SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2018-19

Syllabus for M.Sc. (Electronics)

(પીજી બોર્ડ તા. ૦૩/૦૫/૨૦૧૭)

Semester IV

PS04CELE21: IC FABRICATION TECHNOLOGY

TOTAL 100 MARKS (EXTERNAL - 70, INTERNAL-30)
University Examination -3 Hours Duration

Outline:
This course aims at understanding the manufacturing methods and their underlying scientific principles in the context of technologies used in IC chip fabrication.

UNIT-1

Semiconductor Materials, Crystal Structures, Energy Bands, Intrinsic Career Concentration, Donors and Acceptors, Electron Mobility, Resistivity and Conductivity, Crystal Growth, Electronic Grade Silicon, Czochralski Crystal Growth, Float-Zone Process, Characterization, Wafer Preparation, Epitaxy, Chemical Vapor Deposition (CVD), Growth Model, Growth Chemistry, Doping and Autodoping, Reactors, Defects, Selective Epitaxial Growth, Low-Temperature Epitaxy (LTE) and Molecular Beam Epitaxy (MBE), Rapid Thermal Epitaxy (RTE).

UNIT-2

Oxidation, Theory of Oxide Growth, Experimental Fits- Orientation Dependence and Effects of Impurities, High Pressure Oxidation, Plasma Oxidation, and Rapid Thermal Oxidation, Oxide Properties, Dopant Redistribution at the Interface, Lithography, Clean Room, Optical Lithography, Masks, Photoresist, Pattern Transfer, Electron Lithography, X-Ray Lithography, Ion Lithography, Comparison of Lithographic Techniques

UNIT-3

Etching, Wet Chemical Etching, Dry Etching, Plasma Excitation and Plasma - Surface Interaction, Simple Plasma Etching Systems, Diffusion, Diffusion Theory, Diffusion Profiles, Constant-Surface-Concentration Diffusion, Constant-Total-Dopant Diffusion, Dual Diffusion Process, Extrinsic Diffusion, Diffusion in Silicon, Oxide Masking, Lateral Diffusion, Fast Diffusants, Diffusion in Polysilicon, Ion Implantation, Implant Uniformity, Contamination

UNIT-4

Annealing, Furnace annealing, Rapid Thermal Annealing, Metallization, Metallization Choices, Metal Corrosion, Testing-Assembly and Packaging of IC, Die Bonding and Wire Bonding, Flip-Chip Technique, Hermetic and Plastic Packages, Through-Hole and Surface-Mount Packages, Tape Carrier Packages.

Outline:
Study of this course will enable students to understand in-depth of Integrated Circuit manufacturing process with latest development of in the area of IC design, manufacturing and packaging.

BOOKS:

1. **VLSI Technology**
   S. M. Sze, (Mc Graw-Hill International Edition, N.Y, U.S.A.)
2. **VLSI Technology**
   Sujata Pandey & Manoj P Pandey(Dhanpat Rai & Co. New Delhi, INDIA)
3. **The Science and Engineering of Microelectronic Fabrication** Stephen A Campbell, (Oxford University Press Inc. N.Y., U.S.A.)
4. **Semiconductor Devices - Physics and Technology** S. **M.** Sze, (John Willey & Sons Inc., U.S.A.)
5. **Modern Semiconductor Fabrication Technology**
   Peter Gise & Richard Blanchard (Reston Book - Prentice Hall, N.J., U.S.A.)
6. **Integrated Circuits**
   K.R.Botkar (Khanna Publishers, New Delhi, INDIA)

PS04CELE22: FIBER OPTICS AND ITS APPLICATIONS
TOTAL 100 MARKS (EXTERNAL - 70, INTERNAL-30)
University Examination -3 Hours Duration

Outline:
This paper introduces a relatively new topic in the field of communication – Fiber Optics. The syllabus covers the history and theory of using guided light as a communication medium as well as the basic optical fiber and its applications.

UNIT-1
Light propagation-Ray theory transmission-meridional rays, another alternative path – skew rays, Types, characteristics and data rate in optical fibers, Modes in fibers, Modes coupling, Transmission characteristics in optical fibers- attenuation, absorption, scattering, polarization, dispersion-intermodal and intra modal , Bandwidth and data rate, Fiber materials- Fiber fabrication and preparation, splicing, connectors, couplers and switches, connection losses, Mechanical properties of fibers.

UNIT-2
Optical processes in semiconductors-Optical absorption and emission, Spontaneous and stimulated emission Optical sources –LED-working process of simple PN Junction LED, Special Class LEDs- Double Hetro-junction LED, Edge Emitting LED, Surface Emitting LED, LASER-Optical feedback and laser oscillation Quantum –well lasers , their structures and characteristics, Drive Electronics LED drivers - digital and analog, Laser diode drivers.

UNIT-3
Optical detectors- Principle of operation –photo detectors, P-N, PIN, Avalanche photodiode, Phototransistor, Responsivity and Quantum Efficiency of Photo detectors, Delectability, Noise and bandwidth, Detector circuitry and receivers-preamplifier, Automatic gain control

UNIT-4
Fiber optic communication system –Optical Time Division Multiplexing, Wave length Division Multiplexing- Demultiplexing, Bandwidth and rise time budgets, Noise and Bit Error Rate and eye Pattern, Optical Fiber measurement and field testing- Equipment used in field testing- Optical Power meter, Optical Time Domain Reflectometer (OTDR),Application of Fiber optics- Long –Haul communication, Fiber optic sensors, Local Area Networks, Fiber Distributed Data Interface , Medical and military applications, ISDN

Outcome:
The subject of Fiber optics and its applications will provide the students an insight into the "working" of the practical aspects of the fiber optic communication.

BOOKS:

1. **Optical Fiber Communication- Principle and practice**
   John M. Senior, Prentice Hall of India
2. **Fiber optic communication and other applications**
   Henry Zanger & Cynthia Zanger, Maxwell Macmillan International Edition
3. **An Introduction toOptical Fibers**
   Allen H. Cherin, Mcgrow Hill International Edition
4. **Optical Fiber Communication**
   Gerd Keiser, Mcgrow Hill International Edition

PS04CELE23: SENSOR TECHNOLOGY
TOTAL 100 MARKS (EXTERNAL-70, INTERNAL 30)
University Examination -3 Hours Duration

Outline**:**
The subject is designed to Chemical, Bio, Optical Fiber, SAW, Si and Micromachined sensors along with smart, Integrated and bus operated sensing systems. It deals with classification and the performance parameters to compare and select the most suitable sensor for the given application.

UNIT-I
Importance of Sensors, Introduction, Classification of Sensors, Sensor Parameters- Static and Dynamic, Errors in Measurements, Standards of Measurement, Integrated Sensors, Bus-organized sensing system.

UNIT-II
Chemical Sensors: Characteristics, Specific Difficulties, Classification, Direct Sensors:- Metal Oxide; Chem FET; Electrochemical; Enhanced Catalytic; Complex Sensors:- Thermal, Pellistor, Multi sensor Arrays, Electronic Nose, Smart Chemical Sensors.
Fiber Optic Sensors (FOSs), Basic Concepts, Architecture of Fiber Optics Sensors (FOSs), Applications- Temperature, Liquid Level, Fluid Flow and Microbend Sensor.

UNIT-III
Resonating Quartz Sensors, Piezoelectricity, Resonance and Quartz properties, Electronic equipments for Quartz Sensors, Surface Acoustic Wave Sensors (SAW), SAW Sensors Operation- Chemical and Physical Sensors, Magnetic Field Sensors, Mechanical Sensor

UNIT-IV
Biosensors - Introduction and Definition, Receptor : Molecular Recognition Element immobilization methods. Silicon Micromachining - Introduction, IC Technologies and Micromachining methods, Silicon Sensors. Micro Electro Mechanical Sensors (MEMs), Smart Sensors.

Outcome:
The leaner will get a complete idea about the modern generation of sensors for various applications and a basic understanding for the comparative analysis of various sensors and systems.

Basic Text & Reference Books:-

1. **Measurement and Instrumentation System W.Bolton**
   Butterworth-Heinemann Publisher, 1998
2. **Sensors for Domestic Applications**
   Alnaldo D'Amico and Giorgio Sbeveglieri, World Scientific Co. (USA)
3. **Sensors and Transducers,**
   D. Patranabis, Prentice/Hall of India Private Limited, N.Delhi (INDIA),(Second Edition)
4. **Advance in Biosensors** A.P.F. Turner, Jai Press Ltd., N.Delhi (INDIA)
5. **Biosensors - An Introduction Brian Eggins**
   Wiley Teuiner Publications, 1996
6. **Biosensors Principles & Applications**
   Loic J. Blum and Pierre R. Coulet, Marcel Dekker, Inc. (USA)
7. **Semiconductor Sensors** S.M.Sze, A Wiley-Inter science Publication, 1994

PS04EELE21: DESIGN OF VLSI SYSTEMS
TOTAL 100 MARKS (EXTERNAL - 70, INTERNAL-30)
University Examination -3 Hours Duration

Outline:
Study digital system and VLSI design methodology, design for testability and design verification. Learn methods to improve digital VLSI systems performance: reliability, manufacturability, cost, power, security, etc. Learn hardware design language (HDL). Implementing the HDL code on FPGA and CPLD

UNIT-1
An overview of VLSI, VLSI Design Methodology, Design Flow, VLSI Road Map, Logic Design with MOSFET, Elements of Physical Design. System level physical design: Large scale physical design, Interconnectivity, Delay model, Cross talk, Floor Planning & Routing, I/O Circuits, Power Distribution & Consumption, Clock Distribution

UNIT-2
Reliability & testing of VLSI Circuits: Introduction to Testing of VLSI Circuits, Fault Models, Gate level testing, Boundary Scan testing, Ad-hoc Testing, Test Generation Methods, D-Algorithm, Introduction to ATPG.

UNIT-3
System Specification using HDL, Introduction to HDL, VHDL modeling concept, Scalar data type & operations in VHDL, Sequential statements, Composite data type, Basic Modeling Constructs.

UNIT-4
Subprogram in VHDL, Packages & USE Clauses, VHDL standard package-1164, Alias, Constants, Components and configurations, Files and Input/Output. Designing with Programmable Logic Devices, Digital Design with State Machine chart, Designing with FPGAs & CPLDs, VHDL model for memory buses.

Outcome:
Upon successful completion of this subject the student will be able to:

1. Design complex digital systems using VLSI design methodology.
2. Design a digital system using given specifications and design constraints.
3. Plan and choose digital system testing strategy
4. Plan digital system verification strategy

BOOKS:

1. **Introduction to VLSI Circuits & Systems** John P. Uyemura, John Willey & sons (Asia) Pvt Ltd. NY,(USA)
2. **The Designer guide to VHDL** Peter J Ashenden, Harcourt India Pvt. Ltd., N.Delhi (INDIA)
3. **Digital logic design principles** Norman Balabanian & Bradely Carlson, John Willey & Sons Pvt. Ltd. . NY,(USA)
4. **Modern VLSI Design : System on Silicon** Wayne Wolf, Pearson education - Prentice Hall ,New Delhi (INDIA)
5. **Principles of CMOS VLSI Design : A system perspective** Neil H.E. Weste and Kamran Eshraghian Pearson Education -Prentice Hall New Delhi (INDIA)

6. **Digital Integrated Circuits : A Design Perspective** Jan M. Rabeay, Anantha Chandrakasan and Borivoje Nikolic Prentice Hall of India (EEE), New Delhi (INDIA)
7. **Digital Systems Design using VHDL** Charles H. Roth Jr., Thomson Brooks/ Cole (USA)

PS04EELE22: COMPUTER BASED INDUSTRIAL CONTROL
TOTAL 100 MARKS (EXTERNAL-70, INTERNAL 30)
University Examination -3 Hours Duration

Outline:

Study of Computer based Industrial Control is a course focused on carious Control scheme used in the Industrial Environment for Monitoring, Controlling various parameters in the field via Computerized Networked.

UNIT-1
Expectations from Automation, Current trends in Computer Control of Process Plants, Process Definition, Feedback Control, Basic Principles of Single controller loop, Two-position Control, Multi-position control, PID Control, Multi-variable Control, Feed Forward Control. Introduction of Building Blocks of Automation System, Processing System, Multimicroprocessor Systems.

UNIT-2
Local Area Networks, Analog and digital I/O Modules, Supervisory control and Data Acquisition Systems, Remote Terminal Unit, Direct Digital Control-Structure and Software. Distributed Digital Control, History, Functional Requirements of (Distributed) Process Control System, System Architecture, DCS, Final Control Element- Pneumatic, Hydraulic; Electric Actuation.

UNIT-3
Introduction to Intelligent Controllers, Model Based Controllers, Predictive control, Artificial Intelligent Based Systems, Expert Controller, Fuzzy Logic System. Fuzzy Controller. Fuzzy Logic Tools, Conventional Control Systems, Fuzzy Logic Control Systems, Fuzzy Logic Control vs. PID Control.

UNIT-4
Examples of Industrial Applications of FLC, Stability, Neural Controllers, VLSI Implementation of Neural Network. Fuzzy Neural Networks-Fuzzy Multilayer Perception, Fuzzy competitive Learning, Fuzzy Art, Fuzzy Min-Max Networks, Fuzzy Neurons, Fuzzy Neural Control Systems.

Outcome:
Students will learn various aspects of Industrial Control schemes managed by PLC, DCS, SCADA etc.

BOOKS:

1. **Computer based Industrial Control**
   Krishna Kant, Prentice Hall of India, New Delhi (INDIA)
2. **Introduction to Applied Fuzzy Electronics**
   Ahmad M. Ibrahim, Prentice Hall of India, New Delhi (INDIA)

PS04EELE23: PRINCIPLES OF NANOELECTRONICS
TOTAL 100 MARKS (EXTERNAL-70, INTERNAL 30)
University Examination -3 Hours Duration

Outline:
This course focuses on the fundamental concepts and principles of nanoelectronic materials and devices. Nanoelectronics is concerned with electronic devices with one or more dimensions at nanoscale.

UNIT-1
Dimensionality and ideal semiconductor nanostructure, density of states, Quantum size effects and density of states for two dimensional systems, Superlattices, Electron states in quantum wells, wires and dots, Gate oxide tunneling in MOSFETs, Fowler-Nordheim tunneling.

UNIT-2
Double barrier tunneling and resonant tunneling diode, Resonant tunneling transistor, Coulomb blockade in a nano capacitor, Tunnel junction and its excitation by current source, Coulomb blockade in a quantum dot circuit, Coulomb staircase.

UNIT-3
Semiconductor quantum hetero and nano structures, Modulation doping, Energy band transitions in quantum wells, quantum wires and nano wires, Quantum dots and nano particles, Ballistic transport, Transport model, Quantum resistance and conductance.

UNIT-4
Carbon nano tubes and carbon nano wires, Nano scale wire radius, Transport of spin and Spintronics, Single electron transistor, Carbon nano tube transistor, Nano tube hetero junction, Nano tube field effect transistor, Graphene in nano electronic systems.

Outcome:
On completion of this module students are expected to be able to learn the fundamental science and quantum mechanics behind nanoelectronics and also Differentiate between microelectronics and nanoelectronics
They a will also understand the impact of nanoelectronics onto information technology, communication and• computer science.

BOOKS:

1. **Fundamentals of Nanoelectronics**
   George W. Hanson, Pearson Education, New Delhi, INDIA
2. **Nanoelectronics**
   A.S. Bhatia, NuTech Books, New Delhi, INDIA
3. **Low Dimensional Semiconductors: Materials, Physics, Technology & Devices**
   M.J.Kelly, Clarendon Press Oxford, N.Y., USA
4. **Nanoelectronics: Principles and Devices**
   Mircea Dragoman and Daniele, Artech House Publication, N.Y. USA
5. **Semiconductor Heterojunctions and Nanostructures**
   Omar Manasreh, McGraw Hill, N.Y., USA
6. **Quantum Wells, Wires and Dots**
   P.Harrison, Wiley, N.Y., USA
7. **Silicon Nanoelectronics**
   Shunri Oda and David Ferry, Taylor & Francis, N.Y., USA

PS04EELE24: Advanced Digital Systems Design with HDL
TOTAL 100 MARKS (EXTERNAL-70, INTERNAL 30)
University Examination -3 Hours Duration

Objectives:
1. To understand sequential and combinational logic design techniques
2. To introduce HDL
3. To learn various digital circuits using HDL
4. To learn PLD, CPLD, FPGA and their applications

Unit-1 :
Introduction: Introduction to Computer-aided design tools for digital systems. Hardware description languages; introduction to VHDL, data objects, classes and data types, Operators, Overloading, logical operators. Types of delays Entity and Architecture declaration. Introduction to behavioral, dataflow and structural models.
Unit-2 :
VHDL Statements : Assignment statements, sequential statements and process, conditional statements, case statement Array and loops, resolution functions, Packages and Libraries, concurrent statements. Subprograms: Application of Functions and Procedures, Structural Modelling, component declaration, structural layout and generics.
Unit-3 :
Sequential and Combinational Circuit Design: VHDL Models and Simulation of combinational circuits such as Multiplexers, Demultiplexers, encoders, decoders, code converters, comparators, implementation of Boolean functions etc. Sequential Circuits Design : VHDL Models and Simulation of Sequential Circuits Shift Registers, Counters etc.
Unit -4 :
Prototyping and case studies: Design with CPLDs and FPGAs : Programmable logic devices : ROM, PLAs, PALs, GAL, PEEL, CPLDs and FPGA. Design implementation using CPLDs and FPGAs Design of Microcomputer: Basic components of a computer, specifications, architecture of a simple microcomputer system, implementation of a simple microcomputer system using VHDL Reference

Outcome:
Students once complete this course will be able to design and device the systems based on Reconfigurable hardware available in the Market.

Books:
1. Digital System Design using VHDL: Charles. H.Roth ; PWS (1998).
2. VHDL-Analysis & Modelling of Digital Systems: Navabi Z; McGraw Hill.
3. VHDL by Douglas L. Perry, Mc Graw Hill Publications
4. VHDL: Analysis and Modeling of Digital Systems by Zainalabedin Navabi, McGraw-Hill
5. Logic and Computer Design Fundamentals, 2/E, M. Morris Mano

PS04EELE25: CMOS Technology & VLSI Design
TOTAL 100 MARKS (EXTERNAL-70, INTERNAL 30)
University Examination -3 Hours Duration

Objectives:
1. To understand Basics of MOS, nMOS, pMOS and CMOS
3. To learn various characteristics of CMOS
4. To learn CMOS based circuit design

Unit -1

Introduction CMOS Logic: Inverter, NAND Gate, Combinational Logic, NOR Gate, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers, Latches and Flip-Flops, CMOS Fabrication and Layout: Inverter Crosssection, Fabrication Process, Layout Design rules, Gate Layout, MOS Transistor Theory: Ideal I-V Characteristics, C-V Characteristics: MOS Capacitance Models, MOS Gate Capacitance Model, MOS Diffusion Capacitance Model. Non ideal I-V Effects: Velocity Saturation and Mobility Degradation, Channel Length Modulation, Body Effect, Subthreshold Conduction, Junction Leakage, Tunneling, Temp. and Geometry Dependence. DC Transfer characteristics: Complementary CMOS Inverter DC Characteristics, Beta Ratio Effects, Noise Margin, Ratioed Inverter Transfer Function, Pass Transistor DC Characteristics, Tristate Inverter, Switch- Level RC Delay Models.

Unit -2

CMOS Processing Technology CMOS Technologies: Background, Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO2), Isolation, Gate Oxide, Gate and Source/Drain Formation, Contacts and Metallization, Passivation, Metrology. Layout Design Rules: Design Rules Background, Scribe Line and Other Structures, MOSIS Scalable CMOS Design Rules, Micron Design Rules. CMOS Process Enhancements: Transistors, Interconnect, Circuit Elements, Beyond Conventional CMOS.

Unit -3

Circuit Characterization and Performance Estimation Delay Estimation: RC Delay Models, Linear Delay Model, Logical Effort, Parasitic Delay. Logical Effort and Transistor Sizing: Delay in a Logic Gate, Delay in Multistage Logic Networks, choosing the Best Number of Stages. Power Dissipation: Static Dissipation, Dynamic Dissipation, Low-Power Design. Interconnect: Resistance, Capacitance, Delay, Crosstalk. Design Margin: Supply Voltage, Temperature, Process Variation, Design Corners. Reliability, Scaling.

Unit -4

Analog Circuits MOS Small-signal Model, Common Source Amplifier, The CMOS Inverter as an Amplifier, Current Mirrors, Differential Pairs,

Outcome:

Students will be able to design and analyze basic CMOS circuit with the help od backend design tools.

References:

1. Neil H.E. Weste, David Harris, Ayan Banerjee: CMOS VLSI Design, Third Edition, Pearson Education.
2. Neil H.E. Weste, Kamran Eshraghian: Principle of CMOS VLSI Design, Pearson Education.
3. J. P. Uyemura: Chip Design for Submicron VLSI, Cengage Learning.
4. Philip E. Allen and Douglas R Holberg: CMOS Analog Circuit Design, Oxford
5. Carver Mead and Lynn Conway: Introduction to VLSI systems, BS Publication
6. J. P. Uyemura: Introduction to VLSI Circuits and Systems, Wiley.