Poly	Metal 1	Metal 2
Height above substrate h (μm)	0.4	1.0	2.5
Conductor thickness t (μm)	0.4	0.4	0.5

3. Given a square inductor with the dimensions shown in figure. Determine a model for the structure including all model values. The inductor is made out of 3-μm-thick aluminum metal. The inductor is suspended over 5 μm of oxide above a substrate. The underpass is 1-μm aluminum and is 3 μm above the substrate. Assume the vias are lossless.



Inductor with dimensions

4. From the data in table for a typical 50-GHz bipolar process, calculate z_o, f_T and $f_{\max}$ for the 15x transistor. Use this to verify some of the approximations made in the above derivation for $f_{\max}$.

Example Transistors

Parameter	Transistor Size		
	1x	**4x**	**15x**
I_{optf_T} (mA)	0.55	2.4	7.9
C_π (fF)	50	200	700

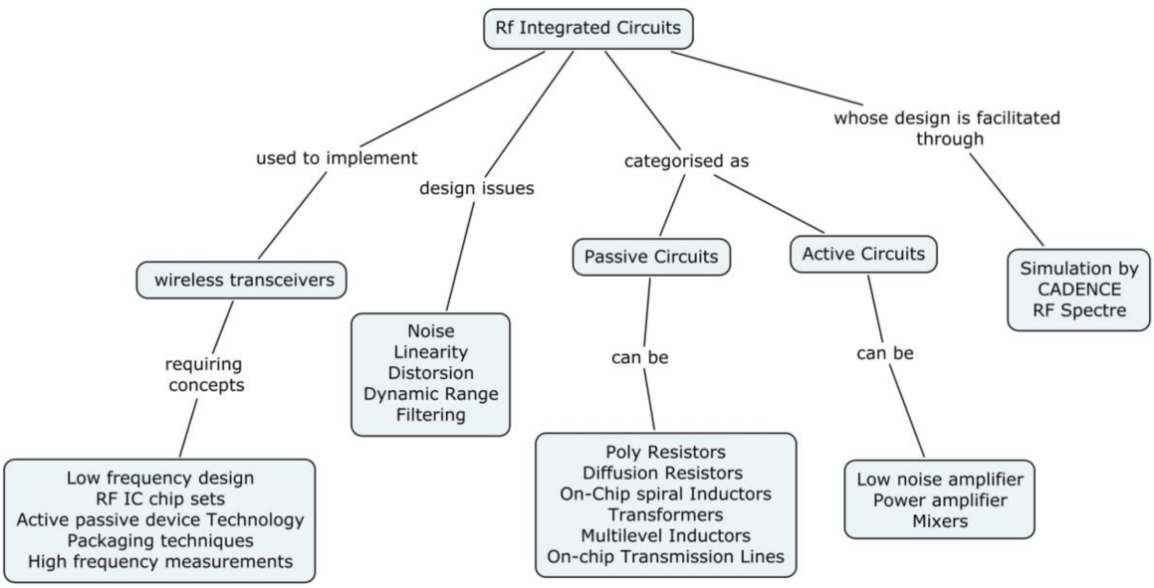
C_{μ} (fF)	2.72	6.96	23.2
r_b (Ω)	65	20.8	5.0

5. Derive the noise figure of the components connected in cascaded sections.
6. Consider a non-linear circuit with 7 and 8 MHz tones applied at the input. Determine all output frequency components, assuming distortion components up to the third order.

Create

1. Design a low-noise amplifier using spectre RF with Typical LNA Characteristics in Heterodyne Systems as NF=2 dB, IIP3= -10 dBm, Gain =15 dB, Input and Output Impedance =50ohms, Input and Output Return Loss= -15 dB, Reverse Isolation= 20 dB. Define Transducer Power Gain (G_T), Operating Power Gain (G_P),and Power Supply Rejection Ratio (PSRR). Draw the test bench setup circuit for LNA, what is your guess about the PSRR of this LNA?
2. Design a transmit mixer using spectra RF with IF is 40MHz and your LO is 5.4GHz. Draw the setup to obtain the PAC and Pnoise analysis.

Concept Map:



Syllabus:

Radio frequency Integrated Circuits: Transceiver architectures-Role of RFICs in Transceiver, Lower frequency design and RFIC design-issues-Active/Passive device technologies for RFIC implementations-Modern RFIC chip sets for current wireless standards, Packaging techniques, High frequency measurement **RFIC**

design issues: Noise, Linearity and distortion in RF circuits, dynamic range, Filtering issues, selectivity, and sensitivity, **Design of Passive circuit elements in IC technologies:** Sheet resistance, Parasitic effects(L and C),metal migration, Poly resistors, diffusion resistors, On chip spiral inductors, design of inductors and Transformers, Lumped model of inductors, Multilevel inductors, on chip transmission lines, **Design of active circuit in IC technologies:** Low noise amplifier, Power amplifier, mixers **Computer aided design of RFICs:** Introduction to Commercial packages, Introduction and usage of CADENCE, Spectre RF tool, LNA, mixer design and simulation using Candence Spectre RF

Text Books:

1. John M. W. Rogers, John W. M. Rogers, Calvin Plett, "Radio Frequency Integrated Circuit Design", Second Edition, Artech house 2010.
2. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Second Edition, Cambridge University Press, 2004.

Reference Books:

1. Robert Caverly, "CMOS RFIC Design Principles" Artech House, 2007.
2. Habil. MBA Frank Ellinger, "Radio frequency integrated circuits and technologies", Springer-Varlag Berlin Heidelberg, 2007.

Course Contents and lecture schedule:

Sl.No:	Topic	No. of Lectures
	Radio frequency Integrated Circuits	
	Introduction	
1	Transceiver architectures-Role of RFICs in Transceiver	1
1.1	Lower frequency design and RFIC design-issues	2
1.2	Active/Passive device technologies for RFIC implementations	1
1.3	Modern RFIC chip sets for current wireless standards	1
1.4	Packaging techniques	1
1.5	High frequency measurement	1
2	**RFIC design issues**	
2.1	Noise	3
2.1	Linearity	2
2.2	Distortion in RF circuits	1
2.3	Dynamic range	1
2.4	Filtering issues, selectivity, and sensitivity	1
3	**Design of Passive circuit elements in IC**	

Sl.No:	Topic	No. of Lectures
	technologies	
3.1	**Introduction**	1
3.2	Sheet resistance, Poly resistors, diffusion resistors	2
3.3	On chip spiral inductors	2
3.4	design of Transformers	1
3.5	Multilevel inductors	3
3.6	on chip transmission lines	1
4	**Design of active circuit in IC technologies**	
4.1	Low noise amplifier	4
4.2	Power amplifier	3
4.3	Mixers	3
5	**Computer aided design of RFICs**	
5.1	Introduction to Commercial packages	1
5.2	Introduction and usage of CADENCE	1
5.3	Spectre RF tool	1
5.4	LNA design and simulation using Spectre RF	3
5.5	Mixer design and simulation using Spectre RF	3
	Total Number of Hours	**44**

Course Designers:

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Sub code	Lectures	Tutorial	Practical	Credit
DCU	3	-	-	3

DCU Satellite Remote Sensing 3:0

Preamble:

The course “Satellite Remote Sensing” is offered in the seventh semester. his course explores the concepts, data capturing mechanisms, data types and general processes of remote sensing technology.

Program Outcomes addressed

a. Graduates will understand the concepts of remote sensing and satellite images with different characteristics.

b. Graduates will demonstrate skills to use remote sensing software to interpret and analyze satellite images.

c. Graduates will be capable of choosing appropriate satellite data for different applications.

Competencies: At the end of the course, the student will be able to

1. Describe the electromagnetic remote sensing process and the radiation principles involved.
2. Understand how the satellite data are captured from the space and what are the platforms used for data acquiring process?
1. Describe the different types remote sensing data and their properties.
2. Describe the role of spatial, spectral ,temporal and radiometric resolutions on Satellite data interpretation and processes.
3. List the common data processing techniques of remote sensing data.
4. Discuss how the remote sensing data can be integrated with geographical information systems.

Tools

Matlab, ENVI, ERDAS IMAGINE, Arc GIS Software.

Assessment Pattern

	Bloom’s Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	40	30	25
2	Understand	30	30	25
3	Apply	30	30	30
4	Analysis	0	10	20
5	Evaluate	0	0	0

6	Create	0	0	0

Course level learning Objectives

Remember

1. What is atmospheric window?
2. Define : spectral reflectance of earth surface features.
3. What are the different types of remote sensing data?
4. What are the properties of SAR data?
5. Explain the across track scanning mechanism.
6. List out the elements used for satellite image interpretation.

Understand

1. The visible band play a critical role in many remote sensing systems.Why?
2. Differentiate diffuse and specular reflectance.
3. Compare across track and along track scanning methods.
4. Why hyper spectral scanning data is preferred for mineral mapping applications?
5. What are the advantages of microwave sensing over optical sensing?

Apply

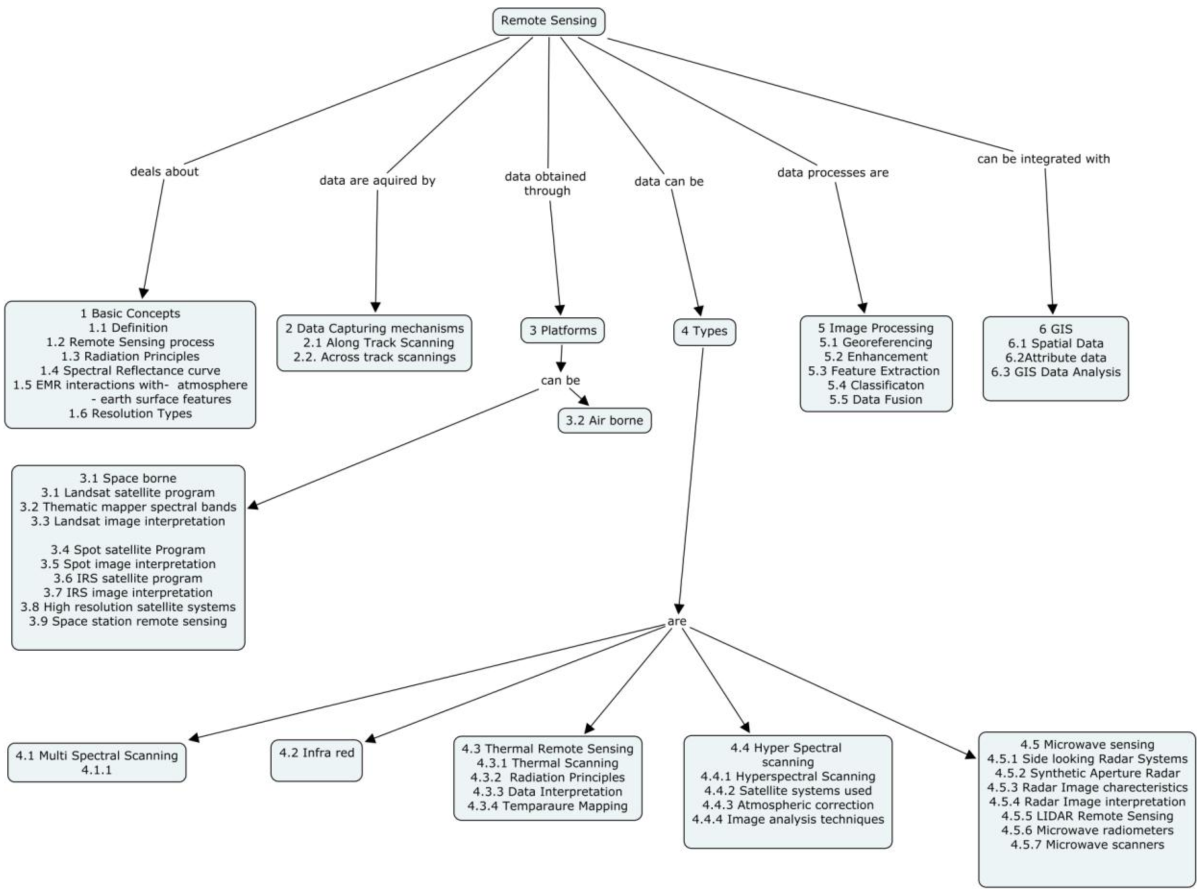
1. Find the spatial resolution of a scanner having a 2.5 milliradian IFOV and operated from 1000m above the terrain.
2. How do we apply histogram algorithm in removal of line striping in a satellite data.
3. A given SLAR system has a 2.0 mrad antenna beamwidth. Determine the azimuth resolution of the system at ranges of 5 and 10 km.
4. A side looking aperture radar transmits pulses over a duration of 0.2 microsecond. Find the resolution of the system at a depression angle of 45 degree.

Analyze

1. If a multi spectral scanning image with a spatial resolution of 23m is given, how will you identify the earth surface features.
2. Assume, you are given MSS, Hyper spectral, SAR and LIDAR satellite data. What will be the appropriate classification strategies required to process each data. Justify your answer.
3. Object Oriented classification techniques are preferred for high resolution data processing. Comment.

4. Given a optical data and SLAR data, what are the interpretation elements referred to identify urban features.

Concept Map:



Basic concepts: Definition, Remote sensing process, Radiation principles, Spectral reflectance curve, EMR interactions with-atmosphere-earth surface features, Resolution types. **Data capturing mechanisms:** Along track scanning, Across track scannings. **Platforms:** Space borne, Landsat satellite program, Thematic mapper spectral bands, Landsat image interpretation, Spot satellite program, Spot image interpretation, IRS satellite program, IRS image interpretation, High resolution satellite system, Space station remote sensing, Air borne. **Types:** Multi spectral scanning, Infrared, Thermal remote sensing, Thermal scanning, radiation principles, Data interpretation, temperature mapping, Hyper spectral scanning, satellite systems used, Atmosphere correction, Image analysis techniques. Microwave sensing, Side looking radar systems, Synthetic aperture radar, Radar image characteristics, Radar image interpretation, LIDAR remote sensing, Microwave radiometers, Microwave scanners. **Image processing:** Georeferencing, Enhancement, Feature extraction, Classification, Data fusion. **GIS**: Spatial data, Attribute data, GIS data analysis.

Text Book:

1. Thomas M.Lillesand, Ralph W.Kiefer, "Remote Sensing And Image Interpretation", Fifth Edition, 2004.

Reference Books:

1. John R. Jensen, "Remote Sensing Of The Environment – An Earth Resource Perspective", Pearson Education Series, 2003.
2. Rafael C.Gonzalez, Richard E.Woods, "Digital Image Processing" (3rd Edition) Rafael C.Gonzalez, Richard E.Woods, Prentice Hall, 2007.
3. Robert A. Schowengerdt, Remote Sensing Models & Methods For Image Processing, III Edition, 2004.
4. J. A. Richards "Remote Sensing Digital Image Analysis: An Introduction", Second Revised Edition, 1993.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Basic concepts**	
1.1	Definition	1
1.2	Remote Sensing Process	1
1.3	Radiation Principles	1
1.4	Spectral Reflectance Curve	1
1.5	EMR Interactions with-atmosphere-earth surface features	1
1.6	Resolution Types	1
2	**Data capturing Mechanisms**	
2.1	Along Track Scanning	1
2.2	Across track scanning	.5
3	**Platforms**	
3.1	Space borne	.5
3.1.1	Landsat satellite program	.5
3.1.2	Thematic mapper spectral bands	1

No.	Topic	No. of Lectures
3.1.3	Landsat image interpretation	1
3.1.4	Spot satellite program	1
3.1.5	Spot image interpretation	1
3.1.6	IRS satellite program	1
3.1.7	IRS image interpretation	1
3.1.8	High resolution satellite system	1
3.1.9	space station remote sensing	.5
3.2	Air borne	1
4	**Types**	
4.1	Multi spectral, Infrared scanning	.5
4.2	Thermal remote sensing, Thermal scanning, Radiation principles	1
4.3	Data interpretation, Temperature mapping, Hyper spectral scanning	1
4.4	Hyper spectral scanning, Satellite systems used, atmospheric correction	1.5
4.5	Image analysis techniques.	1
4.6	Microwave sensing, side looking radar systems, synthetic aperture radar	1
4.7	Radar image characteristics, radar image interpretation,	.5
4.8	LIDAR remote sensing	1
4.9	Microwave radiometers	1.5
4.10	Microwave scanners	3
5	**Image processing**	
5.1	Georeferencing	.5
5.2	Enhancement	1.5
5.3	Feature extraction	1
5.4	Classification	2
5.5	Data fusion	1
6	**GIS**	
6.1	Spatial data	1
6.2	Attribute data	1
6.3	GIS data analysis	2

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
DCV	3	-	-	3

DCV BIO-MEDICAL INSTRUMENTATION 3:0

Preamble: The proposed course is offered in the sixth semester. The course is designed to make the student acquire conceptual knowledge of the physiologicalsystems of the human body and relate them to the parameters that have clinical importance. Thefundamental principles of equipment that are actually in use at the present day are introduced.

Program Outcomes addressed:

a. Graduates will understand the basic need of biomedical instrumentation.

b. Graduates will understand the Purpose of biomedical instrumentation.

c. Graduates will demonstrate the working of different biomedical instruments.

d. Graduates will understand the physiology of biomedical system and different methods in the design of biomedical instruments.

e. Graduates will provide latest knowledge of medical assistance/techniques and therapeutic equipments.

Competencies: At the end of the course, students will be able to

1. Provide an acquaintance about bio-medical applications of different transducers.
2. Provide the latest ideas on devices of non – electrical parameters.
3. Apply the modern methods of imaging techniques in biomedical instrumentation.
4. Demonstrate various modern diagnostic and assisting devices

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3	End-semester examination
1	Remember	40	30	20	30
2	Understand	40	30	40	30
3	Apply	20	40	40	40
4	Analyze	0	0	0	0
5	Evaluate	0	0	0	0
6	Create	0	0	0	0

Course Level Learning Objectives

Remember

1. Define Transducers.
2. What are microelectrodes?
3. Explain in detail about different types of Amplifiers.
4. Define cardiac output?
5. What is Spirometer?
6. What is fibrillation

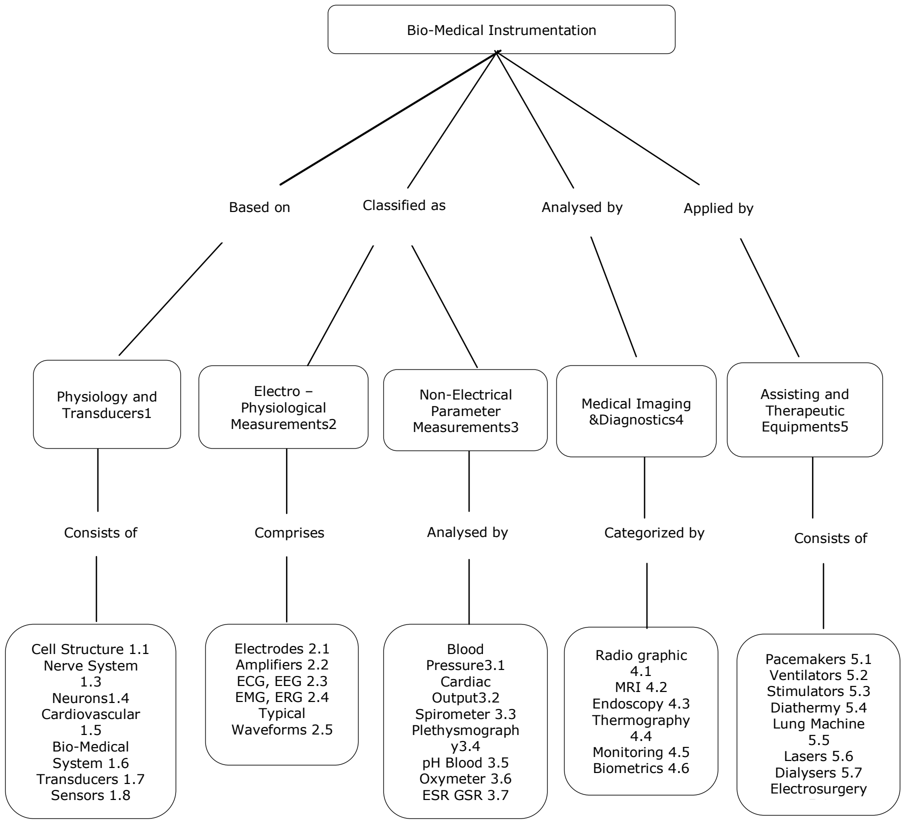
Understand

1. What is the function of Cell?
2. What are resting and action potentials?
3. What is the frequency range of ECG, EEG, and EMG waves?
4. What is called Respiratory Rate?
5. What is the pH value of arterial blood and venous blood?
6. What is the use of Defibrillator?

Apply

1. Relate the relationship between the action potential and muscle contractionwith relevant graph.
2. Describe in detail Central and Peripheral nervous system
3. Describe the medical use of chopper amplifier? Draw the diagram of mechanical chopper amplifier and explain its working.
4. Draw the ECG curves for Normal adult, Myocardialinfraction, Coronary insufficiency and Ventricular fibrillations.
5. Determine the working principle of an electromagnetic type blood flow meter
6. List the principle of Ultrasonography and mention its types.

Concept Map



Syllabus

Physiology and Transducers: Cell and its structure, Resting and Action Potential, Nervous system: Functional organisation of the nervous system, Structure of nervous system, Neurons – Synapse, Transmitters and Neural Communication, Cardiovascular system, respiratory system, Basic components of a bio-medicalsystem, Transducers - Ultrasonic transducers, Temperature measurements - Fiber optic temperature sensors.**Electro – Physiological Measurements:** Electrodes, Limb electrodes, Floating electrodes, pregelled disposable electrodes, Micro, needle and surface electrodes, Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier, ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms. **Non -Electrical Parameter Measurements:** Measurement of blood pressure, Cardiac output, Heart rate, Heart sound, Pulmonary function measurements, Spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers: pH of blood, Measurement of blood pCO2, pO2, finger-tip oxymeter, ESR, GSR measurements.**Medical Imaging and Diagnostics:** Radio graphic and fluoroscopic techniques, Computer tomography, MRI, Ultrasonography, Endoscopy, Thermography, Different types of biotelemetry systems and patient monitoring, Introduction to Biometric systems. **Assisting and Therapeutic Equipments:** Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart –Lung machine, Lasers, Audio meters, Dialysers, Lithotripsy, Electro Surgery.

Text Book:

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd.,2003.
2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002 / PHI.

Reference Books:

1. Joseph J. Carr, John M. Brown, 'Introduction to Biomedical Equipment Technology', Fourth Edition, Pearson.
2. Shakti Chatterjee, Aubert Miller, 'Bio-Medical Instrumentation Systems', Cengage Learning, 2010.
3. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation',Universities press (India) Ltd, Orient Longman ltd, 2000

Lecture Plan:

No.	Topic	No. of Lectures
1	**Physiology and Transducers**	
1.1	Cell and its structure	1
1.2	Resting and Action Potential	1
1.3	Nervous system: Functional organisation of the nervous system, Structure of nervous system	2
1.4	Neurons – Synapse, Transmitters and Neural Communication	1
1.5	Cardiovascular system, respiratory system	1
1.6	Basic components of a bio-medicalsystem	1
1.7	Transducers - Ultrasonic transducers	1
1.8	Temperature measurements - Fiber optic temperature sensors	1
2	**Electro – Physiological Measurements**	
2.1	Electrodes, Limb electrodes, Floating electrodes, pregelled disposable electrodes, Micro, needle and	2

	surface electrodes	
2.2	Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier	2
2.3	ECG, EEGLead systems and recording methods	2
2.4	EMG, ERGLead systems and recording methods	2
2.5	Typical waveforms	1
3.	**Non -Electrical Parameter Measurements**	
3.1	Measurement of blood pressure	2
3.2	Cardiac output, Heart rate, Heart sound	1
3.3	Pulmonary function measurements, Spirometer	1
3.4	Photo Plethysmography, Body Plethysmography	2
3.5	Blood Gas analyzers: pH of blood	2
3.6	Measurement of blood pCO2, pO2, Finger-tip oxymeter	2
3.7	ESR, GSR measurements	2
4	**Medical Imaging and Diagnostics**	
4.1	Radio graphic and fluoroscopic techniques	2
4.2	Computer tomography, MRI	2
4.3	Ultrasonography, Endoscopy	1
4.4	Thermography	1
4.5	Different types of biotelemetry systems and patient monitoring	2
4.6	Introduction to Biometric systems	1
5	**Assisting and Therapeutic Equipments**	
5.1	Pacemakers	1
5.2	Defibrillators, Ventilators	1
5.3	Nerve and muscle stimulators	1
5.4	Diathermy	1
5.5	Heart –Lung machine	2
5.6	Lasers, Audio meters	2
5.7	Dialysers, Lithotripsy	2
5.8	Electro Surgery	1

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
DGD	3	0	-	3

DCW CONTROL SYSTEMS 3:1

Preamble:

Control Systems plays vital role in the advance of engineering and science. Automatic control has become an important and integral part of modern manufacturing and industrial processes. Advances in the theory and practice of automatic control provide the means for attaining optimal performance of dynamic systems improving productivity and reducing repetitive manual operation. The study of control system prepares the student for early productivity upon entering industrial practice. The prerequisite for this course is 'D31: Mathematics-III', 'D33: Signal Processing' and 'D46 Digital Signal Processing'.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies

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

1. Understand the advantages and disadvantages of open loop system and closed loop system.
2. Develop a mathematical model for a given physical system.
3. Develop a state space model of the given system.
4. Determine the unit impulse and unit step responses of first, second and higher order closed loop systems.
5. Generate the root loci of closed loop systems by hand and by use of software packages like MATLAB and LabVIEW.
6. Design and compensation of single-input-single-output linear time invariant control systems.
7. Investigate absolute and relative stability of linear closed loop system from the knowledge of open loop frequency response characteristics such as Bode diagram, polar plot and Nyquist plot.

Methods

1. Differential equations

2. Laplace Transforms
3. Bode plot
4. Polar plot

Tools: MATLAB, LabVIEW

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3	End-semester examination
1	Remember	10	10	0	0
2	Understand	20	20	20	20
3	Apply	40	30	30	30
4	Analyze	30	30	30	30
5	Evaluate	0	0	0	0
6	Create	0	10	20	20

Course Level Learning Objectives

Remember

1. Define loop gain.
2. List the properties of signal flow graph.
2. With reference to time response of a control system, define peak time.
3. State any two limitation of Routh stability criterion.
4. Define state and state variables
5. What are the advantages of closed loop control system?

Understand

1. Consider the differential equation $\frac{d^2y(t)}{dt^2}+2\frac{dy(t)}{dt}+y(t)=\delta(t)$ with $y(t)\big|_{t=0^-}=-2$ and $\frac{dy(t)}{dt}\Big|_{t=0^-}=0$. Find the numerical value of $\frac{dy(t)}{dt}\Big|_{t=0^+}$
2. The transfer function of a compensator is given as $G_c(s)=\frac{s+a}{s+b}$. For what value of a and b $G_c(s)$ becomes a lead compensator?
3. The transfer function of a compensator is given as $G_c(s)=\frac{s-a}{s+b}$. For what values of a and b $G_c(s)$ becomes a lead compensator? And when the phase of the lead compensator is maximum?

4. The unilateral Laplace transform of $f(t)$ is $\frac{1}{s^2+s+1}$, find the unilateral Laplace transform of $tf(t)$

5. The open loop transfer function of a system is given by $G(s)H(s)=k\frac{s(s+1)}{(s+2)(s+3)}$ Draw the root locus plot of the system.

6. How can we identify resonance peak and bandwidth from the Nichols chart?

Apply

1. The open loop transfer function of the unity feedback control system is given by $G(s)=\frac{K}{s(sT+1)}$ where K and T are positive constants. By what factor should the amplifier gain be reduced so that the peak over shoot of unit step response of the system is reduced from 75% to 25%.

2. For the following transfer function $G(s)=\frac{K(s+3)}{s(s+1)(s+2)}$ sketch the Bode magnitude plot by showing slope contribution from each pole and zeros.

3. For an unity feedback system with closed loop transfer function $\frac{G(s)}{1+G(s)}$. Derive the equations for the locus of constant M circles and constant N circles.

4. Draw the Nyquist plot for the system whose open loop transfer function is $G(s)H(s)=\frac{K}{s(s+2)(s+10)}$. Determine the range of K for which the closed loop system is stable.

5. The state space representation of a system is given below:

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u, y = \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

   Obtain the transfer function.

Analyze

1. The state model matrices of a system are given below

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix}$$

Comment on the observability of the system using Gilbert's test.

2. Find the controllability of the system described by the following equation

$$X = \begin{bmatrix} -1 & -1 \\ 2 & -1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U(t)$$

3. Discuss the effect of derivative control on the performance of a second order system.
4. Draw the approximate root locus diagram for a closed loop system whose loop transfer function is given by $G(s)H(s) = \dfrac{K}{s(s+5)(s+5)}$.

   Comment on the stability.
5. The open loop transfer function of a control system is

$$G(s)H(s) = \frac{10}{s(1+0.5s)(1+0.1s)}$$

   a. Draw the Bode plot and determine gain crossover frequency and phase and gain margins
   b. A lead compensator with transfer function $D(s) = \dfrac{(1+0.23s)}{(1+0.023s)}$ is now inserted in the forward path. Determine the new gain cross over frequency and phase and gain margins. Comment upon the effects of lead compensation on system performance.

6. A unity-feedback system has the following open loop frequency response

ω (rad/sec)	2	3	4	5	6	8	10
$\lvert G(j\omega) \rvert$	7.5	4.8	3.15	2.25	1.7	1.0	0.64
$\angle G(j\omega)$	-118^0	-130^0	-140^0	-150^0	-157^0	-170^0	180^0

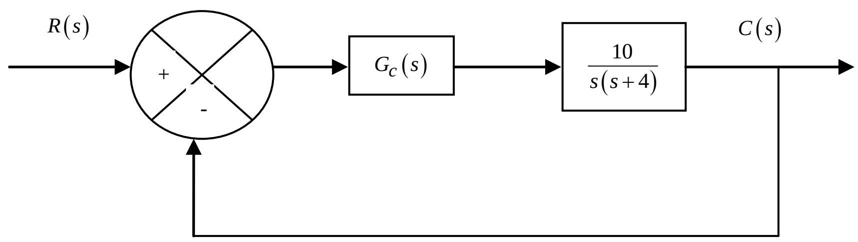
   a. Using Bode plot, evaluate the gain margin and phase margin of the system
   b. Determine the change in gain required so that the gain margin of the system is 20 dB.
   c. Determine the change in gain required so that the phase margin of the system is 60^0.

Create

1. A unity feedback type-0 system with dead time has a forward path transfer function $G(s)=\dfrac{10e^{-0.02s}}{(0.5s+1)(0.1s+1)(0.05s+1)}$

   Design a suitable compensation scheme so that the system acquires damping ratio of 0.4 without loss of steady state accuracy. Use only frequency domain methods.

2. Consider the control system shown in figure. design a lag compensator $G_c(s)$ such that the static velocity error constant K_v is 50 sec^{-1} without appreciably changing the location of the original closed loop poles, which are at $s=-2\pm j\sqrt{6}$



3. The uncompensated open loop transfer function is $G(s)=\dfrac{K}{s^2(s+1.5)}$

   Design a suitable compensator in time domain to meet the following specification:

   Settling time, $t_s < 5\text{sec}$

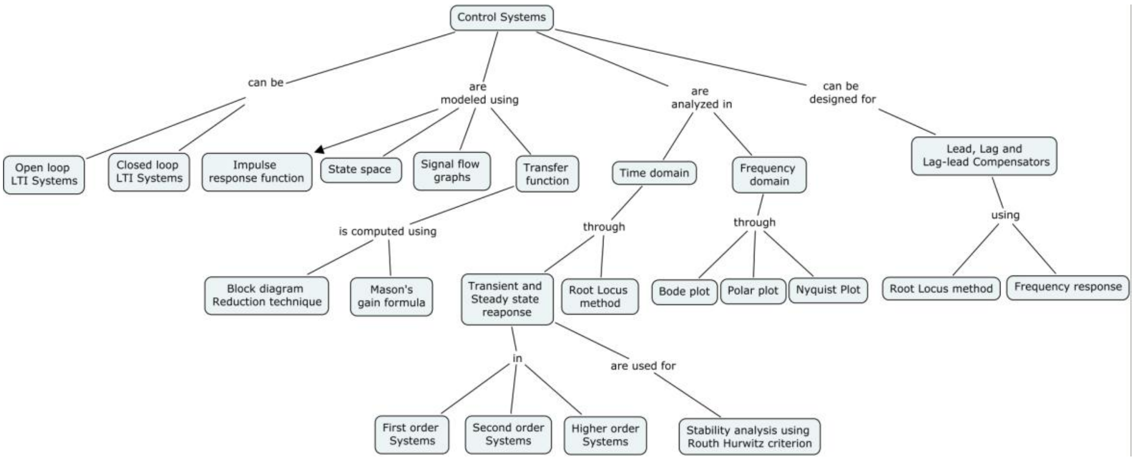
   Peak overshoot for step input=25%

4. The open loop transfer function is $G(s)=\dfrac{K}{s(s+1)(0.5s+1)}$

   Design a lag compensator in frequency domain to meet the following specification:

   i) Static velocity error constant $K_v = 5/\text{sec}$
   ii) Phase margin of atleast 40^0
   iii) Gain margin of atleast 10 dB

Concept Map



Course Contents

Syllabus: Introduction Open loop LTI systems, Closed loop LTI systems **Mathematical Modelling of Control systems** Transfer function and Impulse function, Block diagram reduction, Masons gain formula, Modelling in state space, State space representation, Signal flow graphs **Time Domain Analysis-Transient and steady state response** First order systems, Second order Systems, Higher order systems, Routh's stability criterion, Root locus plots **Frequency Domain Analysis** Bode diagram, Polar plots, Nyquist stability criterion, Stability Analysis **Control System Design by Root Locus Method** Lead Compensation, Lag Compensation, Lag-Lead Compensation **Control System Design by Frequency Response** Lead Compensation, Lag Compensation, Lag-Lead Compensation

Course Contents

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Open loop LTI systems	1
1.2	Closed loop LTI systems	1
2.	**Mathematical Modelling of Control systems**	
2.1	Transfer function and Impulse function	2
2.2	Block diagram reduction	2
2.3	Masons gain formula	2
2.4	Modelling in state space	2

2.5	State space representation	2
2.6	Signal flow graphs	2
3.	**Time Domain Analysis-Transient and steady state response**	
3.1	First order systems	2
3.2	Second order systems	2
3.3	Higher order systems	2
3.4	Routh's stability criterion	2
3.5	Root locus plots	2
4.	**Frequency Domain Analysis**	
4.1	Bode diagram	3
4.2	Polar plots	2
4.3	Nyquist stability criterion	2
4.4	Stability Analysis	2
5.	**Control System Design by Root Locus Method**	
5.1	Lead Compensation	2
5.2	Lag Compensation	2
5.3	Lag-Lead Compensation	2
6	**Control System Design by Frequency Response**	
6.1	Lead Compensation	2
6.2	Lag Compensation	2
6.3	Lag-Lead Compensation	2

Text Book:

1. Katsuhiko Ogata, "Modern Control Engineering", 4th Edition, Prentice Hall,2002

Reference books:

1. M Gopal, "Control Systems Principles and Design", Tata McGraw Hill,2002,
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
3. Nagrath & Gopal, "Modern Control Engineering", New Ages International.

Course Designers:

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CURRICULUM AND DETAILED SYLLABI

FOR

B.E. DEGREE (Electronics and Communication Engg.) PROGRAM

SIXTH SEMESTER – GENERAL ELECTIVE

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2008-2009 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2000 certified
Autonomous Institution affiliated to Anna University)

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Sub code	Lectures	Tutorial	Practical	Credit
DGA	3	-	-	3

DGA Consumer Electronics 3:0

Preamble: Electronics has been growing exponentially in terms of new technologies, ideas, principles and consumer applications. It is of a concern that engineer of any discipline as a consumer needs to know the working principle and handling of versatile consumer electronic equipments. The proposed course 'D6AG Consumer Electronics' , offered as an open elective course by ECE Department will be made available to students of all branches. The course aims at understanding of various electronic audio and video devices and home/office systems. Further this subject will introduce the students with working principles, block diagram, main features of consumer electronics gadgets/goods/devices like audio-systems, CD systems and TV

Program Outcomes addressed:

a. Graduates will demonstrate knowledge of and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering ze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies:

1. Know about various electronic audio and video devices and systems.
2. Understand working principles and main features of consumer electronics gadgets/goods/devices.
3. Understand the home and commercial audio-systems, Disk systems. TV, VCR etc.
4. Know the working of digital clocks, calculators microwave ovens, photostat machines computing systems etc
5. Develop the capabilities of fault diagnosing and rectification of consumer electronic gadgets in a systematic way

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	30	30	30
2	Understand	40	40	50
3	Apply	30	30	20
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. Mention important benefits of electronic tuning.
2. What is MPEG layer 3?
3. What are the key functions of EPABX?
4. What do you mean by NTSC?
5. Mention key advantages PAL system?
6. What are the drawbacks of magnetic tape recording?
7. Define throughput.

Understand

1. How does DVD Player perform skip and search operation?
2. Why do you require 25 frames per second in a TV?
3. What are the advantages of digital recording system
4. Compare LCD and LED TV systems circuit switching with packet switching
5. Identify associated problems of paper jamming in printer
6. Classify print cartridges.

Syllabus

Audio Systems: Microphones, their types; Carbon, velocity, crystal, condenser, cordless etc. Loud Speaker: Direct radiating, horn loaded woofer, tweeter, mid range, multi-speaker system, baffles and enclosures. Sound recording on magnetic tape, its principles, block diagram and tape transport mechanism, Digital sound recording on tape and disc, CD system, Hi-Fi system, pre-amplifier, amplifier and equalizer system, stereo amplifiers , public address systems, Graphics Equalizer, speed Synthesizer, Electronic tuning. **Video Systems**: B& W TV, color TV and HD TV systems, LCD, LED, PLASMA Systems, Electronic cameras, VCR, VCP, CD systems, Memory diskettes, Discs and drums. Dolby noise reduction digital and analog recording. Digital projection systems (LCD, DLP, SVGA to UXGA system) Block diagram and principles of working of cable TV and DTH, cable TV using internet. **Home and office Systems**: Conventional telephone block diagram, Conventional telephone troubles and solutions, Static and phone noise checks, Low sound or distortion, DTMF touch pad problems, Basic cordless phone operation, Cordless phone base unit circuitry, Portable handset unit, Cordless phone troubles and correction hints, , cellular phone system, cell phone operation, Transmit/receive section, CPU and memory logic, PocketNet portables, Ultrasonic remote transmitter, IR remote-control transmitter, Construction and working principles of Dot Matrix Printer, Inkjet Printer, Laser Printer, Printer Controller, Concentric Interface, Signals from PC to Printer & Printer to PC. Switching Systems: Switching systems for telephone exchange , PAB EPABX , modular telephones, Telephone massage recording concepts**.** Facsimile, Xerography: Xerographic Process, Extension to a dynamic copier, Digital Clocks: Working, LSI Digital Clocks, **Compliance:** Product safety and liability issues; standards related to electrical safety and standards related to fire hazards, e.g., UL and VDE. EMI/EMC requirements and design techniques for compliance, e.g. ESD, RF interference and immunity, line current harmonics and mains voltage surge.

Text Book:

Bali S.P , "Consumer Electronics", Pearson Education, 2007

Reference Books:

1. K. Blair, Benson "Audio Engineering Hand book", 2001
2. R.R Gulati, "Colour Television-principles & practice",Wiley Eastern Limited, New Delhi, 2008

3. R.R Gulati, "Complete Satellite & Cable Television", New age International Publisher, 2008
4. RC Vijay, "Colour Television Servicing", BPB Publication, New Delhi, 2007
5. A.K. Maini, "Colour Television & Video Technology", CSB Publishers, 2005
6. S.P. Sharma, "VCR-principles, maintenance & repair", Tata Mc Graw Hill, New Delhi, 2003
7. A.Dhake, "Colour TV", 2001
8. Service Manuals, BPB Publication, New Delhi, 2000

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Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Audio systems**	
1.1	Microphones, their types ; Carbon, velocity, crystal, condenser, cordless etc.	1
1.2	Loud Speaker: Direct radiating, horn loaded woofer,	1
1.3	Tweeter, mid range, multi-speaker system	1
1.4	baffles and enclosures.	1
1.5	Sound recording on magnetic tape, its principles,	1
	block diagram and tape transport mechanism	
1.6	Digital sound recording on tape and disc, CD system,	1
1.7	Hi-Fi system, pre-amplifier, amplifier and equalizer system, stereo amplifiers	1
1.8	public address systems, Graphics Equalizer, speed Synthesizer, Electronic tuning.	1
2	**Video Systems** :	
2.1	Overview of video systems, Black & White TV	1
2.2	color Television system, Block diagram of transmitter and receiver	
2.3	Audio and video sections	1
2.4	High Definition TV systems	1
2.5	LCD, LED, PLASMA Systems	1
2.6	Electronic cameras vidicon, orthicon, 3CCD cameras	1

2.7	VCR, CD systems, Memory diskettes, Discs and drums.	2
2.8	Dolby noise reduction digital and analog recording.	1
2.9	Digital projection systems (LCD, DLP, SVGA to UXGA system)	2
2.10	Block diagram and principles of working of cable TV and DTH, set top box, cable TV using internet.	
3.	**Home and office Systems**	
3.1	Conventional telephone block diagram and working	1
3.2	Conventional telephone troubles and solutions, Static and phone noise checks, Low sound or distortion, DTMF touch pad problems	2
3.3	Basic cordless phone operation, Cordless phone base unit circuitry, Portable handset unit.	1
3.4	Cordless phone troubles and correction hints	1
3.5	cellular phone system, cell phone operation	2
3.6	Transmit/receive section, CPU and memory logic, PocketNet portables	2
3.7	Ultrasonic remote transmitter, IR remote-control transmitter,	1
3.8	Construction and working principles of Dot Matrix Printer, Inkjet Printer	2
3.9	Laser Printer, Printer Controller, Concentric Interface, Signals from PC to Printer & Printer to PC.	
3.10	Switching Systems: Switching systems for telephone exchange.	1
3.11	PABX, EPABX, modular telephones, Telephone massage recording concepts**.**	2
3.12	Facsimile: Block diagram and Working principle of FAX	1
3.13	Xerography: Xerographic Process, Extension to a dynamic copier	1
4	**Compliance:**	1
4.1	Product safety and liability issues	
4.2	standards related to electrical safety	1
4.3	Standards related to fire hazards, e.g., UL and VDE.	1
4.4	EMI/EMC requirements and design techniques for compliance	
4.5	ESD, RF interference and immunity	1
4.6	Line current harmonics and mains voltage surge.	1

Course Designer:

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Sub code	Lectures	Tutorial	Practical	Credit
DGB	3	-	-	3

DGB Multimedia Systems 3:0

Preamble: Multimedia has become an indispensable part of modern computer technology. In this course, students will be introduced to principles and current technologies of multimedia systems. Issues in effectively representing, processing, and retrieving multimedia data such as sound and music, graphics, image and video will be addressed. Latest Web technologies and some advanced topics in current multimedia research will also be discussed.

Program Outcomes addressed:

a. Graduates will demonstrate knowledge of and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering ze problems.

k. Graduate who can participate and succeed in competitive examinations.

Competencies:

1. The ability to: describe different realizations of multimedia tools and the way in which they are used;
2. To understand the structure of the tools in the light of low-level constraints imposed by the adoption of various QoS schemes (bottom up approach);
3. To understand the effects of scale and use on both presentation and lower-level requirements
4. To state the properties of different media streams; compare and contrast different network protocols
5. To describe mechanisms for providing QoS guarantees in the network.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	30	30	20
2	Understand	40	30	40
3	Apply	30	30	20
4	Analyze	0	10	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. Mention key advantages DPCM systems?
2. What is hypermedia?.
3. What is layer 3 in MPEG coding?
4. What are the drawbacks of adaptive DPCM system?
5. Define Nyquist theorem
6. What do you mean by NTSC system?

Understand

1. Identify associated problems with packet loss?
2. Why do you require 25 frames per second in a TV?
3. What are the advantages of digital recording system
4. Compare JPEG and JPEG 2000.
5. Classify watermarking techniques?
6. How does progressive scan get employed?

Apply

1. If the storage requirement is 4024 bytes and 1024 bytes before and after compression, calculate compression ratio?
2. Find Redundancy if C_R = 1.4 ?
3. Compute the entropy of a 2D data matrix of size 4 X 4 filled, one half with one value and the other half with another value.

Syllabus:

Introduction and Overview: Introduction to Multimedia, Hypermedia, Introduction to Data Compression, Discrete Cosine Transform, Coefficient Coding, **Audio Coding:** Analogue and Digital Form, Sample rate (bits/sample), Nyquist rate, CD audio Compression Techniques, Pulse Code modulation, DPCM, Adaptive Differential PCM, Delta modulation schemes, GSM/Code Excited Linear Prediction, MP3/Advanced audio coding, **Video:** Interlacing vs progressive scan – Introduction to TV standards, PAL, NTSC systems, SECAM systems, Video digitization, Raw Image Representation:- RGB, YUV411, YUV422, Indexed color vs true colour, Image Compression:- GIF, JPEG, Motion JPEG, Video Compression: - Motion estimation - Motion compensation, Video Compression Schemes: H.261, H.263, Video Compression Schemes: H.261, H.263, MPEG 1, MPEG 2, MPEG 4, Introduction to MPEG 7, **System Streams:** MPEG program and transport streams H.221 framing (for ISDN), IP-based transport: - packet loss- TCP vs UDP, Application-level framing – RTP, DCCP, Audio/Video synchronization, **Describing Network Traffic:** Traffic patterns , Application requirements, QoS parameters and descriptions Queue management, **IP Multicast:** Service Model, Layered transmission, **Digital rights management:** Legal issues, Watermarking

Text Books:

1. Ze-Nian Li and Mark S. Drew, "Fundamentals of Multimedia", Pearson Prentice Hall, October 2003.
2. K. Rammohanarao, Z. S. Bolzkovic and D. A. Milanovic, "Multimedia Communication Systems", Prentice Hall, May 2002.
3. Yao Wang, Joern Ostermann, and Ya-Qin Zhang, "Video Processing and Communications", Prentice Hall, 2002.
4. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards", Addison-Wesley, 2001.

Reference Books*:*

1. Stephen McGloughlin, "Multimedia: Concepts and Practice", November 2000, Prentice Hall
2. Nigel Chapman and Jenny Chapman, "Digital Multimedia", Wiley, 2000.
3. A. Puri, T. Chen, "Multimedia Systems, Standards, and Networks", Marcel Dekker, 2000
4. Guojun Lu, "Multimedia Database Management Systems", Artech House Publishers, October 1999.

5. R. Steinmetz and K. Nahrstedt, "Multimedia: Computing, Communications and Applications", Prentice Hall, 1997.
6. P. K. Andleigh and K. Thakrar, "Multimedia Systems Design", Prentice Hall, 1996.
7. V. Bhaskaran and K. Konstantinides, "Image and Video Compression Standards: Algorithms and Architecture", 2nd ed., Kluwer Academic Publishers, 1997.
8. Latest publications in multimedia related conferences and journals.

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Introduction and overview**	
1.1	Introduction to Multimedia, Hypermedia	1
1.2	Introduction to Data compression	1
1.3	Discrete Cosine Transform, Coefficient Coding	2
2	**Audio Coding**	
2.1	Analogue and digital form: - Sample rate, bits/sample	1
2.2	Nyquist rate, CD audio Compression techniques:	
2.3	Pulse code modulation, DPCM	1
2.4	Adaptive Differential PCM, Delta modulation schemes	1
2.5	GSM/Code Excited Linear Prediction	2
2.6	MP3/Advanced audio coding	2
3.	**Video**	
3.1	Interlacing vs progressive scan – Introduction to TV standards	1
3.2	PAL, NTSC systems	2
3.3	SECAM systems, Video digitization	1
3.4	Raw Image Representation:- RGB, YUV411	1
3.5	YUV422, Indexed color vs true colour	2
3.6	Image Compression:- GIF, JPEG, Motion JPEG:	2
3.7	Video Compression: - Motion estimation - Motion compensation	3

3.8	Video Compression Schemes: H.261, H.263	2
3.9	MPEG 1, MPEG 2, MPEG 4, Introduction to MPEG 7	
4	**System Streams**	1
4.1	MPEG program and transport streams H.221 framing (for ISDN)	2
4.2	IP-based transport: - packet loss- TCP vs UDP	2
4.3	Application-level framing – RTP, DCCP	2
4.4	Audio/Video synchronization	2
5	**Describing Network Traffic**	1
5.1	Traffic patterns , Application requirements:	1
5.2	QoS parameters and descriptions Queue management	2
6	**IP Multicast**	
6.1	Service Model	2
6.2	Layered transmission	2
7	**Digital rights management**	
	Legal issues, Watermarking	3

Course Designer:

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Sub Code	Lectures	Tutorial	Practical	Credit
DGC	3	-	-	3

DGC Telecom Systems **3:0**

Preamble: The objective of this course is to introduce the concepts of digital communication systems, satellite communication systems, Radio Detection and Ranging (RADAR) systems and wireless communication systems & Standards. In this course, mathematical techniques have been kept relatively at modest level, making it accessible to any discipline of Engineering.

Programme Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

Competencies: At the end of the course, a student will be able to

1. Describe a simplified communication system model in terms of wavelength, frequency, RF spectrum, modulation and demodulation.
2. Determine the communication link budget analysis and apply it to Radar systems.
3. Explain a basic digital communication system using binary encoding
4. Determine the signal to noise ratio (SNR) at the input of a digital communication receiver and SNR at the output of the detector.
5. Describe the general operation of Satellite communication system and determine the SNR for both the uplink and downlink.
6. Describe the cellular concept of Wireless Communication Systems
7. Describe the 2G, 3G and 4G wireless standards for mobile communication, IEEE 802.11b, g Wireless Local area network (WLAN) standards.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	End-semester examination
1	Remember	20	20	20

2	Understand	20	20	20
3	Apply	60	60	60
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course level Learning Objectives

Remember:

1. Draw the block diagram of a simplified model of a communication system
2. Define the term co channel interference and adjacent channel interference.
3. What are the re-use factors for the wireless standards namely AMPS, GSM and IS-95 systems?
4. State μ - Compression Law
5. Give the Radar transmission equation
6. What is skip effect

Understand:

1. Distinguish between flat fading and frequency selective fading.
2. Explain the general operation of Satellite communication system
3. Distinguish between cochannel interference and adjacent channel interference
4. Distinguish between A-law and μ law companding
5. What are the needs for modulation?
6. When the demand for wireless service increases, how is it possible to provide more channels per unit coverage area?

Apply:

1. A certain point in a communication system, the signal power is 5mW and noise power is 100nW.
   a. Determine the absolute SNR and the decibel SNR.
   b. Convert both signal and noise power levels to dBm values and determine the decibel SNR.

2. A satellite is to be placed in an orbit 1000 km above the earth's surface. Determine (a) the required velocity, (b) the circumference of the rotation, and (c) the period of the rotation.
3. Consider a PCM TDM system in which 19 signals are to be processed. Each of the signals has a baseband bandwidth W = 5 KHz, and 8 bits are to be used in each word. Conventional NRZ – L encoding will be used, and an additional 8 – bit sync word will be placed in each frame. Determine the theoretical minimum bandwidth required.
4. In a binary digital communication system, the average signal carrier power at the antenna terminals of the receiver is 200 fW. The equivalent antenna noise temperature is 300 K, and the receiver effective noise temperature referred to the input is 425 K. Determine the detected output signal – to – noise ratio, for binary PCM transmission with 6 – bit words at a data rate of 2 Mbits/s, for (a) PSK with matched filter, (b) ASK with matched filter.
5. A communication system has the following parameters:

   $P_t = 5W$

   $G_t(dB) = 13dB$

   $G_r(dB) = 17dB$

   $d = 80km$

   $f = 3\ GHz$

   Determine the value of the receiver power using Friis transmission formula.
6. A pulse radar system operates at a frequency of 10 GHz with a pulse repetition frequency of 2 kHZ and a pulse width of 6 μs. Determine (a) the maximum unambiguous range, and (b) the resolution or minimum range.

Introduction: Simplified Communication system model, Bandwidth and spectrum, modulation and demodulation, decibel gain and loss ratios, Signal to noise ratio and system level decibel analysis, **Communication Link Analysis:** Friis Link Equation, Decibel forms for the one way link equations, Line of Sight Propagation, Radar link equation, pulse radar, Doppler radar, Reflection and refraction, Ground wave propagation, Sky wave propagation **Digital Communications: Pulse code modulation (PCM),** basic PCM encoding and quantization, companding, baseband encoding forms, Time Division Multiplexing, Binary digital modulation schemes (ASK, PSK, FSK), Bit Error rate Analysis. **Satellite Communication Systems:** Orbital Mechanics, Satellite Alignment, Space craft communication Systems, Antennas Aboard Satellites and Earth Station, Satellite Link Analysis. **Wireless Communication Systems:** Cellular Concept: Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference, System Capacity, Wireless Standards: 2G, 3G and 4G Mobile Standards, IEEE 802.11b, g Wireless Local area network (WLAN) standards

Text Book:

1. William D.Stanley amd John.M. Jeffords, " Electronic Communications Principles and Systems", Cengage Learning, 2009 (India Edition)

Reference Books

1. Theddore S.Rappaport, " Wireless Communications: Principles and Practice", Second Edition, PHI,2006
2. George Kennedy, "Electronic Communication Systems", Tata McGraw Hill, Third Edition, 1996.
3. Wayne Tomasi, " Advanced Electronic Communication Systems", Prentice Hall International Inc., Fourth Edition, 1998

Course Contents and Lecture Schedule

S.No	Topic	No of lectures
	Introduction	
1	Simplified Communication System Model	1
2	Bandwidth and Spectrum	1
3	Modulation and demodulation	1
4	decibel gain and loss ratios, Signal to noise ratio and system level decibel analysis	2
	Communication Link Analysis:	
5	Friis Link Equation,	2
6	Decibel forms for the one way link equations,	1
7	Line of Sight Propagation,	1

8	Radar link equation	1
9	Pulse radar, Doppler radar	3
10	Reflection and refraction, Ground wave propagation, Sky wave propagation	2
	Digital Communications	
11	Pulse code modulation (PCM)	1
12	Basic PCM encoding and quantization,	2
13	Companding,	1
14	baseband encoding forms	2
15	Time Division Multiplexing	1
16	Binary digital modulation schemes (ASK, PSK, FSK)	3
17	Bit Error rate Analysis.	1
	Satellite Communication Systems:	
18	Orbital Mechanics	1
19	Satellite Alignment	1
20	Space craft communication Systems	1
21	Antennas Aboard Satellites and Earth Station	2
22	Satellite Link Analysis	2
	Wireless Communication Systems:	
23	Cellular Concept:	1
24	Frequency Reuse	1
25	Channel Assignment Strategies	1
26	Handoff Strategies	1
27	Interference, System Capacity	1
28	Wireless Standards: 2G, 3G and 4G Mobile Standards	2
29	IEEE 802.11b, g Wireless Local area network (WLAN) standards	2

Course Designers

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SubCode	Lectures	Tutorial	Practical	Credit
DGD	3	0	-	3

DGD Imaging and Applications 3:0

Preamble: The purpose of this course is to provide the basic concepts and methodologies for Digital Image Processing in three different levels and its applications. At the lowest level, the course introduces the terminology of image processing, how digital images are generated, how the data is digitized, stored, some of the different formats (bmp, gif, tiff, jpeg, etc) and the connected component analysis. Also it includes the preprocessing steps like filtering. In the middle level, it addresses how the algorithm utilizes low level results for the processes such as segmentation and feature detection like edge detection. At highest level, it addresses how the algorithm attempts to extract the semantic information from those provided by the lower levels for classification and recognition.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

e. Graduates will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies: At the end of the course the student should be able to

1. Describe image acquisition, sampling and quantization
2. Understand different types of image transforms and their properties
3. Enhance the images in spatial as well as frequency domains
4. Segment given images in terms of edge, threshold and region.
5. Analyse the connected components.
6. Apply morphological operations like dilation, erosion, opening and closing on given images.
7. Represent, recognize and classify objects from the given images.

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test3/End Semester Examination
1	Remember	20	20	20
2	Understand	40	40	20
3	Apply	40	40	40
4	Analysis	0	0	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning Objectives:

Remember

1. Define mach bands and simultaneous contrast?
2. Define Euclidean distance measure.
3. List the properties of first and second order derivatives.
4. Define chess board distance.
5. Give the PDF of Erlang noise and sketch the PDF.
6. Write the masks to detect horizontal and vertical lines in an image.

Understand

1. Explain sharpening in frequency domain filters.
2. Obtain chain code for the alphabet 'H'.
3. How do you link edge pixels through global processing?
4. Discuss region based segmentation.
5. How boundary descriptors are helpful to describe an object.
6. Consider two 8-bit images whose gray levels span the full range from 1 to 255. Will reversal of the order of the images yield a different result?

Apply

1. Find DCT Transform and its inverse for the following image data.
   5 6
   5 9 [2x2] matrix

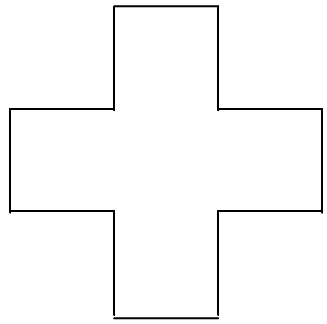
2. For a 5 bit input matrix perform histogram equalization.

10	10	15	0	0
5	0	10	10	15
15	15	2	0	10
5	5	0	10	30

3. Obtain the signatures for a pentagon and a rectangle.

4. Compute the first difference of the code 0101030303323232212111.

5. Obtain the shape number for the following fig.



6. Consider the two image subsets S1 and S2, shown in the following figure. For v= {1},
    a. Determine whether these two subsets are (a) 4-adjacent (b) 8-adjacent or (c) m-adjacent.
    b. Convert a one-pixel-thick 8-path to a 4-path.
    c. Convert a one-pixel-thick m-path to a 4-path.
    d. Show that the boundary of the region is defined in a closed path.

	S1	S2	
0	0 0 0 0	0 0 1 1	0
1	0 0 1 0	0 1 0 0	1
1	0 0 1 0	1 1 0 0	1
0	0 1 1 1	0 0 0 0	0
0	0 1 1 1	0 0 1 1	1

Analyze

1. Morphological Algorithm
    a. Give a morphological algorithm for converting an 8-connected binary boundary to an m-connected boundary. you may assume that the boundary is fully connected.
    b. Does the operation of your algorithm require more than one iteration with each Structuring element? Explain your reasoning
    c. Is the performance of your algorithm independent of the order in which the Structuring elements are applied? if your answer is yes, prove it. otherwise give an example that illustrates the dependence of your procedure on the order of application of the structuring elements.

-1	0	1

2. Show that the Sobel and Prewitt gradient masks of figs (a) and (b) give isotropic results only for horizontal and vertical edge and for edges oriented at +45 & -45.

-1	0	1
-1	0	1

Fig(a)

-1	-1	-1
0	0	0
1	1	1

0	1	1
-1	0	1
-1	-1	0

-1	-1	0
-1	0	1
0	1	1

Fig(b)

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

0	1	2
-1	0	1
-2	-1	0

-2	-1	0
-1	0	1
0	1	2

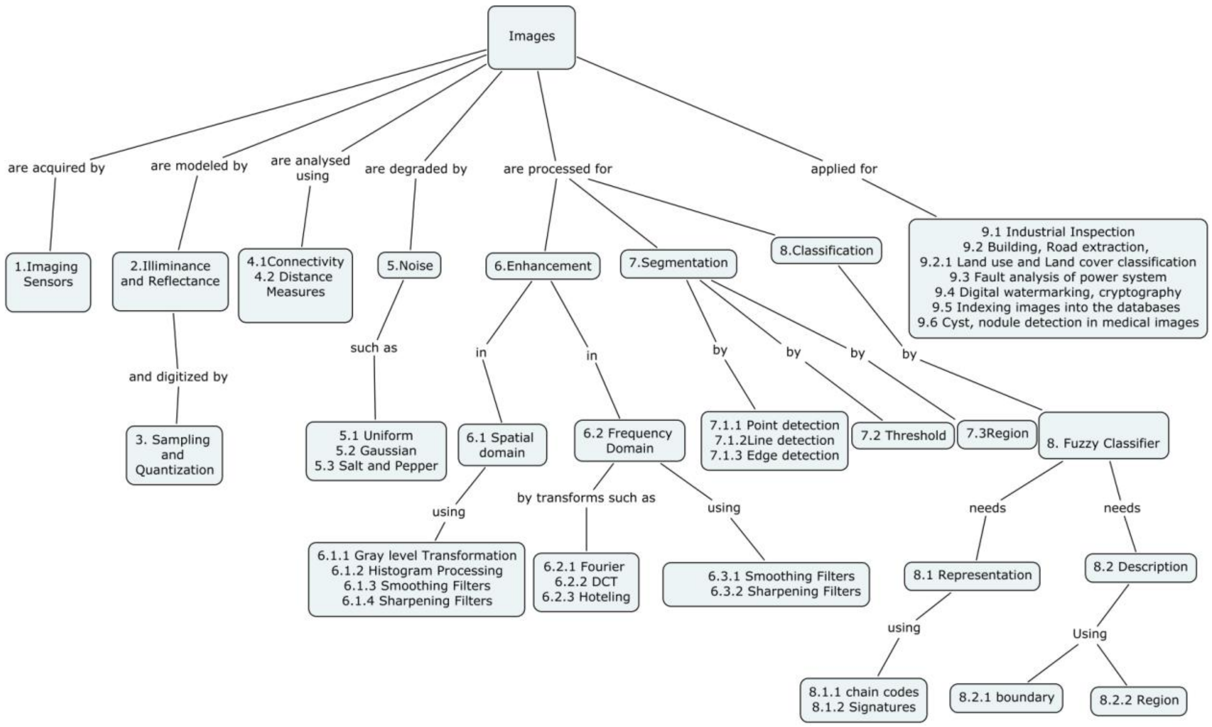
3. You are contracted to design a image processing system for detecting imperfection on the inside of certain solid plastic wafers. The wafers are examine using an X-ray imaging system which yields 8-bit images of 512×512 resolution. In the absence of imperfection the images appear "bland" having a mean gray level of 100 and variance 400.The imperfection appear as blob like regions in which 70% of the pixels have excursion in intensity of 50 gray levels or less about a mean of 100.A wafer is considered defective such a region occupies an area exceeding 20 ×20 pixels in size. Propose a system based on texture analysis.
4. (a) Let v = {0,1} and compare the lengths of the shortest 4-, 8- and m-path between p and q. If a particular path does not exist between these two points explain, why?

   (b) Repeat for V= {1, 2}

```
    1 2 1 1 (q)
    2 0 2 2
    1 2 1 1
(p) 1 0 1 2
```

5. Analyse how the missing components have been identified in a PCB manufacturing company?

Concept Map



Syllabus

Imaging Technologies -Image sensing and acquisition- Components of an Image processing system –Image Sampling and Quantization –Basic relationship between pixels –Distance Measures – Image Transforms- Fourier – Discrete cosine –Hotelling transform. **Preprocessing**- **Image Enhancement***:* Sources of noise-noise models - Gray level Transformations – Histogram processing – spatial filtering – smoothing, sharpening filters– Smoothing, sharpening Frequency domain filters –Spatial filtering: Mean, order statistics, Frequency domain filtering: smoothing-sharpening **Image Segmentation***:* Point detection – line detection – Edge detection –Edge linking and boundary detection - Thresholding – Global Thresholding-Threshold selection – Region oriented segmentation – Basic formulation – Region growing by pixel aggregation – Region splitting & merging **Representation:** Chain codes – signatures – Boundary segments – skeleton of region – **Description:** Boundary descriptors – simple descriptors – shape numbers, **Post Processing**–Morphology - dilation and erosion – opening and closing – Basic morphological algorithm. **Object classification and Recognition –** Neural- Fuzzy Classifiers- **Applications-** Industrial inspection- Crack identification, Missing component identification-Quality, quantity control-Building, Road extraction, Change detection- Indexing into databases Digital watermarking, cryptography- Cyst, nodule detection in medical images

Reference Books:

1. Rafael.C.Gonzalez and Richard.E. Woods, "Digital Image Processing", Pearson Education, 2003
2. G.J.Awcock and R.Thomas, "Applied Image Processing", McGraw-Hill, 1996
3. Rafael.C.Gonzalez, Richard.E. Woods and Steven L. Eddins, "Digital Image Processing using MATLAB", Pearson Education, 2004
4. Anil K.Jain, "Fundamentals of Digital Image Processing", Pearson Education 2003
5. Rafael.C.Gonzalez and Richard.E. Woods, "Digital Image Processing", Addison Wesley 1993.
6. Santanu Chaudhury, Shree K Nayar, "Computer Vision, Graphics and Image Processing-Recent Advances" , Viva Books, 1999

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Imaging Sensors**	1
2.	**Image Model**	
2.1	Illuminance	1
3.	Reflectance	1
3.1	**Digitization**	
3.2	Sampling and Quantization	1
4.	**Connectivity, Distance Measures**	1
5.	**Noise**	1
5.1	Uniform	1
5.2	Gaussian	
5.3	Salt and Pepper	1
6.	**Image Enhancement**	
6.1	Spatial domain	1
6.1.1	Gray level Transformation	1
6.1.2	Histogram Processing	2
6.1.3	Smoothing Filters	1
6.1.4	Sharpening Filters	1
6.2	Frequency Domain	1
6.2.1	Smoothing Filters	2
6.2.2	Sharpening Filters	1
	Transforms	
6.2.3	Fourier	2

No.	Topic	No. of Lectures
6.2.4	Discrete Cosine	1
6.2.5	Hotelling (PCA)	2
7	**Segmentation**	
7.1.1	Point detection	1
7.1.2	Line detection	1
7.1.3	Edge detection	2
7.1.4	Linking Edges	1
7.2.1	Local Threshold	1
7.2.2	Global Threshold	1
7.3.1	Region Growing	1
7.3.2	Region Splitting	1
7.3.3	Region Merging	1
8.	**Classification**	
8.1	Fuzzy Classifier	1
8.2	Representation	
8.2.1	chain codes	1
8.2.2	Signatures	1
8.3	Description	
8.3.1	Boundary	1
8.3.2	Region	1
9	**Applications**	
9.1	Industrial inspection- Crack identification, Missing component identification	1
9.2	Building, Road extraction, Change detection, Land use and Land cover classification	2
9.3	Fault analysis of power system	1
9.4	Digital watermarking, cryptography	1
9.5	Indexing images into the databases	1
9.6	Cyst, nodule detection in medical images	1
	Total Number of Hours	40

Course Designer

1. B.Yogameena, ymece@tce.edu

Sub code	Lectures	Tutorial	Practical	Credit
D1A	-	-	-	1

D1A Global Positioning Systems 1:0

Preamble:

The Global Positioning System (GPS) is a location system based on a constellation of about 24 satellites orbiting the earth at altitudes of approximately 11,000 miles. GPS satellites are orbited high enough to avoid the problems associated with land based systems, yet can provide accurate positioning 24 hours a day, anywhere in the world. Uncorrected positions determined from GPS satellite signals produce accuracies in the range of 50 to 100 meters. When using a technique called differential correction, users can get positions accurate to within 5 meters or less. Today, GPS units are becoming smaller and less expensive, there are an expanding number of applications for GPS. In transportation applications, GPS assists pilots and drivers in pinpointing their locations and avoiding collisions. Farmers can use GPS to guide equipment and control accurate distribution of fertilizers and other chemicals. Recreationally, GPS is used for providing accurate locations and as a navigation tool for hikers, hunters and boaters.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies:

At the end of the course the student should be able to

1. Explain the function of GPS and its signal structure
2. Determine the user position using the concept of triangulation
3. Explain the signal processing at receiver and determine the processing gain
4. Explain the concept of Bayes criteria and likelihood ratio test
5. Apply the Bayes criteria for GPS applications
6. Apply sequential detection theory to GPS

7. Apply the Bayes criteria for GPS applications
8. Explain the concept of Kalman filter and Extended Kalman Filter
9. Apply the concept of Kalman filter to GPS, for position and velocity tracking

Assessment Pattern

	Bloom's Category	/End-semester examination
1	Remember	0
2	Understand	40
3	Apply	60
4	Analyze	0
5	Evaluate	0
6	Create	0

Syllabus:

GPS fundamentals: Concept of triangulation to get user position, GPS signal structure, Overview of typical receiver processing, Processing gain, coherent and non-coherent accumulation, **Detection theory:** Introduction, Probability theory refresher, Binary hypothesis testing, Bayes criteria and Likelihood ratio test, Detection theory - Examples & Applications to GPS, Recap of Bayes criteria, Neyman-Pearson criterion and Likelihood ratio test, Simple Examples, Detection theory formulation applied to GPS Satellite Acquisition, Sequential detection theory and application to GPS, **Kalman filter:** Introduction, Kalman filter theory, Extended Kalman filter, Kalman filter - Application to GPS, Problem formulation and application of Kalman filter to GPS, for Position and Velocity tracking

References

1. Steven M.Kay, " Fundamentals of Statistical Signal Processing", Vol I Estimation Theory, Prentice Hall Inc, 1998
2. Steven M.Kay, " Fundamentals of Statistical Signal Processing", Vol II Detection Theory, Prentice Hall Inc, 1998,

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**GPS**	
1.1	GPS Fundamentals	1
1.2	Concept of triangulation to get user position	1
1.3	GPS signal structure	1
1.4	Overview of typical receiver processing,	1
1.5	Processing gain, coherent and non-coherent accumulation	1
2	**Detection Theory**	
2.1	Introduction, Probability Theory Refresher	1
2.2	Binary Hypothesis Testing	1
2.3	Bayes Criteria and Likelihood Ratio Test	1
3	**Detection Theory – Examples and Applications**	
3.1	Recap of Bayes Criteria	1
3.2	Neyman-Pearson Criterion and Likelihood Ratio Test	1
3.3	Simple Examples	1
3.4	Detection theory formulation applied to GPS Satellite Acquisition	1
3.5	Sequential detection theory and application to GPS	1
4	**Kalman Filter**	

No.	Topic	No. of Lectures
4.1	Kalman Filter Theory	1
4.2	Extended Kalman Filter	1
4.3	Application to GPS	1
4.4	Problem formulation and application of Kalman filter to GPS, for position and velocity tracking	1
Total		**17**

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D1B	-	-	-	1

D1B VLSI Implementation of Communication Transceivers 1:0

Preamble:

This course integrates VLSI architecture theory and algorithms for the implementation of communication transmitter and receiver. with low power consumption. This course also deals with the design of high-speed, low-area, and low-power VLSI systems for the implementation of communication systems. It covers pipelining and parallel processing architectures extensively as well as the concepts of PLL.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies:

At the end of the course the student should be able to

1. Explain the concept of RTL coding and Canonic Signed Digit representation
2. Implement DSP algorithms using the concepts of pipelining and parallel architectures
3. Implement multirate digital filters using ALU-RAM
4. Explain the concept of PLL
5. Implement PLL on FPGA
6. Implement FM transceiver, using the digital filters and PLL

Assessment Pattern

	Bloom's Category	End-semester examination
1	Remember	0
2	Understand	20
3	Apply	60
4	Analyze	0
5	Evaluate	20
6	Create	0

Syllabus

Communication Transceivers: introduction to communication receiver and transmitter, Case study: FM Transceiver with specific focus on digital filters and PLL. **Digital Design:** RTL Coding, the concepts of digital synthesis. Examples of digital FIR filters: RTL coding, synthesis and FPGA implementation. Digital filters – architectures: Pipelining of FIR digital filters, Parallel architecture, Canonical Signed Digit (CSD) implementation, Multirate filters – low power implementation, ALU-RAM based digital filter implementation. **PLL basics:** Introduction - Applications in a Communication Transceiver, Integer and Fractional PLLs, Analog vs digital PLL-Tradeoffs, PLL metrics –Response time, Noise bandwidth, 1st and 2nd order PLL analysis, performance, **PLL advanced:** Specifications of PLL, Phase Noise ,Reference Spurs, Phase noise in open loop and closed loop, PLL Phase noise contributors, Building blocks: VCO, PFD, TDC, Laboratory practices on Basic digital FIR filter FPGA emulation, Digital PLL on FPGA, ALU-RAM based multirate digital filter

References:

1. PLL Performance, Simulation and Design Handbook 4th Edition, National Semiconductor, http://www.national.com/analog/timing/pll_designbook
2. K K Parhi , "VLSI Digital Signal Processing Systems', Wiley India Pvt Ltd, 2007,
3. B Razavi, "RF Microelectronics", Prentice Hall, 1998

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Communication Transceivers**	
1.1	introduction to communication receiver and transmitter	1
1.2	Case study: FM Transceiver with specific focus on digital filters and PLL.	1
2	**Digital Design**	
2.1	RTL Coding	1
2.2	Digital Synthesis	1
2.3	Examples: Digital FIR Filter, RTL Coding synthesis and FPGA Implementation	1
3	**Digital Filters – Architectures**	
3.1	Pipelining of FIR digital filters	1
3.2	Parallel Architectures	1
3.3	CSD Implementation	1
3.4	Multirate Filters low power implementation	1
3.5	ALU RAM based Digital Filter implementation	1
4	**PLL**	
4.1	Application to Communication Transceiver	1
4.2	Integer and Fractional PLLs, Analog Vs Digital PLL tradeoffs	1

No.	Topic	No. of Lectures
4.3	PLL Metrics – Response time, noise Bandwidth	1
4.4	First and second order PLL analysis, Performance	1
4.5	PLL Advanced: Phase noise, reference spurs, building blocks of PLL	3
5	Laboratory Experiments for practice	
5.1	Basic Digital FIR Filter FPGA Emulation	Exercise
5.2	Digital PLL on FPGA	Exercise
5.3	ALU-RAM based Multirate Digital Filters	Exercise
Total		**17**

Course Designers

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Sub code	Lectures	Tutorial	Practical	Credit
D1C	-	-	-	1

D1C Introduction to High Speed Signaling 1:0

Preamble:

Interconnections between the transistor level circuits represent a major bottleneck for managing signal integrity in high speed electronic systems. In such systems, the effect of the package and printed circuit board can have a large effect on signal integrity, which can ultimately cause functional failures unless the interconnection structures are designed appropriately. With high speed buses and interfaces operating in the package and printed circuit board, establishing signal integrity on these interconnects is paramount to ensuring adequate system performance. Signal integrity is often times affected by the power distribution effects which manifest itself as power supply and simultaneous switching noise. Hence, for high speed signaling, both signal and power distribution related issues need to be tackled simultaneously.

Program Outcomes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies:

At the end of the course the student should be able to

1. Understand the meaning of transistor and interconnect scaling
2. Recognize the importance of RC versus RLGC dominated wires and transmission lines
3. Design clock distribution networks in the package using H-tree topology
4. Understand the concept of equalization
5. Understand the importance of signal referencing and return path discontinuities
6. Calculate power distribution impedance
7. Design power distribution components including bypass capacitors
8. Develop methods for improving insertion loss of signal lines
9. Calculate cavity resonances and develop methods for their mitigation

Assessment Pattern

	Bloom's Category	/End-semester examination
1	Remember	0
2	Understand	40
3	Apply	60
4	Analyze	0
5	Evaluate	0
6	Create	0

Syllabus:

Introduction: Fundamentals of packaging, **Device and Interconnect Scaling**: CMOS scaling, RC dominated on-chip wires, Power-performance tradeoff, package/PCB wiring ,**Clock Distribution Network:** Common clock vs ynchronous, H-Tree design, **Equalization:** Basic principle, Implementation for package wiring , **Signal Referencing:** Return path discontinuities, minimizing insertion loss ,**Power Distribution:** IR drop, AC impedance, Target impedance, **Power Distribution Components:** Voltage Regulator Module, Bypass capacitors, power planes, **Simultaneous Switching Noise:** Noise generation, Mitigation using bypass capacitors, Managing signal integrity, **Simulation Exercises**

References

1. Class Handout
2. Power Integrity Modeling and Design for Semiconductors and Systems, Madhavan Swaminathan and Ege Engin, Prentice Hall, 2007, ISBN0_13_615206_6.

Software Tools

1. ADS from Agilent
2. Sphinx from E-System Design

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Fundamentals of Packaging	1
2	**Device and Interconnect scaling**	
2.1	CMOS scaling,	1
2.2	RC dominated on-chip wires	1
2.2	performance tradeoff, package/PCB wiring	1
3	**Clock Distribution Network**	
3.1	Common clock vs Synchronous, H-Tree design	1
4	**Equalization**	
4.1	Basic principle, Implementation for package wiring	1
5	**Signal Referencing**	
5.1	Return path discontinuities, minimizing insertion loss	1
6	**Power Distribution**	
6.1	IR drop, AC impedance, Target impedance	1
7	**Power Distribution Components**	
7.1	Voltage Regulator Module	1
7.2	Bypass capacitors, power planes	1
8	**Simultaneous Switching Noise**	
8.1	Noise generation, Mitigation using bypass capacitors	1
8.2	Managing signal integrity	1
9	**Simulation Exercises**	3
	Total	**15**

Course Designers

1. Madhavan Swaminathan madhavan@ece.gatech.edu
2. S. Rajaram

Biography:

Madhavan Swaminathan is the Joseph M. Pettit Professor of Electronics in the School of Electrical and Computer Engineering and Director of the Interconnect and Packaging Center, Georgia Tech. He is the co-founder of Jacket Micro Devices, a company that specializes in integrated RF modules and substrates for wireless applications (acquired by AVX Corporation) and the founder of E-System Design, a company focusing on the development of CAD tools for achieving signal and power integrity in integrated 3D micro and nano-systems, where he serves as the CTO. He was formerly the Deputy Director of the Microsystems Packaging Research Center at Georgia Tech. Prior to joining Georgia Tech, he was with IBM working on packaging for supercomputers. He is the author of more than 325 journal and conference publications, holds 22 patents, is the author of 3 book chapters and is the primary author of the book entitled "Power Integrity Modeling and Design for Semiconductors and Systems", Prentice Hall, Nov 2007 and co-editor of "Introduction to System on Package", McGraw Hill, Mar. 2008. He has been honored as an IEEE Fellow for his work on power delivery for digital and mixed signal systems and has been recognized for his work through several awards. He received his M.S and PhD in Electrical Engineering from Syracuse University in 1989 and 1991, respectively.

Sub code	Lectures	Tutorial	Practical	Credit
D1D	1	-	-	1

D1D Systems Engineering 1:0

Preamble:

Systems engineering discipline emerged as an effective way to manage complexity and change in the context of Product or Systems Development. Both complexity and change have escalated in our products, services, and Solutions. Systems engineering is an interdisciplinary approach and means to enable the realization of successful systems. Successful systems here indicates that it serves its purpose in solving customer problem, commercially viable brining in revenue for company and sustaining it for life cycle and disposing it off safely.

In today's world everything is system of system. Let us take an example of digital camera. A digital camera may seem simple, but it is a system of systems with rigidly controlled interfaces. Multiple camera bodies, from simple fixed focus digital cameras to sophisticated single lens reflex cameras have a common interface to digital memory cards. The full single-lens reflex camera system has many different models of camera bodies which interface with 50 or more lens systems and multiple flash units. To be a commercial success these simple to sophisticated camera systems are designed to conform to external interfaces for standard commercial batteries, compact flash memory cards, interface cables, computers, and printer software.

Prerequisite:

- Fair understanding of Product/System Development life cycle
- Appreciation of different disciplines of Electronics, Mechanical and Electrical

Program Outcomes addressed:

a. Graduates will demonstrate knowledge of engineering.

b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

d. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

f. Graduate will demonstrate skills to use modern engineering tools, softwares and equipment to analyze problems.

Competencies:

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

1. Understand the concepts of Systems Engineering.
2. Build successful realization of products and systems.
3. Explain two real time systems through case study

Assessment Pattern:

	Bloom's Category	/End-semester examination
1	Remember	30
2	Understand	40
3	Apply	20
4	Analyze	10
5	Evaluate	0
6	Create	0

Syllabus:

Systems Engineering Overview: Definitions of systems, systems engineering, Concept of Systems, System-of-Systems, System Hierarchy, Use and Value of systems engineering, System Life Cycle Processes and Over View of each process, SEMP, An example. **System Requirements:** What are Requirements, Sources of Requirements, Types of Requirements, Sys Requirement Definition and Analysis process, System specification tree. **System Architecture:** What is System Architecture, Architectural Structures, Architecture Design process. **System Risk Management:** Definition of risks and Characteristics of risks. **System Interface Management:** Types Of interface and Interface management process. **Specialty Engineering:** CE analysis and ILS, EMC Analysis, and all other specialty engineering areas. **Trade Studies, System Development Aspects and Case Studies**

References:

1. Systems Engineering Hand Book: http://incose.org/ProductsPubs/products/sehandbook.aspx
2. Sage, A. P. and Armstrong, J. E., Jr., An Introduction to Systems Engineering, John Wiley & Sons, 2000.

3. Sage, A. P. and Rouse, W. B. (Eds.), Handbook of Systems Engineering and Management, John Wiley and Sons, 1999.
4. NASA Systems Engg Handbook
5. Systems Engineering Tools and Methods
http://www.crcpress.com/us/product.asp?sku=K10460&dept%5Fid=1&af=WAUER

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Systems Engineering Overview:**	
	• Definitions of systems, systems engineering • Concept of Systems, System-of-Systems • System Hierarchy • Use and Value of systems engineering • Roles of Systems Engineers • System Life Cycle Processes • Overview of system requirements, system integration/ testing, verification/ validation, SEMP • An example	2
2	**System Requirements**	
	• What are Requirements • Sources of Requirements • Types of Requirements • System Requirement Definition process • System Requirement Analysis process • System specification tree	3
3	**System Architecture**	
	• What is System Architecture • Constituents of system architecture • Architectural Structures • Architecture Design process • Case Study for Systems Requirements and Architecture	3
4	**System Risk Management and System Interface Management**	
	• Definition of risks • Characteristics of risks • Risk management activities • Risk Categories • Types Of interface • Interface management process	1

No.	Topic	No. of Lectures
	• N2 Diagram • Concept of ICD	
5	**Specialty Engineering**	
	• CE analysis • ILS, EMC Analysis, EIA • Lifecycle cost Analysis • All others – Manufacturing & Producibility Analysis, Safety and Health Hazard, Sustainment engineering, training, usability • Value Engineering	1
6	**Trade Studies and System Development Aspects**	
	• What are Trade Studies • Levels of formality of trade studies • Trade study interdependency analysis • Technology Readiness Levels • System Readiness Levels • System Evolution aspects (including levels of invention, S-Curves)	1
7	Case Study	3
	Total	**14**

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Biography:

Srinivasan Rajagopal (Srini) is currently Director-Systems Engineering with Automation Control Systems (ACS), Honeywell Technology Solutions, Bangalore. He has 20 Years of experience in the industry. He started his career working with South India Viscose, Coimbatore as Instrumentation & Maintenance Engineer and then in Project Engineering for new plant building using DCS. He then moved to various industries of Oil & Gas, Petrochemical including a stint in gulf countries before moving in to Honeywell and has been there since the last 13 years. During his stint with Honeywell, he held various roles and responsibilities on the way to play Systems Engineer role in 2004. He played lead roles and supporting roles in creating 5 products that are out in the market – Embedded controllers to Advanced applications. He formally established the Systems Engineering organization for the ACS business of Honeywell in India and nurturing it for the past two and half years

Ramakrishnan Raman (Ramki) is currently Practice Head – Reuse Engineering at Honeywell Technology Solutions, Bangalore. He has over 14 years of extensive systems engineering & software engineering experience in domains of Building/ Industrial Automation, and Avionics/ Aerospace. He is the Point-Of-Contact for the International Council On Systems Engineering (INCOSE) in India, and is an INCOSE Ambassador. He has contributed to the revision of INCOSE Systems Engineer Handbook V 3.1, and in the review of ISO/IEC 15288 and ISO IEC TR 24748-2 standards. He is actively engaged in the promotion of INCOSE in India, both in the industry as well as in academic institutions, and in setting up of INCOSE chapter in India. He is also an Executive Committee member of Asia Pacific Council on Systems Engineering, representing India. At Honeywell, he has significantly contributed to the design & development of many complex systems in Building/ Industrial Automation, and Avionics/ Aerospace. He was a key contributor to development of the organization's systems engineering processes, the software architecture & design processes, and has led the systems engineering council for the Aerospace business unit in Honeywell Technology Solutions**.**

V Suryanarayanan (Surya) is currently Principal Systems Engineer and leads the Honeywell Process Solutions-Advanced Solutions group of Systems Engineers at Honeywell Technology Solutions. He has a B.E. in Instrumentation from College of Engineering, Osmania University and a M.E in Software Systems from BITS, Pilani. He has over 14 years of experience in the Industrial Automation domain. He started his career at Nagarjuna Fertilizers and Chemicals Limited, Kakinada as an Instrumentation maintenance engineer. He then completed his Masters Degree in software systems and joined Honeywell Technology Solutions in Bangalore. During his 13+ year stint in Honeywell, he held various roles and responsibilities on the way to play the Systems Engineer role in 2006. He played lead and supporting roles in the design and development of multiple complex systems for Industrial customers that are in the market today. He started the Systems Engineering organization for the Advanced Solutions line of business at HTS in 2009 and is continuing to nurture and grow the capabilities of this group.

S Madhanmohan (Madhan) is working with Honeywell Technology Solutions for more than 9 years in Honeywell Process Solution – Advance Solution Group of Automation Control Systems. He has been working in Advance Applications area in the Industrial Automation area with more emphasis in Manufacturing Execution System (MES) Applications. He is currently playing the Systems Engineer role for Next Generation MES Applications Platform. He completed his BE (ECE) from University of Madras and MTech (CSE) from VIT University, Vellore.