

DEPARTMENT OF MATERIALS SCIENCE  
SYLLABUS FOR PET

Section-I

**Instructions:**

Please set 50 questions of multiple choice in section-I

**Unit 1: The Phase transformations:**

Time scale for phase changes, Nucleation and growth, nucleation kinetics; the growth and overall transformation kinetics, Applications; Precipitation process, solidification and crystallization; Glass transition, recovery, re-crystallization and grain growth.

Single and multiphase Solids, Solid solutions and Hume-Rothery rules, Properties of alloys; Solid solutions and two component alloy systems; Gibbs phase rule; solubility limit, phase- martensite and austenite, spheroidite - cementite, Pearlite, microstructure, phase equilibria, First, Second and third Eutectic, iron-carbon system, Continuous cooling transformation diagram (for iron - carbon alloy), eutectoid, peritectic and peritectoid systems.

**Crystal Imperfections and diffusion:**

Schottky and Frenkel defects, Expression for their equilibrium concentrations, Color centers in crystals, Dislocations-edge and screw dislocations, stress and strain fields of dislocations, dislocation multiplication (Frank-Reid Mechanism), grain boundaries-tilt and twist boundaries,

Theory of diffusion, Self-diffusion, Fick's law of diffusion (1st and 2nd ), Kirkendall effect, activation energy for diffusion, Application of diffusion.

**Unit 2:**

**Basics of quantum mechanics:**

Experimental background inadequacy of classical theory (includes black body radiation-qualitative treatment), Uncertainty principle. Interpretation of Wave particle dualism and complementarity's. Postulates of quantum mechanics, wave function and boundary valued conditions.

**Schrodinger wave equation:**

Development of wave equation: A free particle in One-dimension and extension to three dimensions, normalization, orthogonality, expectation value, quantum mechanical degeneracy, Dirac delta functions and Ehrenfest's theorem.

**Some exactly soluble Eigen value problems:**

One-dimensional: A particle in a square well potential, Harmonic oscillator.

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Three-dimensional: particle in a box. Particle in spherically symmetric potential, Rigid rotor, Hydrogen atom, Hartree self-consistent field method.

**Approximation methods for stationary states:**

Time-Independent perturbation theory: non-degenerate and degenerate cases, perturbed harmonic oscillator. Time dependent perturbation method.

The variation method. Application to ground state of hydrogen and helium atoms. WKB method, Application to barrier penetration. Bohr-Sommerfeld quantum condition.

**Unit 3: Engineering Materials:**

**Clays and Refractories:**

Clays-Types, structures, treatment and activation, and general properties of clays.

Refractories and whitewares- classification, elementary idea of manufacturing process technology, basic properties and application.

**Glass:**

Introduction- basic concept of glass structure, elementary concepts of glass manufacturing process. Types and applications.

**Instrumentation of Scientific equipments:**

X-ray Diffractometer, Scanning electron microscope, Transmission electron microscope, Atomic force microscope, UV and IR spectrophotometers,

**Reference Books:**

1. Elementary Solid state Physics: Principles and applications, M. A. Omar, Add:- Wes.
2. Introduction to Solid state Physics, C. Kittel, Wiley Eastern.
3. Solid state Physics. A. J. Dekker, PHI.
4. Solid state Physics, Asheroff and Mernim.
5. Problems in Solid-State Physics, S. O. Pillai, TMH.
6. Introduction to Materials Science and Engineering-Yip-Wah Chung
7. Quantum Mechanics, L.L.Schiff. McGraw Hill 1968.
8. Quantum Mechanics, F.Schwabl, Narosa, 1992.
9. A textbook of Quantum Mechanics. P.M.Mathews and K.Venkateshan, TMH, 1994.
10. A. D. Helfric and W. C Cooper, PHI, 1994.
11. Handbook of Analytic Instrumentation, R. S. Khandpur, TMH 1989.
12. Instrumentation Measurements and analysis, B. C. Nakra and K. K Chaudhary. TMH, 1985.
13. Transducers and Instrumentation D V S Murthy, PHI, 1995.
14. Transmission electron microscopy, A Text Book for Materials Science (Vol-1-4), David B, et al
15. Scanning and Transmission electron microscopy, an introduction, by Stanley L F, et al

## Section-II

### Instructions:

Please set 50 question of multiple choice in Section II.

### Unit 4:

#### Ionic Liquids:

Understanding of the terms, synthesis (chemical and Microwave), purification and characterisation,.

#### Coordination compounds

Bonding and structures (based on hybridizations- tetrahedral and octahedral). Inner and outer sphere complexes- definition and suitable examples.

#### Elementary Organic chemistry

Nomenclature (General and IUPAC of some typical organic molecules) classification of organic compounds. Hybridization of carbon compounds ( $sp$ ,  $sp^2$ , and  $sp^3$ ) Aliphatic nucleophilic substitution at saturated carbon atom. Mechanism, scope and stereochemistry of  $SN^1$  and  $SN^2$  reactions. Stereochemistry- Optical isomerism,

#### Organometallic compounds:

Synthesis and uses of Grignard reagents organolithium and silicon compounds in materials synthesis. Metal carbonyls

### Unit 5: Materials synthesis:

Solid state Reactions: General principles, experimental procedures, and applications in the synthesis of materials, the following synthetic strategies - co-precipitation as a precursor to solid-state reactions. Preparative strategies in Solid State Chemistry: Wet chemical methods-sol-gel, combustion, emulsion, film casting. Chemical vapour deposition, aerosol hydrothermal and solvothermal methods. Langmuir-Blodgett films.

#### Electrochemistry:

Electrolytic conductance – Debye-Huckel theory of Interionic attraction, Debye-Huckel limited law, energetics of electrochemical reactions, electrode potential and EMP application of EMF measurements, potentiometric titrations.

Corrosion – Introduction and importance of corrosion studies, theories of corrosion, factors influencing corrosion, forms of corrosion, corrosion control measure,.

#### Chemical Thermodynamics:

Brief resume of concepts of laws of thermodynamics. Free energy, chemical potential and entropy. Gibb's-Helmholtz equation and Maxwell's relation.

### **Chemical Dynamics:**

Elementary concepts, collision and transition state theories, first and second order reactions and their determinations (any one methods).

### **Unit 6:Polymers:**

Basic concepts of polymers, classification of polymers-linear, branched, cross-linked polymers, co-polymers; polymer blends and interpenetrating networks.Understanding the molecular weight of polymers-number average/weight average/z-average, viscosity average.degree of polymerizations. Viscosity method for molecular weight determination.techniques for polymerization-bulk, solution, suspension, emulsion.

### **Synthesis of nanomaterials:**

Chemical routes to synthesis- sol gel, hydrothermal, solvothermal, combustion and chemical vapour deposition.

### **Thermal methods of Analysis:**

Principles, Instrumentation and applications of TGA, DTG,DTA, DSC and TMA techniques for ceramics, composites and polymers.

### **Reference Books:**

- 1.Concise Inorganic Chemistry, J D Lee, ELBS Publications.
- 2.Advanced Inorganic Chemistry, F A Cotton and Wilkinson, John Wiley publications.
- 3.Theoretical Inorganic Chemistry, M. C. Day, Jr. and J. Selbin East west Press.
- 4.Materials Science and Engineering, CRC Press, Yip-Wah Chung.
- 5.Materials Science and Engineering, an Introduction, W D Callister Jr., John Wiley and Sons.
- 6.Elements of Materials Science and Engineering, L H Van Vlack.
- 7.Coordination Chemistry, by F. Basalo and others.
- 8.Comprehensive Coordination Chemistry, G. Wilkinson, R. D. Gillars and J. A. Mc.
- 9.Principles of Organometallic Chemistry, G. E. Coater, M. L. H. Green, P, Powell & K. Wade.
- 10.Organometallic Chemistry – A Unified Approach – R. C. Mehrotra and A. Singh.
- 11.Organic Chemistry by Morrison and Boyd.Organic Chemistry by I.L. Finar.
- 12.Topics in current Chemistry, V Balzari and others (edts.), Chapter on Ionic Liquids, B. Kirchna, Springer, 2009.
- 13.Introduction to Ionic Crystals, Michale F, RSIC pub., 2009.
- 14.Nano: The Essentials, T.Pradeep. Tata McGraw Hill, New Delhi (2007)
- 15.Introduction to Nanotechnology, Charles P Poole Jr and Frank J Ownes, John Wiley Sons, Inc (2003).
- 16.Polymers, D J Wanton and J P Lorimer, Oxford series Press.
- 17.Principles of Polymer Science, D Bahadur and N V Sastry, Narosa Publication.
- 18.Elements of Polymer Science and Engineering, Alfred Rudil, Academic Press.
- 19.Polymer Science by V R Gowarikar and others, new age international.

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