Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara
(Autonomous)

M. Sc. I

Revised Syllabus 2021-22

Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara

(Autonomous Institute)

Department of Electronics

Revised Syllabus and Scheme of Credit for

M. Sc. Electronics

Under Choice Based Credit System (CBCS) wef (June 2021-22)

- **OBJECTIVES:**
  1. To create post-graduates with sound knowledge of fundamentals of Electronics, who can contribute towards advancing science and technology.
  2. To create post-graduates with sufficient capabilities in Electronics who can become researchers and developers to satisfy the needs of the core Electronics industry.
  3. To develop ability among students to formulate, analyze and solve real life problems faced in Electronics industry.
  4. To provide opportunity to students to learn the latest trends in Electronics and make them ready for life-long learning process.
  5. To make the students aware of professional ethics of the Industry, and prepare them with basic soft skills essential for working in community and professional teams.
  6. To prepare the students for post graduate studies through competitive examinations, enabling them to reach higher echelons of excellence
  7. To produce electronic professionals who can be directly employed or start his/her own work as Electronic circuit Designer, Electronics consultant, testing professional, Service engineer and even an entrepreneur in electronic industry.
  8. Develop designing and analyzing attitude about networks and wireless communication
- **OUTCOMES:**

  After completing this courses students shall be expert in following things:
  1. Technologies involved in end to end Microwave Solutions
  2. To learn suitable test procedures to electronic systems for measurement and testing in industrial Application.
  3. Student should avail advanced microcontrollers knowledge
  4. Students will demonstrate their ability of advanced programming to design and

test C programs for various applications

5. Student will be able to work with various designs and simulation platforms.
6. Students will demonstrate their ability to respond the modern communication system.
7. Student will able to develop innovative electronics systems.

- **SCOPE:**

After Successful completion of Two years Masters in Electronics, we observed that the students have the ample opportunities in diversified areas such as:

1. Embedded System Design (Hardware and Software Industry)
2. Power Electronics and Industrial Instrumentation
3. Communication Electronics
4. Research Instrumentation
5. Agro Industries
6. Medical Instrumentation
7. Consumer Electronics

Shikshan Sanstha"s

Yashavantrao Chavan Institute of Science, Satara

Department of Electronics

Revised Syllabus for Master of Science (Electronics) Part I

1. SUBJECT: Electronics

2. YEAR OF IMPLEMENTATION: New Syllabi for the M.Sc. I Electronics will be implemented from June 2020 onwards.

3. PREAMBLE:

Master of Science is an integrated academic degree in faculty of Science. The faculty is not ignoring the developments in the field of Electronics. The revision of existing syllabus of Electronics subject in science faculty is essential. This is a humble endeavor to initiate the process towards an era of knowledge. The students from science faculty should also be competent for this change in the technology.

In this year, a student will able to understand handling of laboratory equipments, build Electronics circuits with confidence. In the subject, the student will also get a basic and proper knowledge in the field of Embedded System design

4. GENERAL OBJECTIVES OF THE COURSE:

1. To create post-graduates with sound knowledge of fundamentals of Electronics, who can contribute towards advancing science and technology.
2. To create post-graduates with sufficient capabilities in Electronics who can become researchers and developers to satisfy the needs of the core Electronics industry.
3. To develop ability among students to formulate, analyze and solve real life problems faced in Electronics industry.
4. To provide opportunity to students to learn the latest trends in Electronics and make them ready for life-long learning process.
5. To make the students aware of professional ethics of the Industry, and prepare them with basic soft skills essential for working in community and professional teams.
6. To prepare the students for post graduate studies through competitive examinations, enabling them to reach higher echelons of excellence
7. To produce electronic professionals who can be directly employed or start his/her own work as Electronic circuit Designer, Electronics consultant, testing professional, Service engineer and even an entrepreneur in electronic industry.

5. DURATION: **02 Years** (Full Time)

6. PATTERN: **SEMESTER** EXAM (CBCS)

7. MEDIUM OF INSTRUCTIONS: **ENGLISH**

8. STRUCTURE OF COURSE:

Course Code	Title of the Course	Credits	Teaching Scheme		Evaluation Scheme		
			L	P	ISE	ESE	Total
M.Sc. Part I - Semester I							
MET101	Foundation of Semiconductor Devices	4	4	-	40	60	100
MET102	Instrumentation and Measurement Techniques	4	4	-	40	60	100
MET103	Computer Organization	4	4	-	40	60	100
MET104	Advanced Digital System Design	4	4	-	40	60	100
MEP105	Lab I	4	-	12	40	60	100
MEP106	Lab II	4	-	12	40	60	100
	Total	**24**	**16**	**24**	**240**	**360**	**600**
M.Sc. Part I - Semester II							
MET201	8 bit Microcontrollers and Applications	4	4	-	40	60	100
MET202	Applied Electromagnetics and Microwaves	4	4	-	40	60	100
MET203	Power Electronics	4	4	-	40	60	100
MET204	Fiber Optic Communication Systems	4	4	-	40	60	100
MET205	Computer Networks	4	4	-	40	60	100
MEP206	Lab III	4	-	12	40	60	100
MEP207	Lab IV	4	-	12	40	60	100
	Total	**28**	**20**	**24**	**280**	**420**	**700**
M.Sc. Part II - Semester III							
MET301	Control Systems	4	4	-	40	60	100
MET302	Analog Circuit Design	4	4	-	40	60	100
MET303	Digital Signal Processing	4	4	-	40	60	100
MET304	Elective I	4	4	-	40	60	100
MET305	Elective I	4	4	-	40	60	100
MEP306	Lab V	4	-	12	40	60	100
MEP307	Lab VI	4	-	12	40	60	100
	Total	**28**	**20**	**24**	**280**	**420**	**700**
M. Sc. Part II - Semester IV							
MET401	Elective II	4	4	-	40	60	100
MET402	Elective II	4	4	-	40	60	100
MEP403	Lab VII	4	-	12	40	60	100
MEP404	Internship	4	-	12	40	60	100
	Total	**16**	**8**	**24**	**160**	**240**	**400**
	Grand Total	**96**	**64**	**96**	**960**	**1440**	**2400**

Course Code	Elective -I	Course Code	Elective –II
MET30x	Microcontroller System Design and ARM Architecture	MET40x	ARM Programming and Embedded Communication Protocols
MET30x	Wireless Sensor Network	MET40x	Satellite Communications
MET30x	Advances in Digital Communication	MET40x	Cellular Mobile Communications
MET30x	Mechatronics	MET40x	Industrial Automation
MET30x	Nanoelectronics	MET40x	Advanced Microcontroller and RTOS
MET30x	Antennas	MET40x	Real Time Operating Systems

MET/Pxyz –

M M.Sc.

E Electronics

T Theory

P Practical

x 1 to 4 : Semester number

yz 1 to 7 : course number

Rules and Regulations:

1. Core courses will be offered only to the students of M.Sc. Electronics.
2. The pre-requisites for electives courses will be decided by the departmental committee and Certificate and diploma program will be mandatory for all students.
3. Electives will be offered for minimum 08 and maximum 12 students in view of the infrastructure of the department. Electives to be offered or otherwise will be at the sole discretion of the departmental committee.
4. Minimum attendance required to appear for semester-end examination will be 75 % for each credit course.

9. OTHER FEATURES:

1. **LIBRARY:**

- **REFERENCE BOOKS**

1. Simon Haykin, Barry Van Veen- „Signals & system"- IInd Edition Wiley publication
2. Michael J. Roberts.- „Fundamentals of signals & systems"- Tata McGraw Hill, 2007.
3. Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab- „Signals & system" - IInd Edition – Pearson Education.
1. Charles L. Philips, John M. Parr, Eve A. Rislein „Signals, system & transform", IIIrd Edition, Pearson Education.
2. B.P. Lathi, "Linear Systems and Signals", 2nd Edition, Oxford University Press, 2004.
3. Charles Phillips, "Signals, Systems and Transforms", 3rd Edition, Pearson Education.
4. Nagoor Kani, Signal and Systems, Tata McGraw Hill Education Private Ltd, New Delhi, 3rd reprint, 2011
5. Edward C. Jordan, Electromagnetic waves and Radiating Systems. New Delhi: Prentice-Hall of India Pvt. Ltd., 200

8. Walter C. Johnson, Transmission lines and Networks. New Delhi: McGraw- Hill Book Comp.

9. John D. Ryder, Networks Lines and Fields. New Delhi: PHI, 1983

10. Samuel Y. Liao, Microwave Devices and Circuits. New Delhi: PHI, 2001

11. H.R.L. Lamont, Waveguides. London : Methuen and Company Limited, 1963

12. Robert E. Collin, Foundations for Microwave Engineering. New Delhi: McGraw Hill Book

13. Peter A. Rizzi, Microwave Engineering: Passive Circuits. New Delhi: PHI, 2001

14. F. E. Terman, Electronic and Radio Engineering. New York: McGraw Hill Book Comp. 1955.

15. D.M.Pazar, Microwave Engineering, Singapore: John Wiley and Sons (ASIA) Pte. Ltd., 2004

16. Linda Null and Julia Lobur ,The Essentials of Computer Organization and Architecture, ISBN:076370444x, Jones and Bartlett Publishers © 2003

17. David A. Patterson, John L. Hennessy, Computer Organization and Design, the Hardware/Software Interface, Third Edition (The Morgan Kaufmann Series in Computer Architecture and Design), Publisher: Morgan Kaufman, ISBN- 10: 58606041.

18. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian , Computer Organization and Embedded Systems, McGraw Hill Higher Education, Fifth Education

19. Jerry C. Whitaker, The Electronics Handbook Edited , Published by CRC Press and IEEE Press (1996), Section VII: Microelectronics and Section XIX: Computer Systems

20. Stalling , Computer Organization

21. D.V. Hall, Microprocessors and Interfacing, McGraw Hill (1986)

22. Barry B. Brey, The Intel Microprocessors: Prentice Hall Of India Ltd. (1997)

23. P.C. Sen, Power Electronics

24. R.M. Jalnekar & N.B. Pasalkar ,Power Electronics

25. C.K Dubey, S. R. Doradla, A. Joshi & R.M. Sinha, Thyristor power Controllers.

26. By M. Rashid, Power Electronics.

27. S. B. Dewan, G. R. Sleman, A. Strauphan, Power Semiconductor drives- (Wiley Int.Pub.-John Wiley Sons.)

28. J. B. Scarborough, Numerical Mathematical Analysis, Oxford and IBM Publishing Company

29. M. S. Roden, Analog and Digital Communication systems- 3rd Edition, Prentice Hall of India.

30. B.P. Lathi.,Modern Digital and Analog Communication Systems-

31. M. Kanefsky, Communication Techniques for digital and Analog signals –John Wiley and Son.

32. T.H. Brewster, Telecommunication –McGraw Hill.

33. Das, Chatterjee and Mallick, Principles of Digital communication, Wiley Eastern Ltd.

34. Samuel Y. Liao, Microwave Devices and Circuits. New Delhi : Prentice-Hall of India, 2001

35. K.C. Gupta and Amarjit Singh, Ed., Microwave Integrated Circuits, Wiley Eastern Ltd. 1978

36. Carol G. Montgomery, Ed., Techniques of Microwave Measurement, Vol.1. New York : Dover Publications, Inc., 1966

37. Edward L. Ginzton, Microwave Measurements, New York: McGraw-Hill Book Company, Inc.

38. A.Z. Fradin, Microwave Antennas. Oxford: Pergamon Press, 1961

39. F. E. Terman, Electronic and Radio Engineering, New York: McGraw Hill Book

Company, 1955

40. Merill I Skolink, Introduction to Radar Systems, New Delhi: TMH Publishing Comp., 1997

41. Constantine A. Balanis, Antanna Theoty: Analysis and Design, Singapore: John Wiley and sons (ASIA) Pte. Ltd., 2002

42. Annapurna Das and Sisir K.Das, Microwave Engineering, New Delhi: Tata McGraw-Hill Publishing Company Ltd., 2000

43. Electronic drives- Concept & Applications –Vedam Subrahmanyam (THM)

44. Power Semiconductor drives- S. B. Dewan, G. R. Sleman, A. Strauphan (Wiley Int. Publ.)

45. John M. Optical fiber communications, Principles and Practice: Senior, PHI.

46. Gerd Keiser, Optical fiber communications: Mc-Graw Hill International Edition.

47. Optical fiber communication: J. Gower, PHI.

48. Franz and Jain,Optical communications: components and systems: Narosa Publishing House.

49. Charles K Kao, Optical fiber systems, Technology design and applications: Mc- Graw Hill Int. Ed.

- **JOURNALS AND PERIODICALS**

1. Journal of Instrument Society of India
2. Express Computer
3. Embedded For You
4. Electronics Maker
5. Electronics For You
6. PCQUEST
7. Digit

2. SPECIFIC EQUIPMENTS:

Computers, Laptops, Printers, Scanners, LCD Projectors, E- Podium, Smart Board, Document Camera, Visualizer

3. LABORATORY EQUIPMENTS:

1. Digital storage Oscilloscope: 60 MHz
2. Signal generator

3. Microwave Test bench (Gunn Source)

4. Antenna Trainer

5. Arduino Development Board

6. CPLD development boards

7. Microcontroller Boards – 8051, MSP430, PIC18F, AVR MEGA32, ARDUINO NANO, UNO, MEGA

8. KEIL - IDE

9. Mikro C Compilers for 8051, PIC and ARM

10. Soft Computing Tools – SCILAB, MATLAB

11. PCB Designing Tool: DipTrace

Semester I
Course I
MET101: Foundation of Semiconductor Devices

- **Learning Objectives:**
  1. To introduce crystal structure with reference to semiconductors
  2. To introduce quantum and statistical mechanics
  3. To understand the characteristics of semiconductor devices
  4. To introduce theory of diode, transistor and FETs

Unit 1: Theory of Solids **15L**

Crystal structure of solids: Semiconductor materials, types of solids, basics of crystallography, space lattice atomic bonding, unit cell, Miller indices imperfections and impurities in solids, methods for semiconductor crystal growth.

Unit 2: Introduction to Quantum and statistical Mechanics **15L**

Principles of quantum mechanics, Schrodinger wave equation, and Applications of Schrodinger's wave equation for bound state potential problems. Introduction to quantum theory of solids: Allowed & forbidden energy bands, electrical conduction in solids, extensions to three dimensions, density of states, Statistical mechanics: Statistical laws, Fermi-Dirac probability function, the distribution function and the Fermi energy.

Unit 3: Physics of semiconductors **15L**

Semiconductor in equilibrium: Charge carriers in semiconductors, dopant atoms and energy levels, extrinsic semiconductors, Statistics of donors and acceptors, charge neutrality, position of Fermi energy level. Carrier transport phenomena: charge, effective mass, state & carrier distributions, Carrier drift, carrier diffusion, graded impurity distribution, resistivity, Hall Effect. Non-equilibrium excess carriers in semiconductors: Carrier generation and recombination, characteristics of excess carriers, bipolar transport, quasi-Fermi energy levels, excess carrier lifetime, surface effects

Unit 4: Basics of Semiconductor Devices **15L**

Diode: Junction terminologies, Poisson's equation, built-in potential, depletion approximation, diode equation, Qualitative and Quantitative analysis, Reverse-bias breakdown, avalanching, zener process, C-V characteristics, Transient response.
BJT: Terminology, electrostatics and performance parameters, Eber-Moll model, Two port model, hybrid – pi model, device models in spice , Modern BJT structures –polysilicon emitter BJT, Heterojunction bipolar transistor (HBT)
FETs: JFET and MESFET - Junction terminologies, characteristics, ac response, spice models
MOSFET: Fundamentals, Capacitance- voltage characteristics, I-V characteristics, Qualitative Theory of Operation, ID - VD Relationship, ac response, spice models.

- **Learning Outcomes:**
  1. Understand theory of solids
  2. Learn quantum and statistical mechanics.
  3. Learn Physics of semiconductors.
  4. Learn Implement various blocks in computers.
- **Reference Books:**

  1. Donald A. Neamen, Semiconductor Physics and Devices Basic Principles, TMH, 3rd Edition (2003)
  2. Robert F. Pierret, Semiconductor Device fundamentals, Pearson Education
  3. Streetman, Solid State Electronics Devices, PHI, 5th Edition, (2006)
  4. S.M. Sze, Kwok K. N, Physics of Semiconductor Devices, 3ed, Wiley edn.

Semester I
Course II
MET102: Instrumentation and Measurement Techniques

- **Learning Objectives:**
  1. To understand the configurations and functional descriptions of measuring instruments
  2. To understand the basic performance characteristics of instruments
  3. To understand the working principles of various types of sensors and transducers and their use in measuring systems
  4. To study the techniques involved in various types of instruments
  5. To understand the relevance of electronics with other disciplines

Unit 1: Introduction to Measurement and Measurement Systems 15L

Definition and significance of measurement, classification of instruments and types of measurement applications, elements of an instrument / measurement system, active and passive transducers, analog and digital modes of operation, null and deflection methods, input-output configuration of instruments and measurement systems, methods of correction of instruments and measurement systems Generalized performance characteristics of instruments: static characteristics and static calibration, meaning of static calibration, true value, basic statistics, least–squares calibration curves, calibration accuracy versus installed accuracy, combination of components errors in overall system accuracy calculations, theory validation by experimental testing

Unit 2: Static Dynamic Characteristic of Measurement System 15L

Static sensitivity, linearity, threshold, noise floor, resolution, hysteresis and dead space, scale readability, span, generalized static stiffness and input impedance, loading effect Dynamic characteristics: generalized mathematical model of measurement system, operational transfer function, sinusoidal transfer function, zero-order instrument, first order instrument, second order instruments, step response, ramp response, frequency response of first -order instruments and second order instruments Errors in measurement: Types of Errors - gross, systematic, environmental errors, systemic errors, computational error, personal error etc.

Unit 3: Motion Measurement 15L

Methods of transduction, primary sensing elements and transducers, electrical transducers, classification of transducers Motion and dimensional measurement: fundamental standards, relative displacement translational and rotational, calibration, resistive potentiometers, resistance strain gauge, differential transformers, variable–inductance and variable–reluctance pickups, eddy current, non-contacting transducers, capacitance pickups, piezoelectric transducers, digital displacement transducers (translational and rotary encoders), ultrasonic transducers, detailed discussion of strain gauges, LVDT and synchros Relative velocity: translational and rotational, calibration, average velocity from measured x and t, tachometer encoder methods, laser based methods, stroboscopic methods, translational–velocity transducers (moving coil and moving magnet pickups) Relative acceleration measurements: seismic (absolute) displacement pickups, seismic (absolute) velocity pickups, seismic (absolute) acceleration pickups (accelerometers)

Unit 4: Process Parameter Measurements 15L

Force, Torque and Shaft power: standards and calibration, basic methods of, bonded strain gauge, differential transformer, piezoelectric, variable reluctance/ FM oscillator digital system, torque measurement on rotating shafts Pressure and Sound Measurement: standards

and calibration, dead weight gauges and manometers, low pressure measurement - Mcleod gauge, Knudsen gauge, viscosity, thermal conductivity, ionization, sound level meter, microphone, capacitor microphone Flow measurement: Pitot-static tube, Yaw tube, hot wire and hot film anemometers, Laser Doppler anemometer, Gross Volume Flow Rate- rotameter, turbine, ultrasonic flow meter, electromagnetic flow meters Temperature and Heat Measurement Transducers: standards and calibration, bimetallic thermometers, liquid in glass thermometers, pressure thermometers, RTD, thermocouples, thermistors, semiconductor based temperature sensors, detailed discussion on basics of thermocouples, laws of thermocouples, cold junction compensation; thermistor types, materials used, application circuits, LM35 Radiation Fundamentals: detectors, optical pyrometers, IR imaging systems, heat flux sensing slug type sensors, Gorden gauge.

- **Learning Outcomes:**
  1. Understand measurement and measurement systems
  2. Learn static and dynamic systems
  3. Understand various motion measurement methods
  4. Understand Process parameter measurements

- **Reference Books:**

  1. Ernest O. Doeblin and Dhanesh N.Manik, Measurement Systems, Applications and Design, 5th Edition, Tata McGrawHill.
  2. A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation by Dhanpat Rai & Co.
  3. Kalsi , Electronic Instrumentation, TMH.
  4. Cooper and Helfrick, Modern Electronic Instrumentation and Measurements Techniques, PHI.

Semester I
Course III
MET103: Computer Organization

- **Learning Objectives:**
  1. To learn basics of the computer organization
  2. To study fundamental architectures of computer organizations
  3. To learn Parallel Processors concept in Computer Organizations
  4. To learn implementation of functional blocks for computer organizations.

Unit I: Introduction **15L**

Computer system organization – hardware and software components, overview of Operating System, Computer booting process, Instruction set architectures, Chronology of Microprocessor Development w.r.t. CISC/RISC families, Timeline of POWER PC, Alpha SPARC families. Operating system case study: DOS, UNIX.

Unit II: Fundamental Architectures **15L**

Defining a Computer Architecture, Von Neumann and Harvard Architectures, bus topologies, pipelining, Superpipelining, Superscalar processors, Very Long Instruction Word (VLIW) architectures, multithreaded processors – superthreading, hyperthreading

Unit III: Parallel Processors **15L**

Flynn‟s taxonomy, SIMD, MIMD and multi-computer approaches. Implementation Considerations: memory technologies, Hierarchical Memory Systems, caches, prefetching techniques, virtual memory, pipelining, ternary logic, packaging considerations, wafer scale integration.

Unit IV: Implementation of Functional Units **15L**

Memory Management, Arithmetic Logic Unit, Floating Point Unit, Branch Unit, Vector Unit, Load/Store Unit. Development Tools: Microcomputer Development Systems (MDS), In Circuit Emulator (ICE), Assembler, Editors, Logic Analyses.

- **Learning Outcomes:**
  1. Understand Computer system organization – hardware and software
  2. Define Computer Architecture.
  3. Use computer architecture classifications tools in designing of modern processors.
  4. Implement various blocks in computers.
- **Reference Books:**

  1. David A. Patterson, John L. Hennessy, Computer Organization and Design, the Hardware/Software Interface, Third Edition, Publisher: Morgan Kaufman, ISBN- 10: 58606041.
  2. William Stalling, Computer Organization and Architecture, designing for performance, Eighth Edition,
  3. Linda Null and Julia Labur ,The Essentials of Computer Organization and Architecture, ISBN:076370444x,Jones and Bartlett Publishers 2003
  4. Computer Organization and design, P. PAL CHAUDHURI, third Edition, PHI Learning PVT LTD
  5. Computer Organization and design, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, fifth Edition, Tata McGraw-Hill Edition

6. Brian W. Kernighan, Rob Pike, The UNIX Programming Environment, PHI Learning PVT LTD
7. Jerry C. Whitaker, The Electronics Handbook Edited , CRC Press and IEEE Press (1996), Section VII: Microelectronics and Section XIX: Computer Systems
8. D.V. Hall, Microprocessors and Interfacing, McGraw Hill (1986)
9. Barry B. Brey, The Intel Microprocessors: Prentice Hall Of India Ltd. (1997)

Semester I
Course IV
MET104: Advanced Digital System Design

- **Learning Objectives:**
  1. To make the students able to understand key ideas behind digital system design.
  2. To introduce the students able to design CMOS based circuit design necessary as a foundation of VLSI technology.
  3. To make students able to solve problems on Digital Systems and CMOS Design techniques
  4. To make students able to qualify aptitude test being conducted by Industries working on VLSI and Embedded system design.

Unit I: Combinational Logic Design **15L**

Decoder Design using Universal Gates: BCD to Binary, BCD to 7 Segment, 3:8 Decoder, Concept of Redundant Logic. One-hot encoder, One-Cold Encoder and its importance. Four, Five Variable K-Map, Variable Reduction in K-Map, Folded K-Map, and Implementation of Logic Functions: using K-Map, using Multiplexor (MUX) ICs. Comparison between Decoder and DMUX. Full Adder using DMUX. Designing Logic Gates using MUXs. BCD Adder using ICs, Single bit comparator.

Unit II: Sequential Logic Design **15L**

Difference between Flip-Flop (F/F) and Latch, F/F Characteristics, F/F Conversions, Race Condition in JK F/F, Excitation table of F/Fs. Finite State Machines (FSMs): Moore and Mealy Machine, Asynchronous Counter Design: 2-bit, 3-bit and 4-bit, Glitches, Synchronous Counters Design: 2-bit, 3-bit and 4-bit using FSM. Decade Counter Design using FSM. Synchronous Counter design for given state diagram.

Unit III: Foundations of CMOS Technology **15L**

Construction of p-MOS and n-MOS, MOS Logic Characteristics, Concept of Feature Size, Comparison between TTL and CMOS Technology, CMOS Series Characteristics, TTL Driving CMOS and CMOS Driving TTL.

Unit IV: CMOS Based Logic Design **15L**

CMOS as Inverter, Designing CMOS Structure for Logic Gates and for given Boolean Equations, CMOS based combinational circuit design for 2:4 Decoder, 3:8 Decoder, 4:2 Priority Encoder, Half Adder and Full Adder.

- **Learning Outcomes:**
  1. Understand measurement and measurement systems
  2. Design and constructs logic as well as arithmetical circuits
  3. Calculate various important parameters of Digital logic families
  4. Design & analyze combinational logic and sequential logic circuits

- **Reference Books:**

  1. R.J.Tocci, Digital Systems Principles and Applications, PHI Pvt. Ltd.
  2. N.G. Palan, Digital Electronics, Technova Publications.
  3. John F. Wakerly, Digital Design Principles and Practices Prentice HallInternational Edition.

Semester I
LAB –I
MEP105: General Electronics Lab
(Hardware and Software Lab)

- **Learning Objectives:**
  1. To study various types of Instruments and measurement systems.
  2. To study transducer and their response.
  3. To learn designing of digital systems
  4. To design digital systems for an applications

Practical Set
Group A

- Practical based on Instrumentation and Measurement System
  1. Design build and test rms to dc converter for voltage measurement of ac signal
  2. Displacement measurement using LVDT, signal conditioning and DPM
  3. Temperature measurement using PT100, signal conditioning and DPM
  4. Temperature measurement using thermocouple with cold junction compensation
  5. To build and test current telemetry (4 to 20 mA)
  6. Ultrasonic transmitter and receiver, distance measurement
  7. RPM measurement using various methods
  8. Design and calibrate light intensity meter using photodiode or LDR and the necessary signal conditioning and display.
  9. Study of Strain Measurement using Strain Gauges and Cantilever Assembly
  10. Determination of Linear Range of operation of Strain Measurement

Group B

- **Practical based on Advanced Digital System Design**
  1. Two digit combinational lock
  2. Keyboard encoder with latches
  3. Traffic light controller
  4. Multiplexed display (Bank token / two digit counter)
  5. Bidirectional stepper motor control (Sequence Generator)
  6. One digit BCD adder and 8-bit adder / subtractor
  7. Object counter (use of MMV, counter)
  8. Binary-Gray and Gray-Binary code converter
  9. Design build and test IR transmitter and receiver (TSOP1738 or similar) for object detection
  10. Hot wire anemometer

- **Learning Outcomes:**
  1. Design and constructs logic as well as arithmetical circuits
  2. Calculate various important parameters of Digital logic families
  3. Design & analyze combinational logic and sequential logic circuits
  4. Analyze CMOS based logic devices

- **Reference Books:**

1. Ernest O. Doeblin and Dhanesh N Manik, Measurement Systems, Applications and Design,.5th Edition, Tata McGrawHill.
2. A.K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation Dhanpat Rai & Co.
3. Kalsi ,Electronic Instrumentation, TMH.
4. Modern Electronic Instrumentation and Measurements Techniques, Cooper and Helfrick, PHI.
5. R.J.Tocci, Digital Systems Principles and Applications, PHI Pvt. Ltd.
6. N.G. Palan, Digital Electronics, Technova Publications.
7. John F. Wakerly, Digital Design Principles and Practices Prentice Hall International Edition.

Semester I
LAB –II
MEP106: C Programming Lab

- **Learning Objectives:**
  1. To develop programming logic and algorithm writing.
  2. To develop skills for writing programs using C.

Group A

- Basic C Programs.
  1. The printf and Scanf functions
  2. Use of data types, variables.
  3. Expression in C.
  4. Floating Point Operations.
- Conditional Statements.
  1. Program to check whether input alphabet is vowel or not.
  2. Program to input no and check even and odd no.
  3. Program to display sum of digit.
- Looping Structure
  1. Program to display factorial of given number.
  2. Program to accept no and checks if no is palindrome or not.
  3. Program to find sum of first n natural no's.

Group B

- Functions
  1. Write recursive function to print Fibonacci series.
  2. Write function to check given no is Armstrong or not.
  3. Program to display factorial of given number using recursion.
  4. Functions With Argument/non argument and return/no return values.
- Array
  1. Array Declaration
  2. Program to print minimum Number between an Array.
  3. Program to perform string comparison using C.
- Pointers
  1. Declaration and Initialization of Pointers
  2. Accessing String Elements in Pointers.
  3. Accessing array Elements using the pointers.

- **Learning Outcomes:**
  1. To be able to implement programs using C language.
  2. To be able to do simple programs to complex programs.
  3. To be able to process programs and execution of program.
  4. To be able to develop simple applications of real life using structures and files.

- **Reference Books:**

1. Yashavant Kanetkar, Let Us C , BPB Publications
2. Balagurusamy, Programming in ANSI C, 2nd edition, TMH
3. Brian W. Kernighan, D. M. Ritchie, The C Programming Language, Prentice Hall

Semester II

Course V

MET201: 8 bit Microcontrollers and Applications

- **Learning Objectives:**
  1. To understand the architecture of 8 bit microcontrollers
  2. To learn software techniques to embed codes in to the system
  3. To learn the advanced architectures for advanced Embedded systems
  4. Student should perform I/O port, timer, counter and interrupt operations

Unit 1: 8 bit Microcontroller Architecture **15L**

Review of 8051 architecture, on chip peripherals of 8051, Introduction to PIC microcontrollers, PIC architecture, Concept of pipelining, RISC, I/O ports, timers/counters and other peripherals, memory mapping, Interrupt structure, Comparison of PIC with other microcontrollers and microprocessors

Unit II: Programming and interfacing **15L**

Instruction set; addressing modes, assembly language programming, Programs for bit manipulation, generation of delay and wave forms. PWM control etc. Hardware interface for LEDs, 7segment display, LCD, Keypad interfacing, dc and stepper motor.

Unit 3: Introduction to AVR Microcontroller **15L**

Architecture (Atmega16), instruction set, addressing modes, memory organization, timers, PWM, I/O ports, ADC, interrupts, serial communication. Basic Assembly Programs: arithmetic, logical, code converter, block data transfer, I/O programming for ADC, timer and I/O ports

Unit 4: Applications of AVR Microcontroller **15L**

Design of General Purpose Target Board: reset, oscillator circuit, derivatives of AVR, Real world interfacing with the microcontrollers and programming in C for interfacing LED, Seven Segment Display, dot matrix display and LCD displays (text and graphic), keyboard and motors (DC, stepper, and servo), I2C and SPI based RTC, EEPROM, DAC and ADC

- **Learning Outcomes:**
  1. Learn architecture of 8 bit microcontrollers
  2. Able to write programs for any application
  3. Design and test advanced Embedded systems using 8 bit microcontrollers
  4. Able to perform interfacings of various real world devices

- **Reference Books:**

  1. Chuck Helebuyck ,Programming PIC microcontrollers with PIC basic
  2. Milan Verle,PIC microcontrollers-programming in basic
  3. Kirk Zurell, C Programming for Embedded Systems, Pearson Education.
  4. Mazidi and Naimi, AVR Microcontroller and Embedded Systems using Assembly and C, Pearson education, 2011.
  5. Barnett, Larry D. O'Cull and Sarah A. Cox, Delmar,Embedded C Programming and the Atmel AVR,
     Cengage Learning, 2007.
  6. Mazidi, Mckinlay and Causey, PIC Microcontroller and Embedded Systems, , Pearson Education.
  7. Stephen Kochan, Hayden, Programming in C, Books/Macmillan.

Semester II
Course VI
MET202: Applied Electromagnetics and Microwaves

- **Learning Objectives:**
  1. To introduce to students the concepts of electromagnetics
  2. To understand the theory of transmission lines and wave guides
  3. To study various parameters of antennas
  4. To study various methods of generation of microwaves

Unit 1: Electromagnetic Waves **15L**

Physical quantities as vectors, gradient, curl, and divergence, rotation operator, covariant and contra-variant vectors, line, surface and volume – integrals, Gauss and Stokes theorem complex plane, polar form of complex number, complex functions, Cauchy-Riemann conditions, orthogonal functions and relation with Laplace equation

Maxwell's equations, continuity equation, electric and magnetic wave equations in time domain and frequency domain, wave propagation in conducting and non-conducting media, skin depth and high frequency propagation, boundary conditions at the interface between two mediums, Pointing theorem and its applications

Unit 2: Transmission Lines **15L**

Types of transmission lines, microstrip lines, two wire transmission line, transmission line equations for voltages and currents, inductance and capacitance per unit length of two wire and coaxial cable transmission line, characteristic impedance, propagation constants, attenuation and phase constants, phase velocity, reflection and transmission coefficients, SWR, line impedance, normalized impedance and admittance, Smith chart construction and applications, single stub and double stub matching, applications to reflection of EM-waves at interfaces for normal incidence

Unit 3: Waveguides and Components **15L**

Concept of waveguides, frequency range, relation to transmission lines. Rectangular Waveguides: TM and TE Modes, concept of cut-off frequency, guide impedance, phase velocity, guide wavelength for TE and TM modes, Applications to TE mode in rectangular waveguide, power losses in rectangular waveguide Circular waveguide introduction only

Optical Fiber: principles of operation and construction, difference between conducting circular waveguide and fiber Different methods of excitation of TE and TM modes in waveguides Cavity Resonators, Q factor of cavity resonators

Unit 4: Electromagnetic Radiation **15L**

Potentials of electromagnetic fields, retarded potential, radiation from oscillating dipole, concept of near zone and radiation zone, radiation resistance, role of antenna in exciting different TE, TM modes in wave guides

Antenna Parameters: gain, directivity, power, aperture, Friis equation, radiation pattern Application Areas: antenna temperature, Signal to Noise Ratio (SNR), remote sensing, RADAR Equation

Antennas Types: λ/2 antenna, antenna arrays, horn antennas, parabolic dish antennas, End fire antenna – Yagi Uda, patch antenna, microstrip antennas EMI and EMC Generation of Microwaves: principle, physical structure and working of - Gunn effect diodes, magnetron oscillator, reflex Klystron oscillator.

- **Learning Outcomes:**
  1. Calculate power output and efficiency of microwave tubes
  2. Make use of various microwave devices with proper characteristics
  3. Find Micro strip Lines-characteristics
  4. Measure Microwave parameters.

- **Reference Books:**

  1. Samuel Y. Liao, Microwave Devices and Circuits, PHI, 3rd Edition, 2002.
  2. N. Sadiku, Principles of Electromagnetics, Oxford University Press.
  3. Kraus and Fleiseh, Electromagnetics with Applications, McGraw Hill, 5th Edn, 1999.
  4. Electromagnetics, J.D. Kraus, 4th Edn, McGraw Hill, 1992.

Semester II
Course VII
MET203: Power Electronics

- **Learning Objectives:**
  1. To learn the advanced power electronics circuits.
  2. To understand concepts of choppers
  3. To study the designing of Inverters
  4. To study the designing of converters

Unit I: Basics of Electrical machines: 15L

Introduction to motors, Types of D.C. Motors, BLDC Motors, Torque Speed Characteristics. Types of Induction Motors. Construction and Working of Synchronous Machines and Stepper Motors. Interface techniques of Stepper Motor with IBM PCs and Digital Circuits. Concept of Full-Step, Half-Step and Micro-stepping in Stepper Motors.

Unit II: Choppers: 15L

Introduction and Classification of Choppers, Control Strategies: Pulse Width Modulation,

Constant Pulse Width Variable Frequency, Current Limit Control, Variable Pulse Width and

Frequency. Chopper Configurations Single Quadrant Chopper, Four- Quadrant Chopper.

Step-Down and Chopper with Resistive Load. Step-Up Chopper. Three-Thyristor Choppers,

Resonant Pulse Chopper.

Unit III: Transistorised Inverter Circuits: 15L

Half Bridge Inverter: Square Wave Half Bridge Inverter, Quasi-square wave inverter, PWM

Inverter, Thyristorized Half Bridge Inverter. Push-Pull Inverter, Single-phase bridge inverter

with resistive and inductive load, PWM bridge Inverter, Three phase inverters. Voltage Control of Single Phase Inverter. SPWM, MPWM, Sinusoidal PWM, Modified Sinusoidal pulse width modulation and Phase displacement control. Voltage control of Three Phase inverters.

Unit IV: Thyristorised Inverters: 15L

Forced commutated thyristor inverters. i.e. Auxillary commutated inverters, Mc Murray

commutated inverter, Complementary commutated inverters /Mc-Murray Bedford inverter,

Current source inverter, Series resonant inverter with unidirectional and bidirectional switches, Parallel resonant inverters, Resonant DC link inverter.

- **Learning Outcomes:**
  1. Design a Chopper as per end users requirement.
  2. Design a Transistorized inverter as per end users requirement.
  3. Design a Thyristorized inverter as per end users requirement.
  4. Design PWM converters
- **Reference Books:**

1. P.C. Sen, Power Electronics
3. S. R. Doradla, A. Joshi & R.M. Sinha , Thyristor power Controllers. C.K Dubey,
4. M. Rashid ,Power Electronics
5. S. B. Dewan, G.R. Sleman, A. Strauphan ,Power Semiconductor drives- (Wiley Int.Pub.- John Wiley Sons.)

Semester II
Course
VIII
MET204: Fiber Optic Communication Systems

- **Learning Objectives:**
  1. To understand basics of optical fiber
  2. To learn components of optical communication systems
  3. To know about the types of optical fibers
  4. To understand fiber optic communication system

Unit 1: Fundamentals of Optical Fiber Communication System 15L

Overview of basics of optical fiber: Total internal reflection. Ray model: Fundamental laws of optics, refraction, Snell's law, critical angle, total internal reflection Ray propagation in step index fiber , Numerical Aperture and acceptance angel , Definition of Skew rays and Meridional rays , Wave model :Phase velocity and group velocity , Modes in optical fiber , V-number & normalized frequency Classification of Optical fiber used in industry: Types of Optical Fiber: SI and GI , SM and MM

Types of losses in Optical fiber: Attenuation, Absorption losses: intrinsic and extrinsic, linear scattering losses: rayleigh and mie, Fiber bend losses: micro and macro. Dispersion: Intermodal Dispersion in multi-mode step index fiber, Intra-modal (Chromatic) Dispersion: material and wave guide dispersion. Dispersion shifted and dispersion flattened fibers

Unit 2: Components of Fiber Optics Communication System 15L

Advantages & disadvantages, General configuration of Fiber optic communication system, Understand driver circuits used in Optical communication system LED driver circuit: Analog, Digital , LASER driver circuit: analog, digital , Optical receiver block diagram Common source FET preamplifier ,Regenerative repeater

Fiber optic cables: Needs of cabling, Fiber Cables: Slotted core, loose tube and multi-fiber ribbon Splicing and joining of fibre cable, Connection losses: Extrinsic Parameters: Fresnel reflection, Misalignment, and Other factors, Intrinsic Parameters: NA mismatch, diameter mismatch, Fiber end preparation for loss minimization.

Splices: Fusions Splices, Mechanical splices: Capillary, V-grooved, Loose tube, spring groove and elastomeric splices. Process of connecting the fibre cable with connectors: Fiber optic connectors: Ferrule, Expanded beam.

Unit 3: Optical Fiber Cables, connectors and integrated optics 15L

Optical components & integrated optics Optical couplers and isolators: types and functions, Optical switches, Beam splitter, Optical multiplexer and demultiplexer, Optical wavelength Converter, Bragg grating, working of optical amplifier

Understand concept of integrated optics: Optical Amplifiers-Semiconductor optical amplifier, EDFA, Raman amplifier, Concept of Integrated optics Characterization & Applications working principle of Optical Power Meter & OTDR, Optical power meter, Optical time domain reflectometer, Understand application of WDM in Fibre optics communication system, WDM & DWDM Fiber Sensors, List application of various LASER used in industries & medical surgery.

Unit 4: Optical System Design: Considerations 15L

Component Choice, Multiplexing, Point-to- Point Links, System Considerations, Link Power Budget with Examples, Overall Fiber Dispersion In Multi-Mode and Single Mode Fibers, Rise Time Budget with Examples. Transmission Distance, Line Coding in Optical Links, WDM, Necessity, Principles, Types of WDM, Measurement of Attenuation and Dispersion, Eye Pattern.

- **Learning Outcomes:**
  1. Analyze the characteristics of optical fiber communication
  2. Find the Losses in optical fibers
  3. Preparation methods of optical fibers
  4. Do Optical fiber measurements
- **Reference Books:**

  1. John M Senior ,Optical Fiber Communication Pearson
  2. R P Khare, Fiber Optics & Optoelectronics Oxford
  3. D C Agarwal , Fiber Optic Communication S Chand
  4. Subir Kumar Sarkar, Optical Fiber & Fiber Optic Communication S Chands
  5. Rajappa PapannareddyPenram, Light wave Communication Systems: A Practical Perspectives

Semester II
Course IX
MET205: Computer Networks

- **Learning Objectives:**
  1. To learn the principles of Linux operating Systems
  2. To study computer networking topologies
  3. To learn OSI reference model
  4. To study internet address

Unit I: UNIX Operating System **15L**

Introduction, applications Unix Shell, Kernel and Application layer, file system features and benefits, File Management in utilities: pwd, cd, ls, cat, mv, ln, rm, rmdir, find, cut and paste etc., Internal file structure, Directory and directories used by Unix system, The Shell: Shell commands, I/O redirection, pipes and filters, pipe fitting, wildcard, matching background processing, shell script shell variables, shell as programming language, Unix vi editor..

Unit II: Computer Networking **15L**

LAN, Cabling and Topologies: Various transmission media, Twisted and untwisted pairs, coaxial cables, fiber-optic cables and characteristics, wireless LAN, Cabling Topologies: hierarchical, bus, ring, star, collapsed star, mesh. Origin and definition of LAN, types and uses of LAN, LAN components: NIC N/W cables, hubs, and OS, LAN types: MAP, ARCnet, Apple Talk etc., MAN and WAN, repeaters, Bridges, Routers, Gateways, Backbones etc.

Unit III: The O.S.I. reference model **15L**

N/W architecture, OSI reference model, data transmission, FDM, TDM, circuit switching, message switching, packet switching, hybrid switching, LAN static and dynamic channel allocation, LAN protocols, IEEE standard 802 for LAN, comprises of LAN‟s, The Internet: Introduction, Architecture.

Unit IV: Internet addresses **15L**

Three primary classes of IP addresses, Dotted decimal notation, network, broadcast and loopback address. Internet Protocol (IP) – Connectionless Datagram Delivery, Routing, Error and Control Messages. User Datagram Protocol (UDP): Introduction, Format of UDP Messages, UDP encapsulation, UDP port numbers. Transmission Control Protocol (TCP): Reliability of transmission, ports, connections and endpoints, Concept of sliding windows, TCP segment format, Establishing, closing and resetting a TCP connection, TCP port numbers, ATM Network.

Applications: Remote Login (TELNET), File transfer (FTP), Electronic Mail, (SMTP), Future of TCP/IP – Ipv6 (introduction)

- **Learning Outcomes:**
  1. Work with Linux operating System and perform shell scripting
  2. Understand various network topologies and Local area network
  3. Know network architecture and importance OSI reference model
  4. Learn various internet protocols.
- **Reference Books:**
  1. Andrew S. Tanenbaum, Computer Networks, Fourth Edition

2. Behrouz A Forouzan, TCP/IP Proticol Suite, McGraw-hill
3. Brian W. Kernighan, Rob Pike,The UNIX Programming Environment, PHI Learning PVT LTD
4. Pramod Koparkar, UNIX for You, Tata McGraw-Hill

Semester II
LAB –III
MEP206: Core Electronics Lab
(Hardware and Software Lab)

- **Learning Objectives:**
  1. To learn different Interfacing using 8 bit microcontrollers
  2. To learn Arduino development board and modern OPC
  3. To study standing wave and reflection coefficient of Electromagnetic wave
  4. To study Electromagnetic wave propagation and polarization

Group A

Practical's based on Microcontroller

1. Dot matrix rolling display
2. Use of timer for time delay generation
3. LCD / keyboard Interfacing
4. Bidirectional stepper motor interfacing / Stepper motor Interfacing
5. DC motor control using PWM / intensity control of LED
6. Real Time Clock display on LCD / HyperTerminal (I2C)
7. Use of internal EEPROM/ Serial EEPROM / EEPROM interface using SPI protocol
8. DAC interfacing (square wave, staircase, triangular, sine) use of timer for
9. On-off controller with hysteresis (ADC)
10. Two digit frequency counter or event counter using timer / interrupt

Group B

Practical's based on Microwave and Antenna

1. To determine the standing wave ratio and reflection coefficient of a given waveguide
2. To determine a characteristics of a microstrip transmission line
3. Measurement of primary-secondary coupling factor of a given transformer using LCR meter (calculation of transformer model parameters expected)
4. To plot Equipotential contours and field lines for given charge distribution
5. Use of Smith chart for transmission line pattern and verify using C
6. Study of V-I characteristics of Gunn Diode
7. Study of O/P power and freq. as a function of voltage characteristic of Gunn Diode
8. Study of Square wave modulation through PIN diode characteristic of Gunn Diode
9. Study of Attenuator
10. To study the substitution method for attenuation measurement and determine theattenuation due to a component under test

- **Learning Outcomes:**
  1. Design circuits for various applications using microcontrollers.
  2. Apply the concepts on real- time applications.
  3. To be able to do simple programs to complex programs.
  4. To be able to process programs and execution of program.
  5. To be able to develop simple applications of real life using structures and files.

- **Reference Books:**

  1. Chuck Helebuyck, Programming PIC microcontrollers with PIC basic.
  2. Milan Verle., PIC microcontrollers-programming in basic.
  3. Kirk Zurell, C Programming for Embedded Systems, Pearson Education.
  4. Mazidi andNaimi AVR Microcontroller and Embedded Systems using Assembly and C, , Pearson education, 2011.
  5. Larry D. O'Cull and Sarah A. Cox, Embedded C Programming and the Atmel AVR, Barnett, Delmar, Cengage Learning, 2007.
  6. Mazidi, Mckinlay and Causey, PIC Microcontroller and Embedded Systems, Pearson Education.
  7. Samuel Y. Liao, Microwave Devices and Circuits, PHI, 3rd Edition, 2002.
  8. N. Sadiku, Principles of Electromagnetics, Oxford University Press.
  9. Kraus and Fleiseh, Electromagnetics with Applications, McGraw Hill, 5th Edn, 1999.
  10. J.D. Kraus, Electromagnetics, 4th Edn, McGraw Hill, 1992.

Semester II

LAB –IV

MEP207: Power and Fiber Optics Lab

- **Learning Objectives:**
  1. To learn the advanced power electronics circuits.
  2. To understand concepts of choppers
  3. To study the designing of Inverters
  4. To study the designing of converters

Group A

Practical based on Power Electronics

1. **AC Voltage Control**
   1. To simulate AC voltage control using simulator
2. **PSIM-I Circuit Simulation**
   1. To simulate half wave rectifier using simulator
3. **PCB Design**
   1. To study PCB Designing
4. **SCR Firing Circuit**
   1. To simulate SCR firing circuit simulator
5. **Design of series voltage regulator**
   1. To study and design series voltage regulator using PSIM software
6. **Design BUCK regulator**
   1. To simulate BUCK regulator circuit using PSIM
7. **PCB design**
   1. TO study and design PCB of IC 555 using PROTEL
8. **DC motor control using chopper**
   1. To study DC motor using chopper
9. **ON/OFF control using RTD**
   1. To study the ON/OFF using RTD
10. **Study of Linux Operating system**

Group B

Practical Based on Optoelectronics

1. Measurement of Numerical Aperture of optical fiber
2. Measurement of attenuation of given optical fiber
3. Measurement of bending loss of given optical fiber
4. To Plot characteristics of LED
5. To Plot characteristics of LASER diode
6. To Plot characteristics of Photo Diode
7. To study frequency modulation System
8. To study pulse width modulation system
9. To establish Analog communication optical link
10. To establish Digital communication optical link
11. To Demonstrate OTDR/ Optical Power Meter.
12. To Build fiber optics link using PWM echnique

- **Learning Outcomes:**
  1. Analyze the characteristics of optical fiber communication
  2. Find the Losses in optical fibers
  3. Preparation methods of optical fibers
  4. Do Optical fiber measurements
  5. Design a Chopper as per end users requirement.
  6. Design a Transistorized inverter as per end users requirement.

- **Reference Books:**

  1. P.C. Sen ,Power Electronics
  2. C.K Dubey, S. R. Doradla, A. Joshi & R.M. Sinha, Thyristor power Controllers.
  3. Power Electronics – By M. Rashid
  4. S. B. Dewan, G.R. Sleman, A. Strauphan, Power Semiconductor drives- (Wiley Int.Pub.- John Wiley Sons.)
  5. John M, Optical Fiber Communication Senior Pearson
  6. R P Khare ,Fiber Optics & Optoelectronics Oxford
  7. D C Agarwal ,Fiber Optic Communication ,S Chand
  8. Subir Kumar Sarkar ,Optical Fiber & Fiber Optic Communication ,S Chands
  9. Rajappa PapannareddyPenram
  10. Light wave Communication Systems: A Practical Perspectives