Code: NT **Nanotechnology**

Elements of Material Science: Introduction, Classification of Materials, Space Lattice and Unit Cells, Crystal Systems. Indices for Planes and Directions. Structures of Common Metallic Materials. Crystal Defects: Point, Line and Surface Defects. Dislocations, Types, Burgers' Vector, Dislocation Movement by Climb and Cross Slip. Dislocation Sources, Dislocation Point - Defect Interaction and Pileups. Plastic Deformation of Single Crystals. Deformation by Slip, CRSS for Slip. Deformation by Twinning. Stacking Faults, Hot Working, Cold Working. Recovery, Recrystallization and Grain Growth. Hall- Petch Equation. Tensile Stress-Strain Diagrams, Proof Stress, Yield Stress, Modulus of Elasticity. Typical Stress-Strain Diagrams for Mild Steel, Cast Iron and Aluminum Alloy.

Di-electrics-Polarization mechanisms, Clausius-Mossotti equation, Piezo, Pyro and ferro electricity. Superconductivity - basic phenomenology. Meissner effect, Type-I and Type-II superconductors, BCS theory London equations Laser: operating principles, semi conducting lasers: structures and properties, Quantum well laser: operating principle and applications Materials synthesis: polymers, composites, liquid crystals, organics conductors.

Advanced Material Science: Electrical and Electronic Properties of Materials, Electronic Conductivity, Free Electron Theory and Band Theory of Solids. Intrinsic Semi-Conductors. Super Conductivity. Magnetic Properties, Dia, Para, Ferro, Ferri Magnetism. Soft and Hard Magnetic Materials and Applications. Optical Properties of Materials. Refractive Index, Absorption Emission of Light, Optical Fibers. Opto-Electronic Materials. Polymerization, Cross Linking Glass Transition, Classification of Polymers. Mechanical Properties, Dielectric Behaviour of Materials. Uses of Polymers. Ceramics and Glasses, Crystalline and Non-Crystalline Ceramics. Major Mechanical and Optical Properties. Composite Materials. Classification. Matrices and Reinforcements. Fabrication Methods. Examples and Applications. Nano Materials: Importance, Emergence of Nano- Technology, Bottom-Up and Top-Down Approaches, Challenges in Nano-Technology. Applications.

Electronics: Operational amplifier and its applications: inverting, non-inverting amplifier, adder and integrator, differentiator, wave form generator, comparator and Schmidt trigger, The 555 timer. Digital integrated circuits- NAND and NOR gates as building blocks, XOR gate, simple combination circuits, half and fuller adder, Flip-flop, shift registers and counters Basic principles of A/D and D/A converters, simples applications of A/D and D/A converters Bipolar junction transistors and its applications, Field effect transistor: JFET, MOSFET, C-MOS and CCD Discrete Fourier transform, frequency domain sampling of discrete time signals, properties of DFT, DET as a linear transformation, Relationship of DFT to other 2

transform, frequency analysis of signals using the DFT computation of DFT and FFT algorithms. CMOS process technology.

Quantum Mechanics: Wave-particle duality, Heisenberg's uncertainty principle, The Schrödinger equation, particle in box, harmonic oscillator, tunneling through a barrier. Motion in a central potential, Orbital angular momentum, Addition of angular momentum, Time independent perturbation theory. Fermi's golden rule. Elementary theory of scattering in a central potential. Phase shifts, partial wave analysis. Born approximation, identical particles.

Engineering Mechanics: Concurrent Forces in a Plane and its Equilibrium. Centroids of Composite Plane Figures. General Case of Forces in a Plane. Moment of Inertia of Plane figures. Parallel Axis Theorem. Polar MI. Concept of Mass MI, Kinematic's. Principle of Dynamics Motion of a Particle Under Constant Force. Force Proportional to Displacement and Free Vibrations (SHM). D'Albert's Principle. Momentum. Impulse Work and Energy. Rotation of a Rigid Body about a Fixed Axis. Equation of Motion of a Rigid Body about a Fixed Axis.

Heat Transfer: Elements of Heat Transfer. Steady State Conduction, Convection and Radiation. Furnaces. Heat Utilization in Furnaces, Available Heat, Factors Affecting It. Heat Losses in Furnaces and Furnace Efficiency. Heat Balance and Sankey Diagrams. Principles of Waste Heat Recovery. Recuperators and Regenerators. Types and Applicability. AMTD and LMTD in Recuperators. Protective Atmosphere and their Applications, Salt Bath Furnaces.

Metallurgical Thermodynamics: Introduction - Basic Concepts in Thermodynamics. Objectives and Limitations of Classical Thermodynamics. Zeroth Law of Thermodynamics. First Law of Thermodynamics-Forms of Energy, Heat and Work, Joules Experiments, Conservation of Energy, Concept of Maximum Work, Isothermal Expansion, Reversible, Adiabatic Expansion, Constant Pressure Processes, Constant Volume Processes, Enthalpy. Second Law of Thermodynamics -Efficiency of Cyclic Process. Carnot Cycle. Entropy. Thermodynamic Equation of State. Statistical Entropy. Physical Meaning of Entropy, Boltzman Equation, Mixing Entropy, Stirling's Approximation Auxiliary Functions. Fundamental Equations of State, Max Well Relationships, Other Thermodynamic Relations, Chemical Potential, Gibbs-Helmholtz Equation, Criteria of Equilibria. Third Law of Thermodynamics, Heat Capacity and Entropy Changes.

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