OFFICE OF THE REGISTRAR :: DIBRUGARH UNIVERSITY :: DIBRUGARH

Ref. No. DU/DR-A/131st AC/Syllabi-Elective(ECE)/2024/1451 Date: 09.08.2024

NOTIFICATION

With reference to letter submitted by the Head i/c, Electronics and Communication Engineering vide no. DUIET/B.Tech/ECE/2009-24/789, dated 04.06.2024 and as recommended by the Board of Studies in Electronics & Communication Engineering, DUIET and Joint Meeting (Special) of the Under Graduate Board (128th) and Post Graduate Board (155th), Dibrugarh University held on 06.06.2024, the 131st Meeting (Special) of the Academic Council, Dibrugarh University held on 13.06.2024 vide ***Resolution No. 15*** has approved the syllabi of following Elective Subjects in B. Tech. Programmes for the Department of Electronics and Communication Engineering, DUIET with effect from the batch 2022-2023 batch onwards.

(i) Fundamentals of Semiconductor Physics and Devices
(ii) Instrumentation and Equipment Maintenance.
(iii) Clean Room and Vacuum Technology.
(iv) Semiconductor Packaging and Testing
(v) Fundamentals of VLSI Fabrication

Syllabi are attached herewith.

Issued with due approval.

Sd/- 09/08/2024
Deputy Registrar (Academic)
Dibrugarh University

Copy for kind information and necessary action to:

1. The Hon'ble Vice-Chancellor, Dibrugarh University.
2. The Deans, Dibrugarh University.
3. The Registrar, Dibrugarh University.
4. The Director, DUIET, Dibrugarh University.
5. The Head i/c, Department of Electronics and Communication Engineering, DUIET, Dibrugarh University
6. The Controller of Examinations i/c, Dibrugarh University.
7. The Joint / Deputy Controller of Examinations – 'B', 'C' & 'A', Dibrugarh University.
8. The Programmer, Dibrugarh University with a request to upload the notification in the Dibrugarh University Website.
9. File.

Sd/- 09/08/2024
Deputy Registrar (Academic)
Dibrugarh University

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ELECTIVE	Fundamentals of Semiconductor Physics and Devices	4L:0T:0P	4 Credit

Course Outcome:

Detailed Syllabus

Module-I Crystal Properties and Growth of Semiconductors:

Semiconductor Materials; Crystal Lattices: Periodic Structures, Cubic Lattices, Planes and Directions, Diamond Lattice; Bulk Crystal Growth: Growth of Single-Crystal Ingots, Wafers, Doping;

Bonding Forces and Energy Bands in Solids: Bonding Forces in Solids, Energy Bands, Metals, Semiconductors, and Insulators, Direct and Indirect bandgap Semiconductors, Variation of Energy Bands with Alloy Composition; Charge Carriers in Semiconductors: Electrons and Holes, Effective Mass, Intrinsic Material, Extrinsic Material; Carrier Concentrations: The Fermi Level, Electron and Hole Concentrations at Equilibrium, Temperature Dependence of Carrier Concentrations; Drift of Carriers in Electric and Magnetic Fields: Conductivity and Mobility, Drift and Resistance, Effects of Temperature and Doping on Mobility; Diffusion of Carriers, Diffusion Processes, Diffusion and Drift of Carriers.

Module-II Junctions

Equilibrium Conditions: The Contact Potential, Equilibrium Fermi Levels, Space Charge at a junction; Forward- and Reverse-Biased Junctions: Qualitative Description of Current Flow at a Junction, Carrier Injection, Reverse Bias, Reverse-Bias Breakdown, Zener Breakdown, Avalanche Breakdown, Rectifiers, Time Variation of Stored Charge, Switching Diodes, Capacitance of p-n Junctions, The Varactor Diode, Ohmic Losses, Graded Junctions, Metal–Semiconductor Junctions, Schottky Barriers, Rectifying Contacts, Ohmic Contacts, Typical Schottky Barrier.

Module-III Field-Effect Transistors

The Junction FET, Pinch-off and Saturation, Gate Control, Current–Voltage Characteristics, The Metal–Semiconductor FET, The GaAs MESFET, The High Electron Mobility Transistor (HEMT), Short Channel Effects, The Metal–Insulator–Semiconductor FET, The Ideal MOS

Capacitor, Effects of Real Surfaces, Threshold Voltage, MOS Capacitance–Voltage Analysis, Current–Voltage Characteristics of MOS Gate Oxides, The MOS Field-Effect Transistor, Output Characteristics Transfer Characteristics, Short Channel MOSFET *I–V* Characteristics, Control of Threshold Voltage, Substrate Bias Effects—the "body" effect, Short Channel Effect and Narrow Width Effect, FinFet

Module-IV Bipolar Junction Transistor

Fundamentals of BJT Operation, Amplification with BJTs, Minority Carrier Distributions and Terminal Currents, Solution of the Diffusion Equation in the Base Region Evaluation of the Terminal Currents, Current Transfer Ratio, Generalized Biasing, Charge Control Analysis, Switching, Cutoff, Saturation, The Switching Cycle, Specifications for Switching Transistors, Drift in the Base Region, Base Narrowing, Injection Level; Thermal Effects,Base Resistance and Emitter Crowding, Frequency Limitations of Transistors, Capacitance and Charging Times, Transit Time Effects.

<u>REFERENCE BOOKS:</u>

1. **Solid State Electronic Devices; Ben G. Streetman and S K Banerjee; Pearson**
2. **Semiconductor Physics and Devices: Basic Principles; Donald A. Neamen; McGraw Hill**

ELECTIVE	Instrumentation and Equipment Maintenance	4L:0T:0P	4 Credit

Course Outcome:

CO1: Understand the principles and operation of electrical machines.

CO2: Apply AC bridge networks and measurement techniques.

CO3: Utilise measuring instruments and calibration methods.

CO4: Apply troubleshooting procedures and electronic component testing.

CO5: Perform rework and repair of surface mount assemblies.

Module I:

D.C. Machine, Principle of D.C. motor, A.C. Machine, Basic Principle of operation, Construction, Phasor diagram, equivalent circuit, Efficiency & Regulation of- Single phase transformer, Three phase induction motor, Synchronous Machine

Module II:

Instrument Transformers, Galvanometers, A.C. Bridges, Transducers, Wave Analysers, Different types of Sensors and its use in measurement and instrumentation.

Module III:

Measuring Instruments: Classification of measuring instruments, General consideration of torques employed in indicating type instrument (deflection torque, control torque, damping torque), Construction and working of voltmeter and ammeter, Significance of range extension, Use of series and shunt multipliers, Instrument transformer for range extension, Working principle of potentiometer, Calibration method of ammeter and voltmeter (D.C.) by potentiometer, Multirange ammeter and voltmeter, Simple problems on these topics.

Module IV:

Instrument construction, handling and cooling, cabinets, Fundamental Troubleshooting Procedures Inside An Electronic Equipment: Reading Drawings And Diagrams – Block Diagram, Circuit Diagram, Wiring Diagram, Fault finding aids – Service and maintenance manuals and instruction manuals, Passive Components and Their Testing Passive Components, Logic IC families, Packages in Digital ICs, IC identification, IC pin-outs, Handling ICs, Digital troubleshooting methods.

Module V:

Rework and Repair of Surface Mount Assemblies Surface Mount Technology and surface mount devices Surface Mount Semiconductor packages – SOIC, SOT, LCCC, LGA, BGA, COB, Flatpacks and Quad Packs, Cylindrical Diode Packages, Packaging of Passive Components as SMDs Repairing Surface Mount PCBs, Rework Stations.

Reference Books:

1. A.K. Sawhrey , "A Course in Electrical & Electronics Measurements & Measuring Instruments", Dhanpad Rai Pub., 2015.
2. Khandpur," Modern Electronic Equipment: Trouble- shooting, Repair and Maintenance", TMH, 2006.
3. R. G. Gupta," Electronic Instruments and Systems: Prin- ciples, Maintenance and Troubleshooting", Tata McGraw Hill Edition, 2001.
4. G. C. Loveday, A. H," Electronic Testing and Fault Diagnosis", Wheeler Publishing, 1995.
5. J.G. Joshi ,"Electronic Measurement and Instrumentation" Khanna Publishing House, 2019.

ELECTIVE	**Clean Room and Vacuum Technology**	**3L:0T:0P**	**3 Credit**

Course Outcome:

CO1: Understand cleanroom technology fundamentals, including HVAC systems and safety measures, at a comprehension level.

CO2: Analyze particle technology's role in cleanrooms, evaluating filtration mechanisms and methods to reduce particle contamination.

CO3: Apply vacuum technology principles to design and optimize vacuum systems for various applications.

CO4: Evaluate vacuum system design concepts and applications in fields like microfabrication and space simulation, integrating knowledge at a synthesis level.

Detailed Syllabus

Module 1:

Fundamentals of Cleanroom Technology: Introduction to Cleanroom Technology; Cleanroom Construction: Design and Layout, Heating, Ventilation, and Air Conditioning Systems for Cleanrooms; Cleanroom Components: Safety Cabinets, Air Locks, Air Showers; Cleanroom Garments: Performance Requirements, Materials; Basics of Hygiene: Cleaning, Disinfection, Sterilization.

Module 2:

Particle Technology and Filtration: Introduction to Particle Technology and its Importance in Cleanrooms; Defects Caused by Particles: Probability of Defect Formation, Yield Effects; Particle Characterization: Size Distributions, Properties of Aerosols and Particle Statics/Dynamics; Fundamentals of Sedimentation and Filtration Technology: Filtration Mechanisms, Filter Properties, Pressure Drop, Particle Collection, Types of Filters and Applications, Measurement and Minimization of Particles in Process Gases and Liquids.

Module 3:

Fundamentals of Vacuum Technology: Gas kinetic theory, pressure, conductance, gas flow regimes, vapor pressure, pumping speed, throughput; Gas surface interactions: physisorption, chemisorption, condensation; General working principles and operating regimes of vacuum Pumps: Mechanical, diffusion, molecular drag, turbo molecular, cryopumps, ion pumps; Vacuum Instrumentation: Vacuum gauges, gas regulators, flow meters, residual gas analyzers, interpretation of data.

Module 4:

Vacuum System Design and Applications: Design Concepts: Materials, chambers, components, joins, seals, valve; Overall system design and integration. Problem Solving: Leak detection and detectors, gas signatures. Vacuum Applications: Idea of microfabrication, Thin film technology, Implantation, packaging, cryogenic insulation.

Reference Books:

1. R. P. Donovan, *Particle Control for Semiconductor Manufacturing*. CRC Press.
2. W. Whyte, *Cleanroom Design*. John Wiley.
3. M. Ramstorp, *Introduction to Contamination Control and Cleanroom Technology*. Wiley
4. M. H. Hablanian and H. H. Hablanian, *High-vacuum Technology: A Practical Guide*, 2nd ed. CRC Press, 1997.
5. A. D. Tripathi and A. Gupta, *Ultra High Vacuum Techniques*. Allied Publishers Private Limited, 2002.
6. A. Roth, *Vacuum Technology*, 3rd ed. Elsevier Science
7. High Vacuum Technology, J. Yarwood Chapman and Hall Ltd
8. Handbook of Vacuum Science and Technology, Dorothy M. Hoffman, John H. Thomas, Bawa Singh, Elsevier Science and technology Books

ELECTIVE	Semiconductor Packaging and Testing	4L:0T:0P	4 Credit

Course Outcomes:

At the end of the course learners will be able to

CO1: Discuss the various packaging types

CO2: Design of packages which can withstand higher temperature, vibrations and shock

CO3: Design of PCBs which minimize the EMI and operate at higher frequency

CO4: Analyze the concepts of testing methods.

CO5: Discuss the various packaging types

Module I:

Overview of Electronic Systems Packaging: Functions of Electronic Packaging, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends and Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates

Module II:

Electrical Issues in Packaging: Electrical Issues of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines, Clock Distribution, Noise Sources, Digital and RF Issues.

Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Packaging roadmaps - Hybrid circuits - Resistive, Capacitive and Inductive parasitics.

Module III:

Chip Level Packaging: IC Assembly - Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging, reliability, wafer level burn – in and test. Single chip packaging: functions, types, materials processes, properties, characteristics,

trends. Multi chip packaging: types, design, comparison, trends. System – in - package (SIP); Passives: discrete, integrated, and embedded.

Module IV:

PCB, Surface Mount Technology and Thermal Considerations: Printed Circuit Board: Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges. Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation – Cooling requirements

Module V:

Testing: Reliability, Basic concepts, Environmental interactions. Thermal mismatch and fatigue – failures – thermo mechanically induced –electrically induced – chemically induced. Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability.

Textbook/Reference books:

1. Tummala, Rao R., Fundamentals of Microsystems Packaging, McGraw Hill, 2001.
2. Blackwell (Ed), The electronic packaging handbook, CRC Press, 2000.
3. Tummala, Rao R, Microelectronics packaging handbook, McGraw Hill, 2008.
4. Bosshart, Printed Circuit Boards Design and Technology, TataMcGraw Hill, 1988.
5. R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011.
6. R.S.Khandpur, Printed Circuit Board, Tata McGraw Hill, 2005.
7. Recent literature in Electronic Packaging.
8. Michael L. Bushnell &Vishwani D. Agrawal,” Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits”, Kluwer Academic Publishers.2000.
9. M. Abramovici, M. A. Breuer, and A.D. Friedman, “Digital System Testing and Testable Design”, Computer Science Press,1990

ELECTIVE	Fundamentals of VLSI Fabrication	4L:0T:0P	4 Credit

Course Outcomes:

At the end of the course learners will be able to

CO1: Identify the different methods involved in VLSI fabrication.

CO2: Implement the Silicon wafer cleaning process for device fabrication.

CO3: Design and simulate the fabrication processes required for IC fabrication.

CO4: Explain process integration flow for different IC fabrication technologies.

Module I:

Introduction: History of IC's; Operation & Models for Devices of Interest: CMOS and MEMS. **Electronic Materials:** Crystal Structures, Defects in Crystals, Si, Poly Si, Si Crystal Growth. **Clean room and Wafer Cleaning:** Definition, Need of Clean Room, RCA cleaning of Si.

Module II:

Oxidation: Dry and Wet Oxidation, Kinetics of Oxidation, Oxidation Rate Constants, Dopant Redistribution, Oxide Charges, Device Isolation, LOCOS, Oxidation System, **Lithography:** Overview of Lithography, Radiation Sources, Masks, Photoresist, Components of Photoresist Optical Aligners, Resolution, Depth of Focus, Advanced Lithography: E-beam Lithography, X-ray Lithography, Ion Beam Lithography

Module III:

Diffusion: Pre-Deposition and Drive-in Diffusion Modeling, Dose, 2-Step Diffusions, Successive Diffusion, Lateral Diffusion, Series Resistance, Junction Depth, Irvin's Curves, Diffusion System. **Ion Implantation:** Problems in Thermal Diffusion, Advantages of Ion Implantation, Applications in ICs, Ion Implantation System, Mask, Energy Loss Mechanisms, Depth Profile, Range & Straggle, Lateral Straggle, Dose, Junction Depth, Ion Implantation Damage, Post Implantation Annealing, Ion Channeling, Multi Energy Implantation

Module IV:

Thin Film Deposition: Physical Vapor Deposition: Thermal evaporation, Resistive Evaporation, Electron beam evaporation, Laser ablation, Sputtering **Chemical Vapor Deposition:** Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, Boundaries and Flow, Different kinds of CVD techniques: APCVD, LPCVD, Metalorganic CVD (MOCVD), Plasma Enhanced CVD etc.

Module V:

Etching: Anisotropy, Selectivity, Wet Etching, Plasma Etching, Reactive Ion Etching. Overview of Interconnects, Contacts, Metal gate/Poly Gate, Metallization, Problems in Aluminium Metal contacts, Al spike, Electromigration, Metal Silicide, Multi-Level Metallization, Planarization, Inter Metal Dielectric

Textbook/Reference books:

1. Plummer, Deal and Griffin, "Silicon VLSI Technology" 1st Edition, Pearson Education, 2009.
2. S. M. Sze, "Semiconductor Devices", 2nd Edition, John Wiley & Sons, 2002.
3. S K Gandhi, "Silicon Technology", Wiley India , 2nd edition , 2009
4. Wayne wolf," Modern VLSI design", 2nd Edition, Pearson Education, 2008.