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UNIVERSITY OF MYSORE

Estd. 1916

VishwavidyanilayaKaryasoudha
Crawford Hall, Mysuru- 570 005

No.AC.2(S)/486/16-17 **Dated:** 20.**06.2017**

NOTIFICATION

Sub: Modification in the existing Syllabus of M.Sc. in Electronics from the Academic Year 2017-18.

Ref: 1. Decision of the Faculty of Science & Technology Meeting held on 03.03.2017.
2. Decision of the Academic Council meeting held on 30.03.2017.

*****

The Board of Studies in Electronics (PG) which met on 26.12.2016 has resolved to modify the existing Syllabus of M.Sc. Electronics as an up grade measure and on par with industrial requirements and with the intention of enhancing the employability for the students and also to help them in higher education.

The Faculty of Science and Technology and the Academic Council at their Meetings held on 03.03.2017 and 30.03.2017 respectively have also approved the above said proposal and the same is hereby notified.

The Modified M.Sc. Electronics Syllabus is annexed herewith.

The concerned may download the modified contents in the University Website i.e., www.uni-mysore.ac.in

Draft approved by the Registrar

Sd/-
Deputy Registrar (Academic)

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DOS in Physics, MGM.
3. The Chairperson, BOS/DOS in Electronics (PG), Hemagangotri, Hassan.
4. The Principals of the Affiliated Colleges running PG Program in Science stream only.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Co-ordinator, Directorate of Online & Outreach program, Parakalamata, MGM.
7. The Deputy/Assistant Registrar/Superintendent, AB and EB, University of Mysore, Mysore.
8. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
9. Office file.

UNIVERSITY OF MYSORE
Department of Studies in Electronics
Post Graduate Centre, Hassan – 573 226

Proposed Syllabi, Regulations & Scheme of Study for M.Sc. (Electronics) Programme from the academic year 2017-2018.

Preamble

The objective of updating both syllabi and the scheme of study of M.Sc. (Electronics) is to prepare pupils to face the current challenges in Industry and Academia. With the enforcement of CBCS teaching learning pattern both from UGC and University, the syllabi and the study pattern are updated and executed periodically. The proposed syllabi and the scheme of study equip students with both basics and advanced topics in the field of Electronics. In addition, the revised syllabi incorporate more practical sessions so that theoretical concepts are better understood and it also enables students to get more practical experience.

Programme Objectives

- The main objective of the MSc (Electronics) Programme is to equip the pupils with the knowledge of basics and advanced topics of present day developments in the field of Electronics.
- Design and analysis of Electronic Circuits and Modules
- In the laboratory, the candidate gets the hands on training of design and development of Electronic Circuits
- Equip with the design and programming capability of the Embedded Systems, DSP Processors
- The Project Work enables the student to get exposure to the Industrial Environment and attain the knowledge of design and development of new ideas in the field of Electronics.

Programme Outcomes

After the successful completion of the MSc(Electronics) programme,

- The candidate can get the job opportunities in Electronics Industries and R & D organizations.
- Join the Teaching Profession after fulfilling the requirements like clearing NET, KSET, PhD.
- Take up Research Work leading to the PhD degree and later join for PDF or can join the Teaching or R & D organizations with the higher positions

Eligibility Criteria

Candidates should have Bachelor's Degree with the following criteria.

- B.Sc. with Electronics/Instrumentation as one of the Major/Cognate Subjects.
- B.E./B.Tech./B.S.(ECE, IT, EE, CS&E, Telecommunication, IS&E).

Selection Criteria and Cut-off Percentage

Admission to the programme is through Entrance only. The total percentage for the admission is the average score of both Entrance Examination and the average score of all the papers of the cognate/major subject studied at the Degree level. For examples, if a candidate having a

B.Sc. degree with Physics, Mathematics and Electronics combination, the average score of the degree is calculated by considering all the papers studied pertaining to Electronics only. The cut-off percentages of average degree score and the entrance exam score are as per the University norms. The other admission procedures are as per the Admission Guidelines of the University which are amended from time to time.

Project Work

- Each candidate shall carry out individual minor/major project work. However, maximum of two candidates may join together to do a single project work provided that sufficient work is allocated to each of them.
- Candidates are encouraged to carry out the project work in the Government Research Organizations/recognized R & D centres/Industries so that they get an exposure to Industrial environment. However, students can also do their project work within the Department/in any other Departments of the University/any recognized Universities or Colleges outside the University.
- All permanent faculty members working in the Department are the Project Guides/Internal Guides. Faculty members of other Departments within the University shall be the Co-Guides. The guest faculty members who are presently working in the Department and having more than three years of teaching/research experience shall also be the Co-Guides. When the project work is carried out outside the University, Faculty Members/Scientists who are guiding the candidates in those organizations shall be the External Guides. The candidates should submit periodic progress reports and final project report to the Department through a Guide or through both internal guide and co-guide/external guide.
- Scheme of examination is as per the University guidelines.
- The project report in a soft binging form and also a soft copy of the report should be submitted to the Department.

Distribution of Tutorial Hours

In courses with credit distribution to all components of L, T and P, the number of Tutorial hours/week shall be equally distributed among Theory and Practical sessions. For example, a course with a credit pattern of L: T: P = 2:1:1, out of two hours/week of T, one hour/week be for Theory and the remaining one hour be combined with two hours of Practical sessions. So, the duration for each batch of a practical will be 3 hours/week.

Practical Exercises

Based on the available resources in the Department, the list of practical exercises and the mode of conducting experiments shall be decided by the faculty member who teaches the course. In cases of programming tools, preference may be given for the Open Source Programming Tools. There is no limit for number of experiments. But, minimum number of experiments should have been conducted by the students to suite the semester pattern.

Examination Procedure

The question paper pattern, scheme of continuous and final valuation and other examination procedures are as per the CBCS guidelines of the University which are amended time to time. The duration of the theory examination is as per the University. But, the practical examination duration shall be of **THREE** hours.

Note: If any minor modifications are required in the contents of the syllabi or in the course structure and any other minor modifications required in any other academic issues for the benefit of candidates, the Department council shall decide on the same and implement it with the prior permission from the concerned University authorities.

The course structure and syllabi are herewith annexed.

Chairman
BOS in Electronics
University of Mysore

University of Mysore

Department of Studies in Electronics

Hemagangothri, Hassan – 573220.

Course Structure and Syllabi for M.Sc. (Electronics) under the Choice Based Credit System (CBCS) from the academic year, 2017-18.

Semester – I

Hard Core Courses

SN.	Code	Course Title	L	T	P	Total
1	EL11	Analog Circuit Design	2	1	1	4
2	EL12	Digital Circuit Design	2	1	1	4
3	EL13	Advanced Microprocessors	2	1	1	4

Soft Core Courses

SN.	Code	Course Title	L	T	P	Total
1	ES11	Microwave Communication	3	1	0	4
2	ES12	Control Systems	3	1	0	4
3	ES13	Signals & Systems	2	1	1	4
4	ES14	Solid State Electronics	3	1	0	4

Semester – II

Hard Core Courses

SN.	Code	Course Title	L	T	P	Total
1	EL21	Digital Communication	2	1	1	4
2	EL22	Digital Signal Processing	2	1	1	4
3	EL23	Embedded systems	2	1	1	4

Soft Core Courses

SN.	Code	Course Title	L	T	P	Total
1	ES21	Optical Fibre Communication	3	1	0	4
2	ES22	Object Oriented Programming	2	1	1	4
3	ES23	Antenna & Wave Propagation	3	1	0	4
4	ES24	Cryptography	3	1	0	4

Semester – III

Hard Core Courses

SN.	Code	Course Title	L	T	P	Total
1	EL31	CMOS VLSI Design	3	1	0	4
2	EL32	Power Electronics	2	1	1	4
3	EL33	Digital Image Processing	2	1	1	4

Soft Core Courses

SN.	Code	Course Title	L	T	P	Total
1	ES31	ARM Processors	2	1	1	4
2	ES32	DSP Processors	2	1	1	4
3	ES33	Data Structures in C	2	1	1	4
4	ES34	Information Theory and Coding	3	1	0	4

Semester – IV

Hard Core Course

SN.	Code	Course Title	L	T	P	Total
1	EL41	Project Work	0	0	4	4
2	ES42	Satellite Communication	3	1	0	4

Soft Core Courses

SN.	Code	Course Title	L	T	P	Total
1	ES41	Computer Networks	3	1	0	4
2	ES43	Wireless Sensor Networks	3	1	0	4
3	ES44	Low Power VLSI	3	1	0	4
4	ES45	Speech Processing	3	1	0	4
5	ES46	Nano Electronics	3	1	0	4

Open Elective Courses

Following courses are offered to the students of other Departments as Open Elective Courses. The Department council will decide about the courses offered in a semester.

SN.	Code	Course Title	L	T	P	Total
1	EO1	Fundamentals of Electronics	3	1	0	4
2	EO2	Semiconductor Devices	3	1	0	4
3	EO3	Computer Fundamentals	3	1	0	4
4	EO4	Consumer Electronics	3	1	0	4
5	EO1	Fundamentals of Electronics	3	1	0	4

Summary of Credit Pattern

Semester	**HC**	**SC**	**OE**	Total
I	12	8/12	0	20/24
II	12	4/8	4/0	20/24
III	12	4/8	4/0	20/24
IV	8	4/8	4/0	12/16
Total Credits **(minimum)**	44	28	4	76

Legend

1. L, T and P symbols denote Lecture, Tutorial and Practical. All numerical values represent number of credits allocated to each.
2. HC, SC and OE stands for Hard Core, Soft Core and O Elective Courses respectively.

ANALOG CIRCUIT DESIGN

L: T: P = 2: 1: 1 = 4 Credits

Course Outcomes

- Enable the student to understand the principle of operation of Electronic devices like BJT, FET, MOSFET, etc.
- Obtain the design and analysis skills of Analog circuits like amplifiers, oscillators, filters, tuner and power amplifiers.
- The hands on training in the Laboratory make the student to understand the working of the designed analog circuits and thereby getting the additional proof of the theoretical concepts.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Problem Solving, circuit design and analysis, discussions, seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

MOSFET: Small signal operation models, Single stage MOS amplifiers, MOSFET internal capacitance and high frequency model, Frequency response of Common Source amplifier. **8 Hrs**

Unit 2

Bipolar-junction transistor: Small signal operation and models, single BJT amplifier, BJT internal capacitance and high-frequency model, Frequency response of the common-emitter amplifier. **8 Hrs**

Unit 3

Filters and Tuned amplifiers: All-pass phase shifting circuits, First and second order Low pass & High pass filters, Band pass & Band-stop filters, State-variable band pass filter. Tuned amplifier, Single, double, staggered tuned amplifiers, Instability in tuned amplifiers. **8 Hrs**

Unit 4

Power amplifiers: Types of power amplifiers, Harmonic distortion, Class A Series fed amplifier, Class A transformer coupled amplifier, conversion efficiency, Class A push pull amplifier, conversion efficiency, Class B, Other types of class B amplifier, Class AB Amplifier. **8Hrs**

TEXT BOOK:

1. Adel S Sedra, Kenneth C Smith**, Microelectronic Circuits**, 5th edition, Oxford University Press, 2009.

REFERENCE BOOK:

1. Behzad Razavi, "**Fundamentals of Microelectronics**" , John Wiley, 2008
2. Robert L. Boylestad and Louis Nashelsky, **"Electronic Devices and Circuit Theory"** Pearson, 2010.

PRACTICAL EXERCISES*:*

Designing and implementation of following Analog Circuits

1. Current to Voltage Converter
2. Voltage to Current Converter
3. Single Stage CE Amplifier with Bypass capacitor, Without Bypass Capacitor and Half bypass.
4. Single Stage CC Amplifier using single transistor, CC amplifier using Darlington pair of transistor.
5. Two Stage CE Amplifiers.
6. Two Stage FET Amplifiers.
7. UJT Characteristics and Relaxation Oscillator.
8. SCR Characteristics and Applications.
9. Voltage Series/Voltage Shunt Amplifier.
10. Current Series/Current Shunt Amplifier.

DIGITAL CIRCUIT DESIGN

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

After studying this course, students will be able to

- Develop simplified switching equation using Karnaugh Maps and Quine McClusky techniques.
- Explain the operation of decoders, encoders, multiplexers, demultiplexers, adders, subtractors and comparators.
- Explain the working of Latches and Flip Flops (SR,D,T and JK).
- Design Synchronous/Asynchronous Counters and Shift registers using Flip Flops.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Problem Solving, analysis, discussions, seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit-1

Logic Simplification: Introduction, Minimal expression of incomplete Boolean expressions using K-Map (4 Variable), Quine-McClusky Method of obtaining Prime Implicants and Prime

Implicants, Prime Implicant tables for obtaining irredundant expressions, Prime iplicant and Notation for obtaining Prime Implicants.

Logic design using MSI components: Decimal Adders, Comparators, Decoders, Encoders, Multiplexers. **8 Hrs**

Unit-2

Flip-Flop Applications: Counters, Design of Synchronous counters, Analysis of Synchronous counters, Conversion of one flip-flop type to another, Counter Applications: Digital clock, Frequency counter, Time measurement. **8 Hrs**

Unit-3

Programmable Logic Devices: Programmable logic arrays (PLD), Programmable Read only memories, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), CPLDs, Altera Max 7000 CPLD, FPGA, Altera Flex 8000 FPGAs. **8 Hrs**

Unit-4

Analog to digital conversion: Digital to analog conversion - circuitry, specification and applications, analog to digital conversion, Digital ramp ADC, Data acquisition, Successive approximation ADC, Flash ADC, other ADC methods. **8 Hrs**

TEXT BOOK

1. Donald D Givone**, "Digital Principles and Design",** Tata McGraw Hill Edition.
2. Michael D. Ciletti, **"Advanced Digital Design With The Verilog HDL",** 1st Edition**,** Prentice-Hall (2009),

REFERENCE BOOK:

1. Charles H Roth, Jr; **"Fundamentals of logic design",** Thomson Learning, 2004.
2. Mono and Kim, **"Logic and computer design Fundamentals",** Second edition, Pearson, 2001.
3. Thomas l. Floyd, **"Digital Fundamentals"**, PHI 6th edition, 1996.
4. Ronald J.Tocci, **"Digital Systems and Applications",** PHI, 6th edition, 1996.

PRACTICAL WORK:

Design and Simulate and implement following logic circuits using VHDL

1. Basic gates, Universal gates, XOR and XNOR gates.
2. Half Adder, Full Adder, Half Subtractor, Full Subtractor (Uning both basic gates and NAND gates).
3. Binary to Gray, Gray to Binary, BCD to Excess 3, Excess 3 code to BCD converter
4. 3X8 Decoder, Encoder with and without priority
5. Multiplexer and Demultiplexer , S-R, J-K, D and T Flip flops, Digital comparators
6. Shift registers ,Counters
7. Ripple carry Adder
8. Carry look ahead Adder

ADVANCED MICROPROCESSORS

L: T: P = 2: 1: 1 = 4 Credits

Course Outcomes

- Enable the students to understand the Architecture and working principle of 8086 microprocessor in detail and briefly about advanced x86 family processors.
- Obtain the design and programming skills of microcomputer system construction using microprocessors.
- The hands on training in the Laboratory to program microprocessor using assembly language to make the student to understand the working of microprocessor based system.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Problem Solving using 8086 assembly level programming language and algorithm analysis, discussions, seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Introduction to Microprocessors and Architecture of the 8086 Microprocessors: General Architecture of a Microcomputer System, Evolution of Microprocessor Architecture, Internal Architecture of 8086, software model, Memory Address Space and Data organization, Data types, Segment Registers and Memory Segmentation, Instruction pointer, Data Registers, Pointer and Index Registers, Generating a Memory Address, The Stack, Input/output Address Space.

5Hrs

Unit 2

Programming and Instruction set of 8086: The Microcomputer Program, Assembly language program development on the PC, Addressing modes, Data Transfer, Arithmetic, Logic-Shift-Rotate, Flag Control, Compare, Jump, Subroutine and Subroutine-Handling, the Loop and Loop-Handling, String and String-Handling Instructions**.** **7Hrs**

Unit 3

The 8086 Microprocessor Memory and I/O Interface: minimum Mode and Maximum Mode Systems, Minimum-System-Mode Interface, System Clock, Bus Cycle, Hardware Organization of the Memory Address Space, Memory Bus Status Codes, Memory Control Signals, Read and Write Signals, Memory Interface Circuits. Types of I/O, The Isolated I/O Interface, I/O Data Transfers, I/O Instructions, I/O Bus Cycles,8-Byte wide output ports using Isolated I/O, 8-Byte wide Input Ports using Isolated I/O, Memory Mapped I/O, Programmable I/O port using 8255**.** **10Hrs**

Unit 4

8086 Interrupts: Types of Interrupts, Interrupt Instructions, Enabling/disabling of Interrupts, External Hardware Interrupts Interface, External Hardware sequence, and software Interrupts, Nonmaskable Interrupts, Reset, and Internal Interrupts Functions.

The 80386, 80486, and Pentium Processor Families: 80386 Microprocessor Family- Internal Architecture, Real Mode Software Model and Protected Mode Software Architecture of 80386DX,

Pentium Microprocessor Family- Internal Architecture and Software Architecture.

10Hrs

TEXT BOOKS:

- Waltier A. Triebel and Avtar Singh, ***The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware and applications, 4th*** *Edition,* Pearson, 2007.
- Barry B. Brey**,** ***The Intel Microprocessors 8086/8088, 80186, 80386 and 80486 Architecture, Programming and Interfacing,*** PHI New Delhi.

REFERENCE BOOKS:

- Yu-cheng Liu and Glen A. Gibson, ***Microcomputer Systems: The 8086/8088 Family Architecture, Programming and design,*** PHI, 1997.

PRACTICAL EXERCISES*:*

8086 Assembly Language Programming practice

1. ALP to demonstrate use of Data transfer, Arithmetic ,Logical, Rotate and Shift instructions
2. ALP to demonstrate use of Branching, String instructions.
3. ALP to demonstrate use of Subroutine instructions
4. ALP to demonstrate use of Input and Output instructions.
5. ALP to demonstrate use of Software interrupts instructions.

MICROWAVE COMMUNICATION

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- Enable the students to understand the field of microwave communication from the basics including microwave transmission lines, waveguides, strip lines, microwave sources and diodes (magnetron, klystron, READ, IMPAT, GUN diodes, directional couplers, E-plane, H-plane and magic tee), microwave applications (principle operations of RADARs, Microwaveoven etc.).
- Obtain the design and analysis skills of the above microwave circuits and devices.
- The hands on training in the Laboratory to make the students to understand the working of the designed microwave components by introducing them to some available free EM simulators and thereby getting the additional proof of the theoretical concepts.

Pedagogy Objectives

- The course has Lecture, and Tutorial parts.
- Problem Solving, circuit design and analysis, discussions, seminars are conducted, hands on training (freely available EM simulators) are given in Laboratory to better understand the theoretical concepts in the Tutorial period.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Microwave Transmission Lines: Introduction, transmission lines equations and solutions, reflection and transmission coefficients, standing waves and SWR, line impedance and line admittance. Smith chart, impedance matching using single stubs, Microwave coaxial connectors. **12Hrs**

Unit 2

Microwave Waveguides and Components: Introduction, rectangular waveguides, circular waveguides, microwave cavities, microwave hybrid circuits, directional couplers, circulators and isolators. **12Hrs**

Unit 3

Microwave Diodes and Strip Lines:: Transfer electron devices: Introduction, GUNN effect diodes – GaAs diode, RWH theory, Modes of operation, Avalanche transit time devices: READ diode, IMPATT diode, BARITT diode, Parametric amplifiers. Strip Lines: Introduction, Micro strip lines, Parallel strip lines, Coplanar strip lines, Shielded strip Lines. **12Hrs**

Unit 4

Micro-Strip Antennas: Introduction, Antenna parameters, types of micro strip antennas, Feeding techniques, methods of analysis, transmission line model, cavity model and design examples and applications. **12Hrs**

TEXT BOOKS*:*

1. Samuel Y Liao, **Microwave Devices and Circuits**, 3rd Edition, Pearson Education 2011.
2. Constatine A. Balanis**, Antenna –Theory**, 2nd Edition, WILEY Edition 2007.
3. Annapurna Das, Sisir K Das, **Microwave Engineering**, TMH Publication, 2nd, 2010.

REFERENCE BOOK:

1. David M Pozar, **Microwave Engineering**, John Wiley, 2nd Edition, 2004.

CONTROL SYSTEMS

L: T: P =3:1:0 = 4 Credits

Course Outcomes

- The first semester M.Sc. Electronics students are going to compete with the technical students (BE, M-Tech) after their masters to get the suitable job in industries or institutions, keeping this in mind, students are introduced to understand the control system. This subject is well applied in all industries. The student is going to learn the basics of control system and its applications.

- The topics such as control system modelling, time and frequency response analysis, stability of system, state variable analysis are thoroughly discussed with analytical approach.

Pedagogy Objectives

- The course has Lecture and Tutorial parts.
- Problem Solving, circuit design and analysis, discussions, seminars are conducted in the Tutorial period.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Control System Modelling: Basic Elements of Control System – Open loop and Closed loop systems – Differential equation - Transfer function, Modelling of Electric systems, Translational and rotational mechanical systems - Block diagram reduction Techniques - Signal flow graph
Time Response Analysis : Time response analysis - First Order Systems - Impulse and Step Response analysis of second order systems - Steady state errors – P, PI, PD and PID Compensation **12 Hrs**

Unit 2

Frequency Response Analysis: Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Frequency Domain specifications from the plots - Constant M and N Circles - Nichol's Chart - Use of Nichol's Chart in Control System Analysis. Series, Parallel, series-parallel Compensators - Lead, Lag, and Lead Lag Compensators. **12 Hrs**

Unit 3

Stability Analysis : Stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, Stability, Dominant Poles, Application of Root Locus Diagram - Nyquist Stability Criterion -Relative Stability. **12Hrs**

Unit 4

State Variable Analysis : State space representation of Continuous Time systems – State equations – Transfer function from State Variable Representation – Solutions of the state equations – Concepts of Controllability and Observability – State space representation for Discrete time systems. Sampled Data control systems – Sampling Theorem – Sampler & Hold – Open loop & Closed loop sampled data systems. **12Hrs**

TEXTBOOK

1. J.Nagrath and M.Gopal**, " Control System Engineering"**, New Age International Publishers, 5th Edition, 2007.

REFERENCE

1. Benjamin.C.Kuo, **"Automatic Control Systems"**, Prentice Hall of India, 7th Edition, 1995.
2. M.Gopal, **"Control System – Principles and Design"**, Tata McGraw Hill, 2nd Edition, 2002.

3. Schaum's Outline Series, **Feedback and Control Systems,** Tata McGraw-Hill, 2007.
4. John J.D'azzo & Constantine H.Houpis, **Linear Control System Analysis and Design**, Tata McGrow-Hill, Inc., 1995.
5. Richard C. Dorf & Robert H. Bishop, **"Modern Control Systems",** Addidon – Wesley, 1999.

SIGNALS AND SYSTEMS

L: T: P =2:1:1 = 4 Credits

Course Outcomes

On completion of the course, students will acquire the knowledge of:

- Signals and systems and develop the input-output relationship of LTI systems.
- Analysis of mixed signals and their representing in frequency domain using Fourier analysis tools.
- Analysis of the signals using Fourier, Laplace and Z-transforms.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- In the tutorial sessions, numerical problem solving, discussions and seminars are conducted.
- In the laboratory, simulation experiments are carried out for different signal generation, analysis, and characterization of LTI systems using Fourier, Laplace and Z- transforms.
- Assignments and periodic theory and lab tests are given to evaluate the student's understanding of the subject.

Course Contents

UNIT 1

Signals: Definition, classification, operations and Elementary signals.
Systems: Definition, Interconnections, Properties, Moving Average Systems.
LTI Systems: Convolution Sum, Integral and their evaluation. Interconnections, Properties, Impulse and step Responses, and block diagram Representation. Differential and difference equations and their solutions, Characteristics of Systems, Block Diagram Representation, State-Variable Descriptions. 8 **Hrs**

UNIT 2

Fourier Representation: Complex Sinusoids, Frequency Response, Forward and Inverse Fourier Series and Fourier Transform of Continuous and Discrete Time Signals and their properties, Parseval Relationships, Time-Bandwidth Product, Duality Property.
Mixed Signals: Fourier Transform Representations of Periodic Signals, Convolution and Multiplication with Mixtures of Periodic and Nonperiodic Signals. Fourier Transform Representations of Discrete-Time Signals. Sampling and Reconstruction, Discrete Time processing of Continuous-Time signals, Fourier Series Representations of Finite-Duration Non Periodic Signals, The Discrete time Fourier Series approximation to the Fourier transform. **10 Hrs**.

UNIT 3

Laplace Transform: The Laplace Transform, Unilateral Laplace Transform and its Inversion, Properties. Solving Differential Equations, Laplace Transform Methods in Circuit Analysis, Properties of Bilateral Laplace Transform and ROC, Inversion of Bilateral Laplace transform, Transfer function, Causality and Stability, Frequency Response from Poles and Zeros. 7 **Hrs**

UNIT 4

Z-Transform: The Z–transform, Properties of ROC and properties of Z– transform, Inversion of Z–transform, The Transfer function, causality and Stability, Frequency Response from Poles and Zeros, Unilateral Z-transform. 7 **Hrs**

Text Book:

1. Simon Haykin, Barry Van Veen, "**Signals and Systems**", John Wiley India Pvt. Ltd., 2nd Edn, 2008.

Reference:

1. Alan V Oppenheim, Alan s. Willsky and Hamid Nawab, **"Signals and systems",** Pearson edition Asia/PHI, 2nd Edition, 2002.

Laboratory Exercises

1. Generation and plotting of elementary signals
2. Generate and plot Even and Odd components of a signal
3. Basic Operations on signals of varied lengths and reference points.
4. Computation of linear convolution, cross-correlation and auto-correlation of signals of varied lengths and reference points. Verify the result manually and built-in function
5. Frequency Analysis of signals using Fourier analysis and properties of Fourier Analysis
6. Solution to Differential and Difference Equations built-in function.
7. Study Laplace Transform and its Properties
8. Study of Z-transform and its properties

SOLID STATE ELECTRONIC DEVICES

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- Students acquire the knowledge of transport phenomenon in semiconductor materials.
- Understand the process of semiconductor material growth.
- Gain the knowledge of fabrication and characterization of MESFETS, Opt-electronic devices, and high-frequency semiconductor devices.

Pedagogy Objectives

- Pictorial and video illustrations are presented to understand the various stages of semiconductor material growth and fabrication.
- With the use of device models and mathematical equations, the students are enable to understand the behaviour of solid state electronic devices.

Course Contents

Unit 1

Crystal Properties and Growth of Semiconductors : Semiconductor materials , Periodic Structures, Crystal Lattices, Cubic lattices – Planes and Directions, Diamond lattice, Bulk Crystal Growth, Starting Materials, Growth of Single Crystal lngots, Wafers, Doping, Epitaxial Growth, Lattice Matching in Epitaxial Growth, Vapor, Phase Epitaxy, Atoms and Electrons, Introduction to Physical Models ,Experimental Observations,Photoelectric Effect. **12 Hrs.**

Unit 2

Energy Bands and Charge Carriers in Semiconductors and Junctions : Energy bands in Solids, Energy Bands in Metals, Semiconductors, and Insulators , Direct and Indirect Semiconductors , Variation of Energy Bands with Alloy Composition, Charge Carriers in Semiconductors , Electrons and Holes , Electrons and Holes in Quantum Wells , Carrier Concentrations , Fermi Level , Electron and Hole Concentrations at Equilibrium , Temperature Dependence of Carrier Concentrations , Compensation and Space Charge Neutrality , Drift of Carrier in Electric and Magnetic Fields conductivity and Mobility , Drift and Resistance , Effects of Temperature and Doping on Mobility , High field effects , Hall Effect , invariance of Fermi level at equilibrium , Fabrication of p,n junctions, Metal semiconductor junctions. **12 Hrs**

Unit 3

Metal Oxide Semiconductor FET : GaAS MESFET , High Electron Mobility Transistor , Short channel Effects – Metal Insulator Semiconductor FET , Basic Operation and Fabrication , Effects of Real Surfaces , Threshold Voltage , MOS capacitance Measurements , current – Voltage Characteristics of MOS Gate Oxides , MOS Field Effect Transistor – Output characteristics , Transfer characteristics , Short channel MOSFET V,I characteristics , Control of Threshold Voltage , Substrate Bias Effects , Sub threshold characteristics , Equivalent Circuit for MOSFET , MOSFET Scaling and Hot Electron Effects , Drain , Induced Barrier Lowering , short channel and Narrow Width Effect , Gate Induced Drain Leakage. **12 Hrs.**

Unit 4

Opto Elctronic Devices: Photodiodes , Current and Voltage in illuminated Junction , Solar Cells , Photo detectors , Noise and Bandwidth of Photo detectors , Light Emitting Diodes , Light Emitting Materials , Fiber Optic Communications Multilayer Hetero junctions for LEDs , Lasers , Semiconductor lasers , Population Inversion at a Junction Emission Spectra for p,n junction , Basic Semiconductor lasers , Materials for Semiconductor lasers.

High Frequency and High Power Devices: Tunnel Diodes, IMPATT Diode, operation of TRAPATT and BARITT Diodes, Gunn Diode, transferred, electron mechanism, formation and drift of space charge domains, p-n-p-n Diode, Semiconductor Controlled Rectifier, Insulated Gate Bipolar Transistor. **12 Hrs**

Text book

1. Ben. G. Streetman & Sanjan Banerjee, **Solid State Electronic Devices**, 5th Edition, PHI, 2003.

References

1. Donald A. Neaman, **Semiconductor Physics and Devices**, 3rd Edition, TMH, 2002.
2. Nandita Das Gupta & Aamitava Das Gupta, **Semiconductor Devices Modeling a Technology**, PHI, 2004.
3. D.K. Bhattacharya & Rajinish Sharma, **Solid State Electronic Devices**, Oxford University Press, 2007.

DIGITAL COMMUNICATION

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

- To provide in-depth understanding of sources and signal in modern digital communications with applications to wireless transmission.
- Mathematical modelling to problems in digital communication and to explain how this is used to analyze and synthesize methods and algorithms within the field.
- Learner will be able to analyze different modulation techniques in modern digital communication.
- Learner will be able to understand Error Control Coding and types of codes.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Problem Solving, circuit design and analysis, discussions, seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts. Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Introduction: Sources and Signal, Element of Digital Communications, Channels for Digital Communications.

Fundamental Limits on Performance: Source Coding Theorem, Huffman Coding, Channel Coding Theorem, Matched Filter Receiver. **8Hrs**

Unit 2

Sampling Process: Sampling Theorem, Signal Distortion in sampling, practical aspects of sampling and signal recovery, Time-Division Multiplexing

Waveform Coding Techniques: Pulse-code Modulation, Channel Noise and error Probability, differential PCM, Delta modulation, coding speech at Rate, Application- Digital Multiplexers. **8Hrs**

Unit 3

Digital Modulation Techniques: Digital Modulation Formats, Coherent Binary Modulation Techniques, Coherent Quadrature- Modulation Techniques, Non- Coherent Binary modulation Techniques, Comparison of Binary and Quaternary modulation Techniques, M-ary Modulation Techniques, Power Spectra, Bandwidth Efficiency, M-ary modulation formats Viewed in the light of the Channel Capacity Theorem, Effect of Inter symbol Interference, Bit Verses Symbol Error Probability, Synchronization, Applications. **8Hrs**

Unit 4

Error- Control Coding: Rationale for Coding and Types of Codes, Discrete Memory less Channel, Linear Block Codes, Cyclic Codes, Conventional Codes, Maximum-Likelihood

Decoding of Conventional Codes, Distance Properties of Conventional Codes, Sequential Decoding of Conventional Codes, Trellis Codes, Applications.

Voice Communications: Telephone Systems and Modems: Basic telephone Service, Dialing, Telephone lines, Switching Systems, The Role of Modems, types of Modems. **8Hrs**

TEXT BOOK:

1. Siemon Haykin ,**Digital Communications**, John Wiley 7 sons, 1988.
2. William L. Schweber, **Data Communications**, McGraw-Hill Internal Edn.1988.

REFERENCE BOOKS:

1. Simon Haykin**, Analog and Digital Communication**, John Wiley 7 sons, 1988
2. Herbert Taub &b Donald L. Schilling, **Principles of Communication Systems, TMH**, 2nd Edition, 1999

PRACTICAL EXERCISES:

1. Study of Time Division Multiplexing system, pulse code modulation and demodulation
2. Study of delta modulation and demodulation and observe effect of slope overload.
3. Study pulse data coding techniques for various formats.
4. Data decoding techniques for various formats.
5. Study of amplitude shift keying modulator and demodulator.
6. Study of frequency & phase shift keying modulator and demodulator.
7. Study of Pulse amplitude modulation and de-modulation
8. Study of Pulse width modulation and de-modulation
9. Study of Pulse position modulation and de-modulation

DIGITAL SIGNAL PROCESSING

L: T: P= 2:1:1 = 4 Credits

Course Outcomes

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

- Discrete Fourier transform and its properties.
- Efficient computation Fourier transforms with the FFT algorithms.
- Design and realization of IIR and FIR filters.
- Design, realization and characterization of discrete-time systems.

Pedagogy Objectives

- With sufficient number of numerical examples, assignments, tests and illustrations, the student is made to imbibe the knowledge of signal processing.
- In the laboratory, software simulation of signal processing algorithms, and hardware implementation of FFT algorithms, realization of IIR and FIR filters using floating point DSP processors are carried out.

Course Contents

Unit-1

The Discrete Fourier Transform: Its Properties and Applications: Frequency Domain Sampling: The Discrete Fourier Transform, Properties of the DFT, Linear Filtering methods Based on the DFT, Frequency Analysis of signals using the DFT, The Discrete Cosine transform.

9 Hrs

Unit-2

Efficient Computation of the DFT: Fast Fourier Transform Algorithms: Efficient Computation of the DFT: FFT Algorithms, Applications of FFT Algorithms, Linear Filtering Approach to Computation of the DFT, Quantization Effect In the Computation of the DFT.

9 Hrs

Unit-3

Implementation of Discrete -Time Systems: Structures for the Realization of Discrete -Time Systems, Structures for FIR Systems, Structures for IIR Systems, Representation of Numbers, Quantization of Filter Coefficients, Round-off Effects in Digital Filters. **6 Hrs**

Unit-4

Design of Digital Filters: General considerations, Design of FIR Filters, Design of IIR Filters from Analog Filters, Frequency Transformations. **8Hrs**

TEXT BOOK:

1. John G. Manolakis, **"Digital Signal Processing",** Fourth Edition, Pearson, Publication, 2011.

REFERENCE BOOKS:

1. R W Schafer and Alam V. Oppenheim**, "Digital Signal Processing",** Pearson,2008
2. Leudmann, **"Fundamentals of Digital Signal Processing",** Harper & Row Publication.

PRACTICAL EXERCISES

1. Verification of sampling theorem.
2. Impulse response of a given system
3. Linear convolution of two given sequences.
4. Circular convolution of two given sequences
5. Autocorrelation of a given sequence and verification of its properties.
6. Cross correlation of given sequences and verification of its properties.
7. Solving a given difference equation.
8. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum.
9. Linear convolution of two sequences using DFT and IDFT.
10. Circular convolution of two given sequences using DFT and IDFT
11. Design and implementation of FIR filter to meet given specifications.
12. Design and implementation of IIR filter to meet given specifications.

EMBEDDED SYSTEMS

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

On successful completion of the course:

- Enable the student to understand the working principle, designing and construction of embedded system using microcontroller.
- Obtain the design and programming skills of PIC microcontroller and its peripherals using embedded C programming language.
- The hands on training given in the Laboratory to program microcontroller and its peripheral using C language to make the student to understand the working of embedded system and designing.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Programming PIC microcontroller using embedded C, discussions, seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts of embedded systems software and hardware.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Unit 1

Intoduction: An embedded system, features of embedded system, components of embedded system, examples of embedded system application, Harvard and Van-Neumann Architecture, Processors in embedded systems (RISC, CISC), Communication Protocols – RS 232, I2C, USB, USART, SPI, CAN, PCMCIA, and IrDA. **8hrs**

Unit 2

PIC micro-controllers: Overview and features (18F458), Architecture, memory organization, interrupts, inbuilt controller features, Assembly instructions and addressing modes, **8hrs**

Unit 3

PIC Programming in C: Data types and time delays in C, I/O programming, logic operation, data conversions, data serialization, Program ROM allocation, Data RAM allocation, Timer programming, serial port programming, interrupt programming, keyboard and LCD Interfacing, ADC, DAC interfacing, Using Flash and EEPROM memories for data storage, CCP, SPI Protocol, Stepper motor and DC motor interfacing. **8hrs**

Unit 4

Real-Time Kernels and Operating Systems: Tasks and Things, Programs and Processes, The CPU is a resource, Threads – Lightweight and heavyweight, Sharing Resources, Foreground/Background Systems, The operating System, The real time operating system (RTOS), OS architecture, Tasks and Task control blocks, memory management revisited.

8hrs

TEXT BOOKS:

1. James K Peckol***, "Embedded Systems – A contemporary Design Tool",*** John Wily, 2008.
2. Muhamad Ali Mazid, Rolind D. Mckinlay ***"PIC Microcontroller and Embedded Systems",*** Pearson education, 2008

REFERENCE BOOKS:

1. John Pitman, "***Design with PIC Microcontrollers",*** Prentice hall, 1997.
2. Richard Barnett, ***"Embedded C Programming & Atmel AVR",*** Thomson Publication.
3. Jonathan W Valvano, ***"Embedded Microcomputer systems",*** Thomson Publication
4. David E. Simon, ***"An Embedded Software",*** Addison- Wesley, 1999.
5. Rajkamal, ***"Embedded Systems",*** 2nd Edition, Tata McGraw Hill ,2008

PRACTICAL EXERCISE:

1. Arithmetic and Logic programs
2. Square wave generation using ports
3. Key interfacing and LED Interfacing
4. Seven segment display interfacing
6. Traffic light control system, Water level controller, Flow & Temperature measurement
7. Interfacing ADC, DAC, Stepper motor, LCD, Serial port using RS232C.
8. Timer/Counter operations, Digital clock, Object counter

OBJECT ORIENTED PROGRAMMING

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

- Enable the students to understand the computer application design using object oriented programming.
- Obtain the knowledge and skills of object oriented programming using C++ Programming language.
- The hands on training in the Laboratory to program computer application using C++ language to make the student to understand the object oriented programming techniques.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Algorithm analysis, discussions, seminars are conducted in the Tutorial period..
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

OOP preliminaries: Contrast with Structured Programming; basic concepts of objects, classes, abstraction, encapsulation, polymorphism, inheritance, dynamic binding & message communication.

C++ preliminaries: Tokens, Keywords, Variable, scope of variables, Data type, pointers, generic pointers, operators-scope resolution, member de-referencing operators, memory management operators, manipulators, type cast operators; Symbolic constants, Type compatibility, Dynamic initialization, Flexible declaration, Reference variable, Call by reference. **8Hrs**

Unit 2

Objects & Classes: abstract & declaration syntax, visibility label-private, public, protected, Inline concept, Static data member & member function, Array of objects, Pointer to objects & members, Array of pointers to objects.

Functions: Declaration & definition, exploring arrays & strings, function overloading, const function, passing & returning object through function, The Friend function. **8Hrs**

Unit 3

Constructors & Destructors: Default constructors, default argument constructor, parameterized constructor, Copy constructor, Destructor.

Inheritance and Polymorphism: Visibility modes, Single Inheritance, Multi-level Inheritance, Hierarchical Inheritance, Multiple Inheritance, Hybrid Inheritance, Virtual base class, abstract class. Function overloading, Operator overloading, overloading unary, binary, string manipulation using operators. Run time - Virtual function, pointer to object, this pointer, pure virtual function.

8Hrs

Unit 4

Files & advanced features: C++ file streams, stream classes, detecting end-of-file, file pointers & their manipulations; managing console I/O, Templates & Exception handling, class templates, templates function. **8Hrs**

TEXT BOOK:

1. Object Oriented Programming using C++, Robert Lafore, Pearson.

REFERENCES:

2. Object Oriented Programming using C++, Balagurusamy, TMGH
3. Waite Groups C++ Primer Plus, Stephen Prata, Techmedia.
4. The C++ Programming Language, B.J. Stroustrup, Pearson.
5. C++ Complete Reference, Shield, MGH

PRACTICAL EXERCISE:

1. Formatted I/O
2. File I/O
3. Pointer to characters; Pointer arithmetic;Array of pointers
4. A simple program demonstrating references
5. Function; Nested structure ; C++ class; Constructor ; Destructor ; Inheritance
6. Calling base class's constructor in derived class
7. Pointer to derived objects, Virtual functions and polymorphism

OPTICAL FIBER COMMUNICATION

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- It provides the students, the fundamentals of properties of light helpful for optical fibre communications.
- Enrich the knowledge about losses in optical fibre to make the efficient utilization of fibre.
- Able to understand the concepts of light emitting diodes and laser diodes used as optical sources and different diodes used as detectors and its operational features.
- To introduce the methods of coupling between various optical components to improve the power launching capability.

Pedagogy Objectives

- The course has lecture and tutorial sessions.
- The concepts are delivered through teaching, discussions and questioning.
- The deep insight of latest optical technological concepts through presentations by students.
- The regular assignments and periodic tests help in evaluation of their understanding.
- Hands-on by experts from telecom department gives the practical understanding.

Course Contents

Unit 1

Optical Fibers: Structures and Wave Guides, fundamentals, Nature of Light, Basic Optical Laws and Definitions, Optical Fiber Types, Rays And Modes, Step index Fibers, Ray optics.
Signal Degradation in Optical Fibers: Attenuation, Scattering Losses, Radiative losses, Absorption Losses, Core and Cladding Losses, signal Distortion in Optical Wave Guides, Group Delay, Dispersion, Pulse Broadening in Graded Index Wave guides. **12Hrs**

Unit 2

Optical Sources: LED'S- Structure, Source Materials, Internal Quantum Efficiency, Modulation Capability, Transient response, Power Bandwidth Product, Laser Diodes- Structures, Threshold Conditions, Model Properties and Radiation Patterns, Modulation of Laser diodes, Temperature Effects, Light source Linearity, model and Reflection Noise, Reliability considerations. **12 Hrs**

Unit 3

Power Launching and Coupling: Source to Fiber Power Launching, Source Output Pattern, Power Coupling Calculations, Power launching V/s Wave Length, Equilibrium Numerical Aperture Len sing Schemes for Coupling Improvement, Non Imaging Micro sphere, Laser Diode to Fiber coupling, Fiber to Fiber Joints, Misalignment, Fiber related Losses, Fiber and Face preparation, Splicing Techniques, Fiber connection. **12Hrs**

Unit 4

Photo Detectors: Physical Principals, the PIN Photo Detectors, Avalanche Photo Diodes, Photo detector Response time, avalanche Multiplication Noise, Temperature Effects on Avalanche Gain, Photodiodes Materials.
Optical Receivers Operations: Fundamentals of Receiver operation, Digital signal Transmission, Error source, Receiver Configuration, Digital receiver performance Calculation, Receiver Noise,

Shot noise, Sensitivity, Nonzero Extinction Ration, Preamplifier Design, High Impedance FET Amplifier, High Impedance Bipolar Transmitter Amplifier, Trans-Impedance Amplifier, Analog Receivers. **12Hrs**

TEXT BOOK:

1.Gerd Keiser, **"Optical Fiber Communications"**. McGraw Hill International.

REFERENCE BOOKS:

1. Senior. M, **"Optical Fiber Communications",**Prentice Hall 2nd Edition 1992

2. Gower**, "Fiber Optics"**, Personick – Khanna Publishers, Delhi.

ANTENNA AND WAVE PROPAGATION

L: T: P 3:1:0 = 4 Credits

Course Outcomes

- The first semester M.Sc. Electronics students are aware of microwave communication, so in their second semester they are going to study the antennas and its application in microwave communication. Here different types of antennas are introduced and both theoretical and some simulation study is carried out in this course.
- This subject is well applied in all radio frequency (RF) industries. The student is going to learn the basics of antenna system and its applications.
- The topics such as Introduction to Antenna and its theory, Types of Antennas, Applications in real time domain are thoroughly discussed with analytical approach.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Problem Solving, different types of antenna design and analysis, discussions, seminars are conducted in the Tutorial period.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Electromagnetic Radiation and Antenna Fundamentals: Review of electromagnetic theory: Vector potential, Solution of wave equation, retarded case, Hertizian dipole. Antenna characteristics: Radiation pattern, Beam solid angle, Directivity, Gain, Input impedance, Polarization, Bandwidth, Reciprocity, Equivalence of Radiation patterns, Equivalence of Impedances, Effective aperture, Vector effective length, Antenna temperature. **12Hrs**

Unit 2

Wire Antennas and Antenna Arrays: Wire antennas: Short dipole, Radiation resistance and Directivity, Half wave Dipole, Monopole, Small loop antennas. Antenna Arrays: Linear Array and Pattern Multiplication, Two-element Array, Uniform Array, Polynomial representation.

12Hrs

Unit 3

Aperture Antennas : Aperture Antennas: Magnetic Current and its fields, Uniqueness theorem, Field equivalence principle, Duality principle, Method of Images, Pattern properties, Slot antenna, Horn Antenna, Pyramidal Horn Antenna, Reflector Antenna-Flat reflector, Corner Reflector, Common curved reflector shapes, Lens Antenna.

12Hrs

Unit 4

Microstrip Antennas and Antenna Measurements: Introduction, types of micro strip antennas, Feeding techniques, methods of analysis, transmission line model, cavity model and design examples and applications. Fundamentals of near and far field measurement techniques.

12Hrs

TEXTBOOKS

1. E.C.Jordan and Balmain, **"Electromagnetic Waves and Radiating Systems**", Pearson Education / PHI, 2006
2. A.R.Harish, M.Sachidanada, **"Antennas and Wave Propagation",** Oxford University Press, 2007.

REFERENCES

1. John D.Kraus, Ronald J Marhefka and Ahmad S Khan, "**Antennas for All Applications"**, Tata McGraw-Hill Book Company, 3 ed, 2007.
2. G.S.N.Raju, **Antenna Wave Propagation**, Pearson Education, 2004.
3. Constantine A. Balanis, **Antenna Theory Analysis and Design**, John Wiley, 2nd Edition, 2007.

CRYPTOGRAPHY

L: T: P = 3: 1: 0 = 4 Credits

Course Outcomes

- Evaluate security mechanisms using rigorous approaches, including theoretical concepts.
- Illustrate various Public key cryptographic techniques.
- Evaluate the authentication and hash algorithms and basic concepts of system level security.
- Understand the most common type of cryptographic algorithm.
- Be able to perform simple vulnerability assessments and password audits.

Pedagogy Objectives

- The course has Lecture and Tutorial parts.
- Problem Solving, circuit design and analysis, discussions and seminars are conducted in the Tutorial period.

- Assignments and periodic tests are given to evaluate the student's understanding of the subject.
- Utilize their training and experience in creative and design processes toward their job functions.

Course Contents

Unit 1

Introduction: OSI Security Architecture - Classical Encryption techniques – Cipher Principles – Data Encryption Standard – Block Cipher Design Principles and Modes of Operation – Evaluation criteria for AES – AES Cipher – Triple DES – Placement of Encryption Function – Traffic Confidentiality. **12 Hrs**

Unit 2

Public Key Cryptography: Key Management - Diffie-Hellman key Exchange – Elliptic Curve Architecture and Cryptography - Introduction to Number Theory – Confidentiality using Symmetric Encryption – Public Key Cryptography and RSA. **12 Hrs**

Unit 3

Authentication and Hash Function: Authentication requirements – Authentication functions – Message Authentication Codes – Hash Functions – Security of Hash Functions and MACs – MD5 message Digest algorithm - Secure Hash Algorithm – RIPEMD – HMAC Digital Signatures – Authentication Protocols – Digital Signature Standard **12Hrs**

Unit 4

Network Security: Authentication Applications: Kerberos – X.509 Authentication Service – Electronic Mail Security – PGP – S/MIME - IP Security – Web Security.

System Level Security: Intrusion detection – password management – Viruses and related Threats – Virus Counter measures – Firewall Design Principles – Trusted Systems**.**

12Hrs

TEXT BOOKS

1. William Stallings, **"Cryptography And Network Security – Principles and Practices**", Pearson Education, Third Edition, 2003.
2. Behrouz A. Foruzan, "**Cryptography and Network Security",** Tata McGraw-Hill, 2007

REFERENCES

1. Bruce Schneier, **"Applied Cryptography",** John Wiley & Sons Inc, 2001.
2. Charles B. Pfleeger, Shari Lawrence Pfleeger, "**Security in Computing**", Third Edition, Pearson Education, 2003
3. Wade Trappe and Lawrence C. Washington , **" Introduction to Cryptography with Coding theory"** , Pearson Education, 2007.
4. Wenbo Mao, **" Modern Cryptography Theory and Practice"** , Pearson Education , 2007
5. Thomas Calabrese, **"Information Security Intelligence : Cryptographic Principles and Applications",** Thomson Delmar Learning,2006.
6. Atul Kahate**, "Cryptography and Network Security"**, Tata McGraw-Hill, 2003.

CMOS VLSI DESIGN

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- Provides the processing methods for basic metal oxide semiconductor technologies and details of representation and design rules of circuits.
- Glimpse of logic structures and details of electrical properties in terms of physical structure to understand the concept of scaling.
- Subsystem design concepts with few basic design examples provides for overview of CMOS designing.
- The illustration of process for different fundamental sub- systems and memories with clocking strategy helps for overall CMOS design.

Pedagogy Objectives

- The course is divided into lecture and tutorial sessions.
- The practicing of designing by drawing the structures and detail explanation.
- Assignments and periodic tests help in evaluation of the deep understanding.
- Helps in undertaking projects based on advanced VLSI.

Course Contents

Unit - 1

Basic mos technology: Integrated circuits era, Enhancement and depletion mode MOS transistors, nMOS fabrication, CMOS fabrication, Thermal aspects of processing, BiCMOS technology, Production of E-beam masks.

Mos transistor theory: Introduction, MOS Device Design Equations, The Complementary CMOS Inverter – DC Characteristics, Static Load MOS Inverters, The Differential Inverter, The Transmission Gate, Tristate Inverter**.**

Circuit design processes: MOS layers, Stick diagrams, Design rules and layout – lambda-based design and other rules. Examples, Layout diagrams, Symbolic diagrams, Tutorial exercises, Basic Physical Design of Simple logic gates.

12Hrs

Unit - 2

Cmos logic structures: CMOS Complementary Logic, Bi CMOS Logic, Pseudo-nMOS Logic, Dynamic CMOS Logic, Clocked CMOS Logic, Pass Transistor Logic, CMOS Domino Logic Cascaded Voltage Switch Logic (CVSL).

Basic circuit concepts: Sheet resistance, Area capacitances, Capacitance calculations, The delay unit, Inverter delays, Driving capacitive loads, Propagation delays. Wiring capacitance

Scaling of mos circuits: Scaling models and factors, Limits on scaling, Limits due to current density and noise. **12Hrs**

Unit - 3

Cmos subsystem design: Architectural issues. Switch logic, Gate logic. Design examples – combinational logic, Clocked circuits. Other system considerations, Clocking Strategies

12Hrs

Unit - 4

CMOS subsystem design processes: General considerations, Process illustration, ALU subsystem, Adders, Multiplier.

Memory, registers and clock: Timing considerations, Memory elements, Memory cell arrays.

12Hrs

TEXT BOOKS:

1. *Basic VLSI design*, **Douglas A Pucknell, PHI,** 3rd edition **2004**
2. *Principles of CMOS VLSI design*, **Neil Weste & Eshraghian, Addison Wesley** 2nd **edition.**

REFERENCE BOOKS:

1. *Introduction to VLSI systems*, **Mead & Conway-** *Addison Wesley-2nd edition*
2. *VLSI Design Techniques for Analog and Digital circuits*, **Geiger, Allen, Strader Tata Mc Grawhill.**

POWER ELECTRONICS

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

- In the first and second semester, our students have good knowledge on low power electronic circuits and applications but it is not sufficient for them to work in industries. They need to study the electronics components, devices, circuits designed and operated in high power rating applications in real time applications.
- Keeping this in mind the third semester students are introduced to study the power electronics as hardcore subject. This subject is well planned and various topics such as introduction, power devices such as SCR, DIAC, TRIAC, IGBT, PMOSPET etc., and circuits such as converters, inverters, cyclo-converters are taught as per the industrial requirements.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Problem Solving, circuit design and analysis, discussions, seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Power Electronics Devices : Characteristics of power devices – characteristics of SCR, diac, triac, SCS, GTO, PUJT – power transistors – power FETs – LASCR – two transistor model of SCR – Protection of thyristors against over voltage – over current, dv/dt and di/dt.

Triggering Techniques : Turn on circuits for SCR – triggering with single pulse and train of pulses – synchronizing with supply – gate triggering circuits- triggering with microprocessor – forced commutation – different techniques – series and parallel operations of SCRs.

10Hrs

Unit 2

Controlled Rectifiers : Converters – single phase – three phase – half controlled and fully controlled rectifiers –Waveforms of load voltage and line current under constant load current – effect of transformer leakage inductance – dual converter. **8Hrs**

Unit 3

Inverters : Voltage and current source inverters, resonant, Series inverter, PWM inverter. AC and DC choppers – DC to DC converters – Buck, boost and buck – boost. **6Hrs**

Unit 4

Industrial Applications: DC motor drives – Induction and synchronous motor drives – switched reluctance and brushless motor drives – Battery charger – SMPS – UPS – induction and dielectric heating. **8Hrs**

TEXT BOOKS

1. Muhamed H.Rashid ,**Power Electronics Circuits**, **Devices and Applications**,PHI, 3rd Edition. 2004.
2. M.D. Singh and K.B. Kanchandani**, Power Electronics**, 2nd Edition, TMH, 2007.

REFERENCES

1. Sen,**Power Electronics**, TMH, 1987.
2. Dubey,**Thyristorised Power Controllers**, Wiley Eastern 1986.
4. Lander**, Power Electronics**, 3rd Edition, McGraw-Hill, 1994.
5. Jacob,**Power Electronics**, Thomson Learning, 2002.

PRACTICAL EXERCISES

1. SCR characteristics
2. DIAC Characteristics
3. TRIAC characteristics
4. MOSFET characteristics
5. IGBT characteristics
6. Triggering Circuits
7. UJT triggering of SCR
8. UJT triggering of SCR HWR, FWR
9. AC Voltage control using DIAC and TRIAC
10. Converters, Inverters, Choppers

DIGITAL IMAGE PROCESSING

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

After completion of the DIP course, the students are equipped with the knowledge of:

- Mechanism of human visual system.
- Fundamentals of digital image and its types.
- Various noise sources and their PDFs.
- Spatial domain filtering approaches for image enhancement and recovering the degraded images.
- Understand the basics of image segmentation, compression, and color image processing.

Pedagogy Objectives

- The course has both theory and practical sessions.
- Illustrative images and videos are used in theory sessions to understand the need of digital image processing.
- Students carry out simulation experiments in the lab to implement various image processing algorithms.

Course Contents

Unit 1

Introduction: Fundamentals of Digital Image Processing, Image processing system components, elements of Visual Perception. Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships between Pixels, Linear and Nonlinear Operations **8Hrs**

Unit 2

Image Enhancement: Basic gray level transformation, Histogram processing, Enhancement Using Arithmetic/Logic Operations, basic spatial filtering, smoothening and sharpening spatial filters, combining the spatial enhancement methods. **8Hrs**

Unit 3

Image Segmentation and Compression: Detection of discontinuous edges, Edge linking and boundary detection, thresholding, region-based segmentation, Image compression models, error free compression, image compression standards, **8Hrs**

Unit 4

Image Restoration: A model of image degradation/restoration process, noise models, restoration in the presence of noise only spatial filtering, Weiner filtering, constrained least square filtering, geometric transforms, Colour Fundamentals. Colour Models, Pseudo colour Image Processing, processing basics of full colour image processing, Digital image processing applications. **8Hrs**

TEXT BOOK

1"Digital Image Processing", Rafael C.Gonzalez, Richard E. Woods, etl , TMH , 2nd Edition 2010.

REFERENCE BOOKS

1. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education, 2001.
2. Digital Image Processing and Analysi", B. Chanda and D. Dutta Majumdar, PHI, 2003.

PRACTICAL EXERCISE

1. Point-to-point transformation.
2. Morphological operations
3. Morphological operations
4. Histogram equalization.
5. Geometric transformations.
6. Two-dimensional Fourier transforms.
7. Two-dimensional Fourier Transform
8. Linear filtering using convolution.
9. Highly selective filters.
10. Ideal filters in the frequency domain.
11. Non Linear filtering using convolution masks.
12. Entropy as a compression measure.
13. Edge detection.

ARM PROCESSORS

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

- Enable the students to understand the Architecture and working principle of ARM Processor family.
- Obtain the knowledge of advanced RISC instruction set, programming digital signal processing application, optimizing programs written in C language for ARM processors.
- The hands on training in the Laboratory to program ARM based microcontroller and it's peripheral to make the students to understand the programming of ARM processors.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.
- Programming ARM and its peripherals, discussions and seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Introduction: Introduction to embedded systems, ARM embedded system, ARM processor fundamentals: Registers, Current program status register, pipeline, exceptions, Interrupts, the Vector table, Core extensions, ARM processor families.

8Hrs

Unit 2

ARM Instruction Set: Introduction to ARM instruction set: Data processing instructions, Branch instructions, load-store instructions, software interrupt instructions, program status register instructions, and Coprocessor instructions.

Thumb Instruction Set and Programming: Introduction to thumb instruction set Thumb programmer's model, Thumb branch instructions, data processing instructions, Single register load-store Instructions, Multiple-Register load-store instruction, Stack instruction, Software interrupts instruction, ARM assembly language Programming

8Hrs

Unit 3

Architectural Support for High-Level languages: Data types, Floating-point data types, The ARM floating point architecture, Expressions, Conditional statements, Loops, functions and procedures. **8Hrs**

Unit 4

DSP on the ARM and Interrupt Handling: Introduction to DSP on the ARM, FIR filters, IIR filters, DFT, Exception Handling, Interrupt, and Interrupt Handling Schemes.

8Hrs

TEXT BOOKS:

1. Andrew N Sloss, Dominic Symes and Chris Wright, **"ARM system developer's guide"**, Elsevier, Morgan Kaufman publishers, 2008.
2. Steve Furber, **"Arm-System-On-Chip- Architecture**", 2nd edition, Pearson, 2011.

REFERENCE BOOKS:

1. Frank vahid/Tony givargis, **"Embedded system design"**, John Wiley &sons, 2003.
2 Dr.K.V.K.K Prasad, **"Embedded/Real time systems, Real-Time systems"**, Dr. K.V.K.K Prasad, Dreamtech press, 2004.

PRACTICAL EXERCISE:

1. Timer/Counter operation
2. Serial port interfacing using RS232C
3. Digital clock
4. Object counter
5. Temperature measurement
6. I2C peripherals interfacing
7. USB peripherals interfacing
8. SPI peripherals interfacing
9. UART peripherals interfacing
10. CAN peripherals interfacing

DSP PROCESSOR

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

- The students will understand the architecture and programming of programmable DSP.
- Get an exposure to the DSK and code composer tools.
- Understand the DSP based application development skills.

Pedagogy Objectives

- Detailed architecture of both fixed and floating point DSP processors are taught.
- Method of programming DSP using code composer studio are discussed.
- In the laboratory, the DSP programming and hardware implementation skills are taught with the TMS320C6713 processors.

Course Contents

Unit 1

Introduction to Programmable DSPs: Digital Signal-Processing System, Programmable Digital Signal Processors, Major features of P-DSPs, Multiplier and Multiplier Accumulator (MAC), Modified Bus Structures and Memory Access Schemes in P-DSPs, Multiple Access Memory, Multiport Memory. **4 Hrs**

Unit 2

Architecture and Instruction Set of the C6x Processor: Introduction, TMS320C6713 Architecture, Functional Units, Fetch and Execute Packets, Pipelining, Registers, Linear and Circular Addressing Modes, TMS320C6x Instruction Set, Assembler Directives, Linear Assembly, ASM Statement within C, C-Callable Assembly Function, Timers, Interrupts, Multichannel Buffered Serial Ports, Direct Memory Access, Memory Considerations, Fixed- and Floating-Point Format, Code Improvement, Constraints, Programming Examples Using C, Assembly, and Linear Assembly. **12 Hrs**

Unit 3

Development Tools: Introduction, DSK Support Tools, Code Composer Studio, Quick Test of DSK, Support Files, Programming Examples to Test the DSK Tools, Support Programs/Files Considerations, Compiler/Assembler/Linker Shell. **4 Hrs**

DSP/BIOS and RTDX Using MATLAB, Visual C++, Visual Basic, and Lab VIEW: Introduction to DSP/BIOS, RTDX Using MATLAB to Provide Interface between PC And DSK, RTDX Using Visual C++ to Interface with DSK, RTDX Using Visual Basic to Provide Interface between PC and DSK, RTDX Using Lab VIEW to Provide Interface between PC and DSK. **6 Hrs**

Unit 4

Applications of Programmable DSP Devices: A DSP System, DSP-Based Biotelemetry Receiver, Speech Processing System, Image Processing System, Position Control System for a Hard Disk drive, DSP-Based Power Meter. **6 Hrs**

TEXT BOOK:

1. Rulph Chassaing, **"Digital Signal Processing and Applications with the C6713 and C6416 DSK** ", John Wiley and sons publication, 2005.
2. Avtar Singh, S. Srinivasan, **"Digital Signal Processing"**, Thomson Publications.

REFERENCE BOOK:

1. "TMS320C6713 Floating-Point Digital Signal Processor", SPRS186L.pdf, December 2001.
2. B. Venkataramani & M. Bhaskar, "**Digital Signal Processors: Architecture, Programming and Applications"** TMH, 2002

LABORATORY EXERCISES

1. FIR Filter Implementation: Band stop and Band pass.
2. FIR program to implement three different low pass filters using a slider for selection.
3. Implementation of Four Different Filters: Low pass, High pass, Band pass, and Band stop.
4. FIR Filter Implementation with a Pseudorandom Noise Sequence as Input to a Filter.
5. FIR Filter Implementation with Internally Generated Pseudorandom Noise as Input to a Filter and Output Stored in Memory.
6. Implementation of Two FIR notch filters to remove sinusoidal noise signals.
7. Implementation to illustrate aliasing and anti aliasing down-sampling to a rate of 4 kHz.
8. Implement an inverse FIR filter.
9. IIR Filter Implementation Using Second-Order Stages in Cascade.
10. Generation of Two Tones Using Two Second-Order Difference Equations.
11. Generate a sine wave using a difference equation.
12. Generate a sweeping sinusoid using a difference equation.

DATA STRUCTURES IN C

L: T: P = 2:1:1 = 4 Credits

Course Outcomes

- Enable the student to understand the data storage and data retrieving methods in computer data.
- Obtain the knowledge and skills of data storing technique such as array, stack, queue, lists, tree, sorting, searching, and storage management of computer data.
- The hands on training in the Laboratory using C/C++ language to make the student to understand data management techniques.

Pedagogy Objectives

- The course has Lecture, Tutorial, and Practical parts.

- Problem solving, discussions, seminars are conducted in the Tutorial period.
- Hands on training are given in Laboratory to better understand the theoretical concepts.
- Assignments and periodic tests are given to evaluate the student's knowledge of the subject.

Course Contents

Unit 1

Data Structures: Introduction – Arrays – Structures – Stack: Definition and examples, Representing Stacks - Queues and lists: Queue and its Representation, lists – Applications of Stack, Queue and Linked Lists. **7 Hrs**

Unit 2

Trees: Binary Trees – Operations on binary trees - Binary Tree Representations – node Representation, internal and external nodes, implicit array representation – Binary tree Traversals - Huffman Algorithm – Representing Lists as Binary Trees **7 Hrs**

Unit 3

Sorting and Searching : General Background – Exchange sorts – Selection and Tree Sorting – Insertion Sorts – Merge and Radix Sorts – Basic Search Techniques – Tree Searching – General Search Trees – Hashing. Graphs and their Applications**:** Graphs – An application of graphs – Representation – transitive closure - Wars hall's algorithm – Shortest path algorithm - a flow Problem – Dijkstra's algorithm – An application of scheduling - Linked representation of Graphs – Graph Traversals. **12 Hrs**

Unit 4

Storage Management: General Lists: Operations, linked list representation, using lists, Freeing list nodes - Automatic list Management: Reference count method, Garbage Collection, Algorithms, Collection and compaction. **6 Hrs**

TEXTBOOK

1. Tanaenbaum A.S., Langram Y. Augestein M.J **"Data Structures using C",** Pearson Education, 2004.

REFERNCES

1. Robert Kruse & Clovis L. Tondo **" Data Structures and Program Design in C",** Prentice Hall, 2nd edition. 1991.
2. Weiss **"Data Structures and Algorithm Analysis in C"**, Addison Wesley, Second Edition, 1997.

PRACTICAL EXERCISE:

- Implement the Polynomial representation using a Array
- Implement the Application of Stack Infix to Postfix
- Make the basic operations of circular Queue
- Implement the Polynomial representation using a Link List

- Implement the Doubly Link-List
- Implement the Binary Tree Traversal.
- Find the Shortest Path using Diskstra's Algo.
- Implement the Shorting using Quick Short method
- Implement the Shorting using Merge Short method
- Implement the Static Hashing using any one method
- Arrange words in dictionary order using Binary Search Tree In order Traversal

INFORMATION THEORY AND CODING

L:T:P = 3:1:0 = 4 Credits

Course Outcomes

Learner will be able to formulate equations for entropy, mutual information and channel capacity for all types of channels.

- Student will learn Information theory and entropy, able to distinguish between different types of Coding theorems, able to design a digital communication system by selecting an appropriate error correcting codes for a particular application.
- Learner will be able to explain various methods of generating and detecting different types of error correcting codes.
- Learner will be able to formulate the basic equations of linear block codes, RS codes, BCH codes and Convolution Codes.

Pedagogy Objectives

- The course has Lecture and Tutorial sessions.
- Problem Solving, circuit design and analysis, discussions and seminars are conducted in the Tutorial period.
- Assignments and periodic tests are given to evaluate the student's knowledge of the subject.

Course Contents

Unit - 1

INFORMATION THEORY: Introduction, Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Mark off statistical model for information source, Entropy and information rate of mark-off source. **SOURCE CODING:** Encoding of the source output, Shannon's encoding algorithm. Communication Channels, Discrete communication channels, Continuous channels. **12 Hrs**

Unit - 2

FUNDAMENTAL LIMITS ON PERFORMANCE: Source coding theorem, Huffman coding, Discrete memory less Channels, Mutual information, Channel Capacity. Channel

coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity Theorem. **12 Hrs**

Unit - 3

INTRODUCTION TO ERROR CONTROL CODING: Introduction, Types of errors, examples, Types of codes Linear Block Codes: Matrix description, Error detection and correction, Standard arrays and table look up for decoding. Binary Cycle Codes, Algebraic structures of cyclic codes, Encoding using an (n-k) bit shift register, Syndrome calculation. BCH codes. **12Hrs**

Unit - 4

RS codes, Golay codes, Shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes. Convolution Codes, Time domain approach. Transform domain approach. **12Hrs**

TEXT BOOKS:

1. Digital and analog communication systems, K. Sam Shanmugam, John Wiley India Pvt. Ltd, 1996.
2. Digital communication, Simon Haykin, John Wiley India Pvt. Ltd, 2008.

REFERENCE BOOKS:

1. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007
2. Digital Communications - Glover and Grant; Pearson Ed. 2nd Ed 2008.

PROJECT WORK

L: T: P = 0:0:4 = 4 Credits

Course Outcomes

- In the 4th semester, students have to carry out full-time project work in Industries/ R&D organizations/Department.
- Students are exposed to the Industry Environment.
- Obtain the practical knowledge of electronic product design and development.
- Acquire the skills of literature review, research paper writing, project report writing, and presentation, etc.

Pedagogy Objectives

- Each student of batch of two students are assigned one external guide and one internal guide.
- With the help of the Guide, students carry-out the literature review to finalize the title of the project and submits the synopsis to the Department.
- Periodic progress of the student in realizing the intended project are monitored by the guide and Department faculty members by way of presentation and progress reports.
- At the end of the project, students have to give the presentation and demo of the developed project.

SATELLITE COMMUNICATION

L:T: P 3:1:0 = 4 Credits

Course Outcomes

- To enable the students to become familiar with satellite communication systems and satellite services.
- Study of satellite orbits and launching, earth segment and space segment components.
- To understand the various terminology, principles, devices, schemes, concept, algorithms and different methodologies used.
- To provide an in-depth understanding of different concepts used in satellite communication system like analog and digital signals.

Pedagogy Objectives

- The course has Lecture and Tutorial sessions.
- Problem Solving, circuit design and analysis, discussions, seminars are conducted in the Tutorial period.

Course Contents

Unit 1

Introduction to Satellite Communication: Introduction, Frequency allocations for Satellite Services, INTELSAT, U.S. Domstas, Polar Orbiting Satellites, Argos System, Cspas-Sarsat, Kepler's first law, Kepler's second law,keplers third law, Definitions of terms for Earth Orbiting Satellites, Orbiting elements, apogee and Perigee Heights, Orbit Perturbations, Inclined Orbits. Geostationary Orbit: Introduction, Antenna Look angles, the Polar Mount antenna, Limits of visibility, Near Geostationary Orbits, Earth Eclipse of Satellite, Sun Transit Outage, Launching Orbits. Polarization- Introduction, antenna Polarization, Polarization, Polarization of Satellite Signals, Cross Polarization Discrimination, Ionospheric Depolarization, Rain Depolarization, Ice polarization. **12Hrs**

Unit 2

Space and Earth Segment: Space segment: Introduction, Power Supply, Attitude Control, Station Keeping, Thermal Control, TT&C Subsystem, Transponder, Earth Segment: Introduction, Receive-Only some TV Systems, Master Antenna TV System, Community Antenna TV System, Transmit-Receive Earth Stations**.** **10Hrs**

Unit 3

Analog Signals: Introduction, The Telephone Channel, Signal Sideband Telephony, FDM telephony, Colour Television, Frequency Modulation.

Digital Signals: Introduction, Digital Baseband Signals, Pulse Code Modulation, Time Division Multiplexing, Bandwidth Requirements, Digital Carrier System, Carrier Recovery Circuits Bit timing Recovery. **16Hrs**

Unit 4

The Space Link : Introduction, Equivalent Radiated Power, Transmission Losses, The Link Power Budget Equation, System Noise, Carrier to Noise Ratio, The Uplink, Downlink, Effects of rain, Combined Uplink and Downlink C/N Ratio, Intermodulation Noise, Inter Satellite Links. **10Hrs**

TEXT BOOK:

1. Dennis Roddy, Satellite **Communications,** 4th editions, Tata Mc-Graw Hill.

REFERENCE

1. Timothy Pratt, Charles Bostian and Jeremy Allnut,t **Satellite Communications** –, 2nd edition, John Wiley & Sons, 2003.
2. W.L. Pitchand, H.L. Suyderhoud, R.A. Nelson, **Satellite Communication Systems engineering** –, 2nd Ed., Pearson education, 2007.

WIRELESS SENSOR NETWORKS

L: T: P 3:0:0 = 3 Credits

Course Outcomes

- Introduces the multiple radio access methods, and data transfer from multiple sensors through wireless transmission media.
- The objective of wireless LAN,MAN, PAN, Adhoc and sensor networks

Pedagogy Objectives

- The course has lecture and tutorial classes.
- The seminars assigned for students on the current trends in computer networks helps in proper visualization of concepts.

Course Contents

Unit 1

Multiple Radio Access: Medium Access Alternatives*:* Fixed-Assignment for Voice Oriented Networks Random Access for Data Oriented Networks, Handoff and Roaming Support, Security and Privacy. Wireless WANs : First Generation Analog, Second Generation TDMA – GSM, Short Messaging Service in GSM, Second Generation CDMA – IS-95, GPRS - Third Generation Systems (WCDMA/CDMA 2000). **12 Hrs**

Unit 2

Wireless LANs : Introduction to wireless LANs - IEEE 802.11 WLAN – Architecture and Services, Physical Layer- MAC sub layer- MAC Management Sub layer, Other IEEE 802.11 standards, HIPERLAN, Wi-Max standard. **12Hrs**

Unit 3

Adhoc and Sensor Networks : Characteristics of MANETs, Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols, Wireless Sensor networks- Classification, MAC and Routing protocols. **12Hrs**

Unit 4

Wireless MANs and PANs : Wireless MANs – Physical and MAC layer details, Wireless PANs – Architecture of Bluetooth Systems, Physical and MAC layer details, Standards.

12Hrs

TEXT BOOKS:

1. William Stallings, **"Wireless Communications and networks"** Pearson / Prentice Hall of India, 2nd Ed., 2007.
2. Dharma Prakash Agrawal & Qing-An Zeng, **"Introduction to Wireless and Mobile Systems",** Thomson India Edition, 2nd Ed., 2007.

REFERENCES:

1. Vijay. K. Garg, **"Wireless Communication and Networking",** Morgan Kaufmann Publishers, 2007.
2. Kaveth Pahlavan, Prashant Krishnamurthy, **"Principles of Wireless Networks",**Pearson Education Asia, 2002.
3. Gary. S. Rogers & John Edwards, **"An Introduction to Wireless Technology",** PearsonEducation, 2007.
4. Clint Smith, P.E. & Daniel Collins, **"3G Wireless Networks"**, Tata McGraw Hill, 2nd Edition,.2007.

COMPUTER NETWORKS

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- Introduces the two network models and various transmission media with data transfer through switching methods.
- The objective of data link layer and concepts of wired and wireless local area networks are provided.
- The network layer concepts like internet protocol addressing, address mapping and different routing protocols are understood.
- The transport layers like user datagram protocol and transmission control protocol with methods of improving the quality of service are learnt.

Pedagogy Objectives

- The course has lecture and tutorial sessions.
- The seminars assigned for students on the current trends in computer networks helps in proper visualization of concepts.
- The workshops on computer networks provides hands-on for future career building.
- The assignments, quizzes, group discussions and written tests improve the evaluation process.

Course Contents

Unit 1

Physical Layer: Data Communications – Networks - Networks models – OSI model – Layers in OSI model –TCP / IP protocol suite – Addressing – Guided and Unguided Transmission media Switching: Circuit switched networks – Data gram Networks – Virtual circuit networks Cable networks for Data transmission: Dialup modems – DSL – Cable TV – Cable TV for Data transfer. **12 Hrs**

Unit 2

Data Link Layer: Data link control: Framing – Flow and error control –Protocols for Noiseless and Noisy Channels – HDLC Multiple access: Random access – Controlled access Wired LANS : Ethernet – IEEE standards – standard Ethernet – changes in the standard – Fast Ethernet – Gigabit Ethernet. Wireless LANS : IEEE 802.11–Bluetooth. Connecting LANS: Connecting devices - Backbone networks - Virtual LANS Virtual circuit networks: Architecture and Layers of Frame Relay and ATM. **12 Hrs**

Unit 3

Network Layer: Logical addressing: IPv4, IPv6 addresses Internet Protocol: Internetworking – IPv4, IPv6 - Address mapping – ARP, RARP, BOOTP, DHCP, ICMP, IGMP, Delivery - Forwarding - Routing – Unicast, Multicast routing protocols. **12Hrs**

Unit 4

Transport Layer: Process-to-Process delivery - User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control – Quality of services (QoS) – Techniques to improve QoS. **12Hrs**

TEXT BOOKS

1. Behrouz A. Foruzan, **"Data Communication and Networking"**, Tata McGraw-Hill, 2006: Unit I-IV
2. Andrew S. Tannenbaum, **"Computer Networks",** Pearson Education, Fourth Edition, 2003: Unit V

REFERENCES

1. Wayne Tomasi, **"Introduction to Data Communication and Networking",** 1/e, Pearson Education.
2. James .F. Kurouse & W. Rouse, **"Computer Networking: A Top down Approach Featuring"**,3/e, Pearson Education.
3. C.Sivaram Murthy, B.S.Manoj, **"Ad hoc Wireless Networks – Architecture and Protocols"**, Second Edition, Pearson Education.
4. Greg Tomshon, Ed Tittel, David Johnson. **"Guide to Networking Essentials"**, fifth Edition, Thomson India Learning, 2007.
5. William Stallings, **"Data and Computer Communication",** Eighth Edition, Pearson Education, 2000.

LOW POWER VLSI DESIGN

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- Enables the need for low power consumption and highlights the sources and design.
- The techniques to reduce the power consumptions in basic CMOS subsystems like adder, multiplier and memories are visualized.
- Power analysis through simulation and probabilistic methods with basics of estimation of power provides better improvement in VLSI.
- Software design helps in detail understanding of synthesis for low power transform.

Pedagogy Objectives

- The course is divided into lecture and tutorial sessions.
- The seminars on advance topics on low power VLSI helps in understanding the current need.
- Assignments and periodic tests required for evaluation.

Course Contents

Unit 1

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. **12Hrs**

Unit 2

POWER OPTIMIZATION: Logic level power optimization – Circuit level low power design – circuit techniques for reducing power consumption in adders and multipliers. DESIGN OF LOW POWER CMOS CIRCUITS Computer arithmetic techniques for low power system – reducing power consumption in memories – low power clock, Inter connect and layout design – Advanced techniques –Special techniques. **12Hrs**

Unit 3

POWER ESTIMATION: Power Estimation technique – logic power estimation – Simulation power analysis –Probabilistic power analysis. **12Hrs**

Unit 4

SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER: Synthesis for low power – Behavioral level transform – software design for low power. **12Hrs**

Text Books:

1. Kaushik Roy and S.C.Prasad, “Low power CMOS VLSI circuit design”, Wiley, 2000.

REFERENCES

1. Dimitrios Soudris, Christians Pignet, Costas Goutis, "Designing CMOS Circuits for Low Power", Kluwer, 2002.

3. J.B.Kulo and J.H Lou, "Low voltage CMOS VLSI Circuits", Wiley 1999.

4. A.P.Chandrasekaran and R.W.Broadersen, "Low power digital CMOS design", Kluwer,1995.

5. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998.

6. Abdelatif Belaouar, Mohamed.I.Elmasry, "Low power digital VLSI design", Kluwer, 1995.

7. James B.Kulo, Shih-Chia Lin, "Low voltage SOI CMOS VLSI devices and Circuits", John Wiley and sons, inc. 2001.

SPEECH PROCESSING

L: T: P 3:1:0 = 4 Credits

Course Outcomes

After completing this course, students will

- Understand the speech phonetics, speech production mechanism, psycho-acoustics.
- Acquire the skills of time-domain and frequency-domain speech processing.
- Techniques of linear predictive analysis and application of audio and speech single processing.

Pedagogy Objectives

- Detailed explanation on the speech production and speech phonetics are discussed.
- With illustration and demo, the time-domain and frequency-domain speech processing is demonstrated.
- Encourage students to develop digital speech processing algorithms and applications.

Course Contents

Unit 1

Mechanics of Speech: Speech production: Mechanism of speech production, Acoustic phonetics – Digitalmodels for speech signals - Representations of speech waveform: Sampling speechsignals, basics of quantization, delta modulation, and Differential PCM – Auditoryperception: psycho acoustics.

Time Domain Methods for Speech Processing: Time domain parameters of Speech signal – Methods for extracting the parametersEnergy, Average Magnitude, Zero crossing Rate – Silence Discrimination using ZCRand energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function. **12Hrs**

Unit 2

Frequency Domain Method for Speech Processing: Short Time Fourier analysis: Fourier transform and linear filtering interpretations,Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis bySynthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder -Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, HomomorphicVocoders. **12Hrs**

Unit 3

Linear Predictive Analysis of Speech: Basic Principles of linear predictive analysis – Auto correlation method – Covariancemethod – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm,– Application of LPC parameters – Pitch detection using LPC parameters – Formantanalysis – VELP – CELP. **12Hrs**

Unit 4

Application of Speech & Audio Signal Processing : Algorithms: Dynamic time warping, K-means clustering and Vector quantization,Gaussian mixture modeling, hidden Markov modeling - Automatic Speech Recognition Feature Extraction for ASR, Deterministic sequence recognition, Statistical Sequencerecognition, Language models - Speaker identification and verification – Voice responsesystem – Speech synthesis: basics of articulatory, source-filter, and concatenative synthesis – VOIP. **12Hrs**

TEXT BOOK:

1. Thomas F, Quatieri**, Discrete-Time Speech Signal Processing**, Prentice Hall / Pearson Education, 2004.

REFERENCES:

1. Ben Gold and Nelson Morgan, **Speech and Audio Signal Processing**, John Wiley and Sons Inc., Singapore, 2004
2. L.R.Rabiner and R.W.Schaffer – **Digital Processing of Speech signals** – Prentice Hall -1979
3. L.R. Rabiner and B. H. Juang, **Fundamentals of Speech Recognition**, Prentice Hall, 1993.
4. J.R. Deller, J.H.L. Hansen and J.G. Proakis, **Discrete Time Processing of Speech Signals,** John Wiley, IEEE Press, 1999.

NANO ELECTRONICS

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- The atomic and molecular structures for basic understanding of Nano-technology, types, materials used and its applications are learnt.
- The mapping of human brain and computer with basic logic devices are analyzed.
- The novel materials, concepts of resonant tunneling and single electron devices are viewed.
- The types of nano-tubes, its electronic properties, synthesis and applications are understood.

Pedagogy Objectives

- The course has lecture and tutorial sessions used to detail the concepts by teaching, discussions and presentations by students.
- The assignments and tests are used for student's evaluation.
- The research paper analysis helps in understanding the future based on nanotechnology.

Course Contents

Unit 1

Introduction to Nanotechnology : Background to nanotechnology: Types of nanotechnology and nanomachines – periodictable – atomic structure – molecules and phases – energy – molecular and atomic size –surface and dimensional space – top down and bottom up; Molecular Nanotechnology:Electron microscope – scanning electron microscope – atomic force microscope – scanning tunnelling microscope – nanomanipulator – nanotweezers – atom manipulation – nanodots – self assembly – dip pen nanolithography. Nanomaterials: preparation –plasma arcing – chemical vapour deposition – sol-gels – electron deposition – ball milling –applications of nanomaterials **12Hrs**

Unit 2

Fundamentals of Nanoelectronics : Fundamentals of logic devices:- Requirements – dynamic properties – threshold gates;physical limits to computations; concepts of logic devices:- classifications – two terminaldevices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of informationprocessing systems;- basic binary operations, measure of performance processingcapability of biological neurons – performance estimation for the human brain. Ultimatecomputation:- power dissipation limit – dissipation in reversible computation – theultimate computer. **12 Hrs**

Unit 3

Silicon MOSFETs& Quantum Transport Devices : Silicon MOSFETS - Novel materials and alternate concepts:- fundamentals of MOSFETDevices- scaling rules – silicon-dioxide based gate dielectrics – metal gates – junctions& contacts – advanced MOSFET concepts Quantum transport devices based on resonant tunneling:- Electron tunneling – resonanttunnelling diodes – resonant tunneling devices; Single electron devices for logicapplications:- Single electron devices – applications of single electron devices to logic circuits.

12 Hrs

Unit 4

Carbon Nanotubes : Carbon Nanotubes: Fullerenes - types of nanotubes – formation of nanotubes –assemblies– purification of carbon nanotubes – electronic propertics – synthesis of carbon nanotubes –carbon nanotube interconnects – carbon nanotube FETs –Nanotube for memory applications – prospects of an all carbon nanotube, nanoelectronics, Molecular Electronics : Electrodes & contacts – functions – molecular electronic devices – first test systems –simulation and circuit design – fabrication; Future applications: MEMS – robots – RandomAccess memory – mass storage devices. **12 Hrs**

TEXTBOOKS

1. Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse, **Nanotechnology: Basic Science and Emerging Technologies**, Chapman & Hall / CRC, 2002

2. T.Pradeep, **NANO: The Essentials – Understanding Nanoscience and Nanotechnology**, TMH, 2007
3. Rainer Waser (Ed.), **Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices,** Wiley-VCH, 2003

FUNDAMENTALS OF ELECTRONICS

L: T: P 3:1:0 = 4 Credits

Course Outcomes

- To study the basics of semiconductor & devices and their applications in different areas.
- To study different biasing techniques to operate transistor, FET, MOSFET and operational amplifiers in different modes.
- Compare design issues, advantages, disadvantages and limitations of Fundamentals of electronics.

Pedagogy Objectives

- This course provides the students with the fundamental skills to understand the basics of semiconductor and components like diode, transistor, FET, MOSFET and operational amplifiers.
- It will build mathematical and numerical background for design of electronics circuits & component value. Students equipped with the knowledge of Development and operation in different areas of electronics systems.
- The assignments and tests used for student's evaluation.

Course Contents

Unit 1

Circuit Elements: Resistors, types of Resistors, Resistor color coding, variable resistors. Capacitors- Mica Capacitors, paper capacitors, Ceramic capacitors, variable capacitors, Electrolytic capacitors. Inductors- Inductance of coils, typical inductance values, Mutual Inductance M, Transformers. Multimeters, Digital Multimeter (DMM) , Meter Applications. Ohms Law –current I=V/R, Voltage V=IR and Resistance R=V/I. Kirchoff's laws- Kirchoff's Current and Kirchoff's Voltage law. **14Hrs**

Unit 2

Alternating Current and Voltage: Alternating Current, Voltage and Current values for a sine wave, peak value, average value, root mean square value, frequency, period, wavelength, phase angle.

Network Theorems: Thevinin's Theorem, Maximum Power transform theorem, Norton'sTheorem. **10Hrs**

Unit 3

Digital Electronics: Analog and Digital signals, Binary Number system, Decimal to Binary Conversions, Binary to Decimal Conversion, Logic gates, OR Gate, AND gate, NOT gate, Combinations of Basic Logic gates, NAND gate as a Universal gate, Exclusive OR gate, Encoders and Decoders, Advantages and Disadvantages of Digital Electronics, Boolean algebra, Boolean theorems, DeMorgan's Theorems. **14Hrs**

Unit 4

Computer Generation and Classification: First Generation of Computers, Second Generation, Third generation, Fourth generation, Fifth generation, Moore's law, Classification of Computers, Distributed Computer System, Parallel Computers. **10Hrs**

TEXT BOOKS:

1. **Basic Electronics: Bernard Grobe,** Tata McGraw-Hill Book Company (Units 1& 2 Chapter 2,6,9,16,17, & 20).
2. **Basic Electronics: Principles of Electronics, V K Mehta, S. Chand** & Company Ltd., New Delhi. (Unit 3& $).
3. **Fundamentals of Computers: V Rajaraman**, Prentice Hall of India, New Delhi (unit 5-chapter12).

REFERENCE:

1. **Integrated Electronics: J Millman and C Halkias,** TMH, 1991.
2. **Basic Electronics Solid State: B.L. Theraja, S Chand** & Company, New Delhi

SEMICONDUCTOR DEVICES

L: T: P 3:1:0 = 4 Credits

Course Outcomes

- Enable the students to understand the Fundamentals of diode and transistors, and electronic appliances.
- Obtain the basic knowledge of electronic communication systems like cell phone, Satellite and RADAR.

Pedagogy Objectives:

- The course has Lecture and Tutorial sessions.
- Discussions, seminars are conducted in the Tutorial period.
- Assignments and periodic tests are given to evaluate the student's knowledge of the subject

Course Contents

Unit 1

Semiconductor Devices: Semiconductor, Intrinsic Semiconductor, Extrinsic Semiconductor, Ntype Semiconductor, P-type Semiconductor, PN Junction, Properties of PN junction, Applying Voltage across PN junction, Volt-Ampere Characteristics of PN junction, Zener diode, Equivalent Circuit of a Zener diode, Zener diode as voltage stabilizer. **12Hrs**

Unit 2

Transistor Characteristics: Transistor Symbol, Naming of Transistor terminals, Working of NPN transistor, Configuration of transistor, CE Characteristics, Applications. **12Hrs**

Unit 3

Electronic Appliances: Television – standards, BW/Colour, CRT/HDTV, Video system – VCR/VCD/DVD players, MP4 players ,Set Top box, CATV and Dish TV, LCD, Plasma & LED TV, Projectors – DLP, Home Theatres, Remote **12Hrs**

Unit 4

Communication: Mobile: Call setup, **SMS (**Short Message Service), **MMS (Multimedia Messaging Service)**, Mobile OS: Windows, Android, Mac, Satellite, Microwave, Radar, Antenna. **12Hrs**

TEXT BOOKS:

1. **Basic Electronics by** B. Basavaraju

REFERENCE:

2. **Electronics Communication:** George Kennedy**, 4th edition.**

COMPUTER FUNDAMENTALS

L: T: P = 3:1:0 = 4 Credits

Course Outcomes

- Enable the students to understand the Fundamentals and working principle of Computer Systems.
- Obtain the basic knowledge of computer hardware and software aspects such as memory, Mother Board, Processor, Chipsets, and programming language.

Pedagogy Objectives

- The course has Lecture and Tutorial sessions.
- Discussions and seminars are conducted in the Tutorial period.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Computer basics: A simple model of a computer, Functions of different units, Types of Computer, Characteristic of computers, features of computers, Microprocessor and specifications, software control, hardware control, problem solving using computers

Input/output units: Description of computer input units, input units, and other input methods computer output units. **12 Hrs**

Unit 2

Computer memory: Memory cell, Memory Organization, Read Only Memory, RAM Types, Fast Page Mode DRAM , Extended Data Out RAM, SDRAM, DDR SDRAM, DDR2, SDRAM, RDRAM, Serial Access Memory, Physical Drives Used to construct Memories, Magnetic Hard disk, Compact Disk read only Memory.

Motherboard: Motherboard Components Processor Sockets/Slots Chipsets Motherboard Selection Criteria (Knowing What to Look For) , Documentation Using Correct Speed-Rated Parts **12Hrs**

Unit 3

Bios: BIOS Basics, BIOS Hardware/Software, Motherboard BIOS, ROM Hardware, ROM Shadowing, ROM Chip Types, ROM BIOS Manufacturers, Upgrading the BIOS, BIOS Update, Determining Your BIOS Version, Backing Up Your BIOS's CMOS Settings, Motherboard CMOS RAM Addresses, Replacing a BIOS ROM **12Hrs**

Unit 4

Computer Language: Why computer language, Machine Language, advantages and disadvantages of Machine language Assembly language, Assembler, cross assembler, advantages and disadvantages of Assembly level language, compiler, cross compiler, Higher level programming language. Advantages and disadvantages of high level language **12Hrs**

TEXT BOOKS:

1. V Rajaraman, Fundamentals of Computers:, P H I, New Delhi, 4th edition.
2. B. Basavaraju, Fundamentals of Electronics.
3. Scott Mueller, 'Upgrading and Repairing PCs', 20th Edition, Pearson Education, 2012
4. Computer organization by Carl Hamacher, Tata Mc-Grawttice, 4th edition.

CONSUMER ELECTRONICS

L: T: P =3:1:0 = 4 Credits

Course Outcomes

- This is open elective subject for other department students. This subject enables the students to understand the principle of operation of Electronic house hold appliances used in their day- to- day life.
- Obtain introduction about electronic instruments and devices such as mobile phones, TVs, Radios, kitchen appliances such as Electric geezers, micro-oven, electronic stoves, refrigerators etc.

Pedagogy Objectives

- The course has Lecture and Tutorial parts.
- Circuit operation, simple design, discussions and seminars are conducted in the Tutorial period.
- Assignments and periodic tests are given to evaluate the student's understanding of the subject.

Course Contents

Unit 1

Audio systems PA system – Microphone, Amplifier, Loudspeakers, Radio receivers – AM/FM Audio recording and reproduction – Cassettes, CD and MP3

12Hrs

Unit 2

TV and Video systems Television – standards, BW/Colour, CRT/HDTV, Video system – VCR/VCD/DVD players, MP4 players ,Set Top box, CATV and Dish TV, LCD, Plasma & LED TV, Projectors – DLP, Home Theatres, Remote Controls **12Hrs**

Unit 3

Landline and Mobile telephony Basic landline equipment – CLI, Cordless Intercom/ EPABX system Mobile phones – GPRS & Bluetooth GPS Navigation system

Office Equipments

Scanners – Barcode / Flat bed , Printers , Xerox , Multifunction units (Print, Scan, fax,copy) **12Hrs**

Unit 4:

Electronic Gadgets and Domestic Appliances Digital clock, Digital camera, Handicam, Home security system, CCTV Air conditioners, Refrigerators, Washing Machine/Dish Washer, Microwave oven, Vacuum cleaners **12Hrs**

Test Books

1. R. P. Bali, "Consumer Electronics", Pearson Education (2008).
2. R. G. Gupta, "Audio and Video systems", Tata McGraw Hill (2004).

Chairman
BOS in Electronics
University of Mysore