AMEI-02 SOLID STATE DEVICES

UNIT-1 CRYSTAL PROPERTIES AND GROWTH OF SEMICONDUCTORS

1.1 Semiconductor materials- Periodic Structures- Crystal Lattices- Cubic lattices-Planes and Directions- The Diamond lattice- Bulk Crystal Growth- Starting Materials

1.2 Growth of Single Crystal ingot's- Wafers-Doping- Epitaxial Growth- Lattice Matching in Epitaxial Growth- Vapor- Phase Epitaxy- Atoms and Electrons

1.3 Introduction to Physical Models Experimental Observations-The Photoelectric Effect-Atomic spectra-The Bohr model- Quantum Mechanics -Probability and the Uncertainty Principle

1.4 The Schrodinger Wave Equation -Potential Well Equation -Potential well Problem-Tunneling.

UNIT-2 ENERGY BANDS AND CHARGE CARRIERS IN SEMICONDUCTORS

2.1 Bonding Forces and Energy bands in Solids-Bonding Forces in Solids-Energy Bands Metals, Semiconductors, and Insulators

2.2 Direct and Indirect Semiconductors Variation of Energy Bands with Alloy Composition-Charge Carriers in Semiconductors Electrons and Holes

2.3 Effective Mass-Intrinsic Material-Extrinsic Material - Electrons and Holes in Quantum Wells-Carrier Concentrations-The Fermi Level-Electron and Hole Concentrations at Equilibrium-

2.4 Temperature Dependence of Carrier Concentrations Compensation and Space Charge Neutrality-Drift of Carrier in Electric and Magnetic Fields conductivity and Mobility

2.5 Drift and Resistance -Effects of Temperature and Doping on Mobility-High -Field effects-The Hall Effect -invariance of the Fermi level at equilibrium

2.6 Excess Carrier in Semiconductors-Optical Absorption- Luminescence Photoluminescence-Electro luminescence-Carrier Lifetime and Photoconductivity Direct Recombination of Electrons and Holes

2.7 Indirect Recombination ; Trapping Steady State Carrier Generation ; Quasi-Fermi Levels-Photoconductive Devices Diffusion of Carriers-Diffusion of Processes

2.8 Diffusion and Drift of Carrier; Built-in Fields-Diffusion and Recombination; The Continuity Equation -Steady state Carrier Injection; Diffusion Length-The Haynes

2.9 Shockley Experiment -Gradients in the Quasi Fermi levels.

UNIT-3 JUNCTIONS

3.1 Fabrication of P-N Junctions- Thermal Oxidation- Diffusion- Rapid Thermal Processing Ion Implantation- Chemical Vapor Deposition Photolithography- Etching

3.2 Metallization Equilibrium Conditions-The Contact Potential-Equilibrium Fermi Levels -Space Charge at a Junction-Forward -and Reverse

3.3 Biased Junctions; -Steady state conditions Qualitative Description Of current flow at a junction-Carrier Injection-Reverse Bias Reverse -Bias Breakdown-

3.4 Zener Breakdown -Avalanche Breakdown-Rectifiers-The Breakdown Diode-Transient and AC Conditions -Time variation of stored charge Reverse Recovery Transient-

3.5 Switching Diodes -Capacitance of P-N Junctions-The Varactor Diode-Deviations from the Simple Theory-Effects of contact Potential on carrier injection

3.6 Recombination and Generation in the Transition Region-Ohmic Losses -Graded Junctions-Metal -Semiconductor Junctions- Schottky Barriers-Rectifying contacts
3.7 Ohmic Contacts-Typical Schottky Barriers- Hetrojunctions

UNIT-4 THE METAL -SEMICONDUCTOR-FET

4.1 The GaAS MESFET-The High Electron Mobility Transistor- Short channel Effects- The Metal Insulator Semiconductor FET-Basic Operation and Fabrication- THE ideal MOS Capacitor
4.2 Effects of Real Surfaces-Threshold Voltage-MOS capacitance Measurements- current-Voltage Characteristics of MOS Gate Oxides-The MOS Field Effect Transistor
4.3 Output characteristics-Transfer characteristics- Mobility Models Short channel MOSFET I-V characteristics- Control of Threshold Voltage -Substrate Bias Effects
4.4 Sub threshold characteristics- Equivalent Circuit for the MOSFET-MOSFET Scaling and Hot Electron Effects-Drain -Induced Barrier Lowering -short channel and Narrow Width Effect
4.5 Gate -Induced Drain Leakage-BJT Fabrication -Minority carrier distribution and Terminal currents-Solution of the Diffusion Equation in the Base Region
4.6 Evaluation of the Terminal currents- Current Transfer Ratio- Generalized Biasing- The coupled- Diode Model- Charge control analysis- Switching- cut off saturation
4.7 The switching cycle-Specifications for switching Transistors-other Important Effects-Drift in the base Narrowing -Avalanche Breakdown -Injection level; Thermal Effects
4.8 Base Resistance and Emitter Crowding - Gummel -Poon Model-Kirk Effect-Frequency Limitations of Transistors-Capacitance and Charging Times-Transit Time Effects
4.9 Webster Effect-High -Frequency Transistors - Heterojunction Bipolar Transistors.

UNIT-5 OPTOELCTRONIC DEVICES

5.1 Photodiodes-Current and Voltage in illuminated Junction-Solar Cells-Photo detectors Noise and Bandwidth of Photo detectors-Light-Emitting Diodes-Light Emitting Materials
5.2 Fiber Optic Communications Multilayer Heterojunctions for LEDs- Lasers Semiconductor lasers-Population Inversion at a Junction Emission Spectra for p-n junction
5.3 The Basic Semiconductor lasers-Materials for Semiconductor lasers Integrated Circuits -Background -Advantages of Integration -Types of Integrated circuits
5.4 Monolithic and Hybrid Circuits-Evolution of Integrated Circuits-Monolithic Device Elements CMOS Process Integration- Silicon -on- Insulator (SOI)-Integration of other Circuit Elements
5.5 Charge Transfer Devices -Dynamic Effects in MOS capacitors The basic CCD-Improvements on the Basic Structure -Applications of CCDs-Ultra Large -Scale Integration (ULSI)
5.6 Logic devices -Semiconductor Memories-Testing, bonding, and Packaging-Testing -Wire Bonding -Flip-flop Techniques-Packaging

References Books:

1. Yannis Tsividis: Operation & Mode line of The MOS Transistor (2nd Edition) Oxford University Press, 1999
2. Nandita Das Gupta & Aamitava Das Gupta- Semiconductor Devices Modeling a Technology, PHI, 2004.