Employability final scan

Physics- courses focusing on employability
Year: 2015-16, 2016-17, 2017-18
1.1.3

PHY4.3(b) Material Science

Unit – I

Engineering materials: **07 Hours**

Materials Science and Engineering, Classification levels of structure, structure- property relationship in materials. (Ref 1, 2 and 3)

Structure of solids: **06 Hours**

The crystalline and non crystalline states, covalent solids, metals and alloys, ionic solids, the structure of silica and silicates. (Ref 1, 2 and 3)

Unit – II

Crystal growth: **07 Hours**

Crystal growth from melt: Bridgemann technique, crystal pulling by czocharalski's method, growth from solutions, hydrothermal method, gel method, zone refining method of purification. (Ref: 2 and 5)

Crystal imperfections: **06 Hours**

Point imperfections, dislocation –edge and screw dislocation, concept of burger vector and burger circuit, surface imperfections, colour centres in ionic solids. (Ref 1, 2 and 3)

Unit – III

Solid phases and phase diagrams: **13 Hours**

Single and multiphase solids, solid solutions and hume-rothery rules, intermediate phase, the intermediate and interstitial compounds, properties of alloys; solid solutions and two component alloy systems; phase diagram, gibbs phase rule, lever rule, first, second and third order phase transitions with examples; some typical phase diagrams: Pb-Sn and Fe-Fe_2O_3 , Eutectic, eutectoid peritectic and peritectoid systems. (Ref 1, 2 and 3)

Unit – IV

The phase transformation: **07 Hours**

Time scale for phase changes; nucleation and growth, nucleation kinetics, the growth and overall transformation kinetics, applications; transformation in steel; precipitation processes, solidification and crystallization, glass transition recovery re-crystallization and grain growths. (Ref 1, 2 and 3)

Diffusion in solids: **06 Hours**

Theory of diffusion, self diffusion, Fick's law of diffusion, Kirkindal effect activation energy of diffusion, applications of diffusion. (Ref 1, 2 and 3)

References:

1) Elements of material science and engineering L H Vanvleck, Addison Wesley 1989, 6th edn
2) Material science and engineering V Raghvan, Prentice Hall of India 3rd edn
3) Material science and processes S K Hazra Choudhary, Indian Distr Co 1977
4) Introduction to solids L V Azaroff ,Tata McGraw Hill
5) Crystal growth B R Pamplin, Pergamon press

PHY4.3(c) Biophysics

Unit – I

Cell biophysics: **13 Hours**

Cell doctrine: general organization and composition of the cells.

Bioenergetics: The biological energy cycle and energy currency. Thermodynamic concepts; free energy of a system – Gibb's free energy function, chemical potential and redox potentials. Energy conversion pathways - Kerb's cycle, respiratory chain, oxidative phosphorylation. Photosynthesis apparatus; mechanisms of energy trapping and transfer photophosphorylation.

Unit – II

Membrane biophysics: **7 Hours**

Cell membranes – structure, function and models; transport across membranes – passive and active processes; chemiosmotic energy and transduction – van't Hoff equation ; ionic equilibrium electrochemical potential; Nernst's equation; flow across membranes-membrane permeability.

Neuro physics: **6 Hours**

The nervous system. Synaptic transmission information processing in neuronal systems. Physical basis of biopotentials; action potential; Nernst Planck equation. Nerve excitation and conduction; Hodgkin – Huxley model.

Unit – III

Physiological biophysics **13 Hours**

Physics of sensory organs – the transmission of information generator potentials. Visual receptor – mechanism of image formation, auditory receptor, mechanism of sound perception; mechanisms of chemical somatic and visceral receptors. Mechanism of muscle contractility and motility. Temporal organization basis of biorhythms.

Unit – IV

Biophysics of the immune system: **13 Hours**

The immune system; cellular basis of immunal responses antibodies and antigens immunological memory. **Genetic Engineering:** Gene, structure, expression and regulation; genetic code genome organization; recombinant technology. Transgenic systems. Cybernetics – genetic information and the brain; neural nets.

References:

1) An introduction to biophysics C Sybesma, Academic 1977
2) Biophysics, V Pattabhi and N Gautham, Narosa 2002
3) Essential of biophysics P Narayan, New Age 2001.
4) Molecular biophysics R B Setlow and E C Polland ,Addn Wesley 1962
5) Biophysics W Hope, W Lohmann H Markl H Ziegler ,Springer Verlag 1983
6) Biophysics and human approach I W Sherman and V G Sherman ,Oxford 1979
7) Molecular biology of the cell B Alerts D Bray, J Lewis M Raft, K Roberts and J D Watson ,Garland 1984
8) Molecular cell biology H Lodish A Berk S L Zipursky P Matsudaira, D Baltomore and J Darnel ,Freeman 2000
9) Biophysical principles of structure and function F M Snell S Shulman R P Spensor and C Moos ,Addn Wesley 1965
10) Principles of neural science E R Kendel J G Schwar ,Elsevier 1982.

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PHY4.4(a) Astrophysics

Unit – I

13 Hours

Basic concepts, Michelson's stellar interferometer, binary stars and their masses, radial and transverse velocities types of optical telescopes and their characteristics, modern telescopes like Gemini Keck etc.

Unit – II

13 Hours

Properties of stars: Spectra of stars, spectral sequence –temperature and luminosity classifications, H-R diagram, Saha's ionization formula and application to stellar spectra, virial theorem, stellar structure equations, star formation and main sequence evolution, mass luminosity relation, White dwarf's, Pulsars, magnetars, Neutron stars and Black holes, variable stars.

Unit – III

13 Hours

The solar system: The surface of the sun, solar interior structure, solar rotation, sun spots, the active sun, properties of interior planets and exterior planets, satellites of planets, comets, asteroids, meteorites, Kuiper Belt Objects and Oort Cloud, Theories of formation of the solar system.

Unit – IV

13 Hours

Star clusters, Galaxies and the Universe: open and global clusters, the structure and contents of milky way galaxy, Hubble's classification of galaxies, galactic structure and dark matter, galactic motions, hubble's law, Olber's paradox. Big bang theory and the origin of the early universe, nucleosynthesis, cosmic microwave background radiation and evolution of the universe.

References

1) The new cosmos A unsold, Springer Verlag 1977
2) Introduction to stellar astrophysics E Bohm Vitense 3rd volume ,CUP 1989
3) Astrophysics and stellar astronomy T L Swihart: Wiley 1968
4) The stars ; their structure and evolution R J Taylor , Cambridge University Press 1993
5) Introduction to Cosmo Log J V Narlikar Y, Cambridge University Press 1993
6) Principles of physical cosmology Peebles P J E, Princeton U P 1993
7) Galaxies their structure and evolution R J Taylor, Cambridge University Press 1993
8) Solar system astrophysics Brandt J C and Hodge, Mc graw Hill 1964
9) The physical universe, F Shu So press 1987
10) Introduction to modern astrophysics Ostlie and Caroll, Addn Wesley 1997
11) Astrophysics concepts M Herwit, John wiley 1990
12) An introduction to astophysics Baidyanath Basu, PHI
13) A textbook of astrophysics and cosmology V B Bhatia, New Age International
14) Our solar system, Rana
15) Stars and galaxies K D Abyankar, Cambridge University Press
16) Astrophysics, Krishanswamy
17) Pulsar Astronomy A G Lyne and G Smith, Cambridge University Press

PHY4.4(b) Physics of Laser and Laser Applications

Unit – I **13 Hours**

Laser characteristics:

Review of fundamentals of lasers – population inversion, pumping techniques and types. Characteristics of laser beams – Gaussian and its properties. Stable two minor optical resonators. Modes of laser oscillations of a laser cavity – longitudinal and transverse. An expression for the number of modes of oscillation in terms of frequency and the cavity length. Mode selection, mode locking, gain in a regenerative laser cavity. Threshold for 3 and 4 level laser systems – mode locking, pulse shortening. Line broadening mechanism. Spectral narrowing and stabilization. Continuous lasers and pulsed lasers.

Unit – II **13 Hours**

Laser systems: High powered lasers and low powered lasers pumping techniques for population inversion. Mechanism and energy levels of the following lasers – Ruby laser Nd YAG laser. Semiconductor lasers, diode pumped solid state lasers – homogenous and hetergenous double heterogenous lasers. Carbon dioxide lasers, excimer lasers, dye laser, argon ion laser. Qualitative treatment of engineering and medical applications of lasers.

Unit – III **13 Hours**

Laser spectroscopic techniques: Spectral characteristics of laser emission – active resonators, gain saturation, spatial hole burning. Laser fluoresescence and Raman scattering and their application in pollution studies. Non-linear spectroscopy – non linear interaction of light with matter. Laser induced multiphoton processes and their application. Ultrahigh resolution spectroscopy with lasers and its applications.

Unit – IV **13 Hours**

Lasers in fiber optics: Review of optical fibers. Propagation of light in a medium with variable reflective index. Optical fiber as a waveguide. Types of optical fibers and their applications – optical switches, optical couplers, transmission characteristics of optical fibers. Types of losses-attenuation loss,

dispersion loss, splice loss etc. intermodal dispersion and material dispersion EDOF as an amplifier – optical fiber communications using lasers. WDM optical fibers. Modal analysis for step index and parabolic index medium. Attenuation of lasers in optical fibers.

References:

1) Lasers: theory and applications K Thyagarjan, AK Ghatak, Mc Milan India 1981
2) Principles of lasers O Swelto, Springer 1998
3) Lasers A E Sigman, University Press 1986
4) Solid state laser engineering W Koechener, Springer verlag 1992
5) Laser spectroscopy W Demtroder, Springer international 2002
6) Laser and nonlinear optics B B Laud, Wiley Eastern ltd 1991
7) Optical electronics Amn Yariv on, holt Rinchart and Winston 1991
8) Fiber-optic communication, D Jafar K Myubaev and Lowell L scheiner
9) Introduction to fiber optics A K Ghatak K Thaygarajan, Cambridge university press 1997
10) Optical electronics A K Ghatak K Thyagarajan, Cambridge University Press 1997.

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PHY4.4(c) Physics of Nanomaterials

Unit – I **13 Hours**

Topics in condensed matter:

Density of states – variation with energy. Variation of density of states and band structure with size of crystal. Density of states for different dimensions.

Introduction to nano materials: (Definitions, reason for interest in nanomaterials, classification of nanostructures, 1D, 2D and 3D confinement, effect of nanostructure on structural and mechanical properties, chemical reactivity and stability thermal magnetic optical and electronic properties, nanoprocess in biosystems) – overview. Mechanical behaviour of nanostructured systems: Effect of gain size on elasticity and hardness – empirical Hall-Petch equation models to explain it modification for small grain sizes. **Gas reactive applications of nanostructrured materials:** Catalysts electrocatalysis processes, impact of nanostructure, Gas sensors; physical principles of semiconductor sensors and nanostructure design. Hydrogen storage: properties of hydrogen storage compounds and nanostructure design. **Nano magnetic materials and applications:** Domain and domain walls- Bulk and nano structures, magnetization processes in particulate nano magnets and layered nano magnets, applications, magnetoresistance, giant magnetoresistance, spin values and tunneling magnetoresistance.

Unit – II **13 Hours**

Overview of semiconductors: Electronic band structure, concept of the effective mass, optical processes, direct and indirect band gap semiconductors, exciton formation superlattice heterostructure. **Quantum size effect:** Quantum confinement in one dimensions quantum wells- Electron confinement in infinitely deep square well square, square well of finite depth, optical absorption in quantum well in the case of heterostructure consisting of thin layer of GaAs sandwiched between thick layers of AlGaAs. Quantum confinement in 2 dimensions- quantum wires, Quantum confinement in 3 dimensions- quantum dots, Applications of wires and dots. **Tunneling transport:** T matrices for potential step and square barrier, current and conductance. Resonant tunneling, charging effects, coulomb blockade and coulomb blockade devices.

Unit – III **13 Hours**

Methods for preparing nanomaterials Bottom up : Nano particles

Nano structures: Quantum dots, quantum well structures, thin film deposition techniques molecular beam of epitaxy MOVPE-MOCVE. Cluster beam evaporation cluster nucleation theory of condensation from super saturated vapor clusters formation. **Top down :** ball milling – details shaker mills, lithography electron beam/ion beam. **Self assembled molecular materials** – principles of self assembly micelar and vesicular polymerization colloidal nano particle crystals self organizing inorganic nanoparticles. **Thin organic films** spin coating of polymers multilayers layer by layer deposition Langmuir Blodgett techniques.

Unit – IV **13 Hours**

Characterization of nanomaterials

Diffraction techniques: X-ray diffraction (XRD) crystallinity, particle/crystallite size determination and structural analysis. **Microscope techniques**: Scanning Electron Microscopy (SEM) – morphology grain size EDX; Transmission Electron Microscopy (TEM)- morphology particle size and electron diffraction. **Scanning probe techniques**: Scanning Tunneling Microscopy (STM) surface imaging and roughness; Atomic Force Microscopy (AFM) – surface imaging and roughness; other scanning probe techniques

Physics - Courses focusing on employability
Year : 2018-19, 2019-20
1.1.3

PST-1.5 (a): Instrumentation

Unit – I: Generalized Characteristics of Instruments **13 Hours**

Static characteristics: accuracy, precision, repeatability, reproducibility, resolution, sensitivity, linearity, drift, span, range.

Dynamic characteristics: transfer function , zero order instruments, first order instruments – step, ramp, frequency responses – second order instruments – step-ramp response – dead time elements.

Types of Errors: gross, systematic, random, linear and nonlinear curve fitting, chi-square test

Unit – II: Vacuum Systems **13 Hours**

Principle and operation of various pumps: rotary, diffiusion, sorption, turbomolecular, ionisation and cryopumping.

Gauges: McLeod, diaphragm, thermocouple, pirani, penning, ionisation and hot and cold cathodes – design of high vacuum systems – high pressure cells – measurements at high pressures.

Unit – III: Thermal Systems **13 Hours**

Temperature scales – liquefaction of gases, achieving low temperature – design of cryostats.

High temperature furnaces: resistance, induction and arc furnaces – high temperature measurements – pyrometers – total and selective radiation pyrometers – optical pyrometer.

Unit – IV: Detectors and Spectroscopy **13 Hours**

Detectors: pyroelectric, thermoelectric, photoconducting, photoelectric, photomultiplier, scintillation types of detectors, photon counters.

Spectroscopy: principles of atomic absorption spectroscopy – instrumentation – single and double beam spectrometers –theory and components of nuclear quadrupole resonance technique – applications.

References:

1) A.K. Sawhney and Puneet Sawhney, A Course in Mechanical Measurement and Instrumentation, DhanpatRai&Sons, New Delhi 2000.
2) Dennis Roddy and John Coolen, Electonic communication, 4th edition, PHI private Ltd., (1999). (Unit – II)
3) C.S. Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw-Hill (1983).
4) H.H. Willard, L.L. Merrit and John A. Dean, Instrumental Methods of Analysis, 6th edition, CBS Publishers & Distributors (1986).
5) D.V.S. Murty, Transducers and Instrumentation, Prentice – Hall of India (P) Ltd., New Delhi (1995).
6) Ernest O. Doebelin, Measurement System Applications and Design, McGraw Hill International Book Company, Singapore (1983)

PST-1.5(b): Astrophysics

Unit – I **13 Hours**

Basic concepts, Michelson's stellar interferometer, binary stars and their masses, radial and transverse velocities types of optical telescopes and their characteristics, modern telescopes like Gemini Keck etc.

Unit – II **13 Hours**

Properties of stars: Spectra of stars, spectral sequence –temperature and luminosity classifications, H-R diagram, Saha's ionization formula and application to stellar spectra, virial theorem, stellar structure equations, star formation and main sequence evolution, mass luminosity relation, White dwarf's, Pulsars, magnetars, Neutron stars and Black holes, variable stars.

Unit – III **13 Hours**

The solar system: The surface of the sun, solar interior structure, solar rotation, sun spots, the active sun, properties of interior planets and exterior planets, satellites of planets, comets, asteroids, meteorites, Kuiper Belt Objects and Oort Cloud, Theories of formation of the solar system.

Unit – IV **13 Hours**

Star clusters, Galaxies and the Universe: open and global clusters, the structure and contents of milky way galaxy, Hubble's classification of galaxies, galactic structure and dark matter, galactic motions, hubble's law, Olber's paradox. Big bang theory and the origin of the early universe, nucleosynthesis, cosmic microwave background radiation and evolution of the universe.

References

1) The new cosmos A unsold, Springer Verlag 1977
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13) A textbook of astrophysics and cosmology V B Bhatia, New Age International
14) Our solar system, Rana
15) Stars and galaxies K D Abyankar, Cambridge University Press
16) Astrophysics, Krishanswamy
17) Pulsar Astronomy A G Lyne and G Smith, Cambridge University Press

1.1.3

PST-2.5(a): Physics of Nanomaterials

Unit – I **13 Hours**

Topics in condensed matter:

Density of states – variation with energy. Variation of density of states and band structure with size of crystal. Density of states for different dimensions.

Introduction to nano materials: (Definitions, reason for interest in nanomaterials, classification of nanostructures, 1D, 2D and 3D confinement, effect of nanostructure on structural and mechanical properties, chemical reactivity and stability thermal magnetic optical and electronic properties, nanoprocess in biosystems) – overview. Mechanical behaviour of nanostructured systems: Effect of gain size on elasticity and hardness – empirical Hall-Petch equation models to explain it modification for small grain sizes, **Gas reactive applications of nanostructrured materials:** Catalysts electrocatalysis processes, impact of nanostructure, Gas sensors; physical principles of semiconductor sensors and nanostructure design. Hydrogen storage: properties of hydrogen storage compounds and nanostructure design. **Nano magnetic materials and applications:** Domain and domain walls- Bulk and nano structures, magnetization processes in particulate nano magnets and layered nano magnets, applications, magnetoresistance, giant magnetoresistance, spin values and tunneling magnetoresistance.

Unit – II **13 Hours**

Overview of semiconductors: Electronic band structure, concept of the effective mass, optical processes, direct and indirect band gap semiconductors, exciton formation superlattice heterostructure. **Quantum size effect:** Quantum confinement in one dimensions quantum wells- Electron confinement in infinitely deep square well square, square well of finite depth, optical absorption in quantum well in the case of heterostructure consisting of thin layer of GaAs sandwiched between thick layers of AlGaAs. Quantum confinement in 2 dimensions- quantum wires, Quantum confinement in 3 dimensions- quantum dots, Applications of wires and dots. **Tunneling transport:** T matrices for potential step and square barrier, current and conductance. Resonant tunneling, charging effects, coulomb blockade and coulomb blockade devices.

Unit – III **13 Hours**

Methods for preparing nanomaterials Bottom up : Nano particles

Nano structures: Quantum dots, quantum well structures, thin film deposition techniques molecular beam of epitaxy MOVPE-MOCVE. Cluster beam evaporation cluster nucleation theory of condensation from super saturated vapor clusters formation. **Top down :** ball milling – details shaker mills, lithography electron beam/ion beam. **Self assembled molecular materials** – principles of self assembly micelar and vesicular polymerization colloidal nano particle crystals self organizing inorganic nanoparticles. **Thin organic films** spin coating of polymers multilayers layer by layer deposition Langmuir Blodgett techniques.

Unit – IV **13 Hours**

Characterization of nanomaterials

Diffraction techniques: X-ray diffraction (XRD) crystallinity, particle/crystallite size determination and structural analysis. **Microscope techniques**: Scanning Electron Microscopy (SEM) – morphology grain size EDX; Transmission Electron Microscopy (TEM)- morphology particle size and electron diffraction. **Scanning probe techniques**: Scanning Tunneling Microscopy (STM) surface imaging and roughness; Atomic Force Microscopy (AFM) – surface imaging and roughness; other scanning probe techniques

1.1.3

PST-2.5(b): Physics of Laser and Laser Applications

Unit – I

Laser characteristics: **13 Hours**

Review of fundamentals of lasers – population inversion, pumping techniques and types. Characteristics of laser beams – Gaussian and its properties. Stable two minor optical resonators. Modes of laser oscillations of a laser cavity – longitudinal and transverse. An expression for the number of modes of oscillation in terms of frequency and the cavity length. Mode selection, mode locking, gain in a regenerative laser cavity. Threshold for 3 and 4 level laser systems – mode locking, pulse shortening. Line broadening mechanism. Spectral narrowing and stabilization. Continuous lasers and pulsed lasers.

Unit – II

13 Hours

Laser systems: High powered lasers and low powered lasers pumping techniques for population inversion. Mechanism and energy levels of the following lasers – Ruby laser Nd YAG laser. Semiconductor lasers, diode pumped solid state lasers – homogenous and hetergenous double heterogenous lasers. Carbon dioxide lasers, excimer lasers, dye laser, argon ion laser. Qualitative treatment of engineering and medical applications of lasers.

Unit – III

13 Hours

Laser spectroscopic techniques: Spectral characteristics of laser emission – active resonators, gain saturation, spatial hole burning. Laser fluoresescence and Raman scattering and their application in pollution studies. Non-linear spectroscopy – non linear interaction of light with matter. Laser induced multiphoton processes and their application. Ultrahigh resolution spectroscopy with lasers and its applications.

Unit – IV

13 Hours

Lasers in fiber optics: Review of optical fibers. Propagation of light in a medium with variable reflective index. Optical fiber as a waveguide. Types of optical fibers and their applications – optical switches, optical couplers, transmission characteristics of optical fibers. Types of losses-attenuation loss, dispersion loss, splice loss etc. intermodal dispersion and material dispersion EDOF as an amplifier – optical fiber communications using lasers. WDM optical fibers. Modal analysis for step index and parabolic index medium. Attenuation of lasers in optical fibers.

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1) Lasers: theory and applications K Thyagarjan, AK Ghatak, Mc Milan India 1981
2) Principles of lasers O Swelto, Springer 1998
3) Lasers A E Sigman, University Press 1986
4) Solid state laser engineering W Koechener, Springer verlag 1992
5) Laser spectroscopy W Demtroder, Springer international 2002
6) Laser and nonlinear optics B B Laud, Wiley Eastern ltd 1991
7) Optical electronics Amn Yariv on, holt Rinchart and Winston 1991
8) Fiber-optic communication, D Jafar K Myubaev and Lowell L scheiner
9) Introduction to fiber optics A K Ghatak K Thaygarajan, Cambridge university press 1997
10) Optical electronics A K Ghatak K Thyagarajan, Cambridge University Press 1997.

1.1.3

PST-4.3(a): Material Science

Unit – I

Engineering materials: **07 Hours**

Materials Science and Engineering, Classification levels of structure, structure- property relationship in materials. (Ref 1, 2 and 3)

Structure of solids: **06 Hours**

The crystalline and non crystalline states, covalent solids, metals and alloys, ionic solids, the structure of silica and silicates. (Ref 1, 2 and 3)

Unit – II

Crystal growth: **07 Hours**

Crystal growth from melt: Bridgemann technique, crystal pulling by czocharalski's method, growth from solutions, hydrothermal method, gel method, zone refining method of purification. (Ref: 2 and 5)

Crystal imperfections: **06 Hours**

Point imperfections, dislocation –edge and screw dislocation, concept of burger vector and burger circuit, surface imperfections, colour centres in ionic solids. (Ref 1, 2 and 3)

Unit – III

Solid phases and phase diagrams: **13 Hours**

Single and multiphase solids, solid solutions and hume-rothery rules, intermediate phase, the intermediate and interstitial compounds, properties of alloys; solid solutions and two component alloy systems; phase diagram, gibbs phase rule, lever rule, first, second and third order phase transitions with examples; some typical phase diagrams: Pb-Sn and Fe-Fe_2O_3 , Eutectic, eutectoid peritectic and peritectoid systems. (Ref 1, 2 and 3)

Unit – IV

The phase transformation: **07 Hours**

Time scale for phase changes; nucleation and growth, nucleation kinetics, the growth and overall transformation kinetics, applications; transformation in steel; precipitation processes, solidification and crystallization, glass transition recovery re-crystallization and grain growths. (Ref 1, 2 and 3)

Diffusion in solids: **06 Hours**

Theory of diffusion, self diffusion, Fick's law of diffusion, Kirkindal effect activation energy of diffusion, applications of diffusion. (Ref 1, 2 and 3)

References:

1) Elements of material science and engineering L H Vanvleck, Addison Wesley 1989, 6th edn
2) Material science and engineering V Raghvan, Prentice Hall of India 3rd edn
3) Material science and processes S K Hazra Choudhary, Indian Distr Co 1977
4) Introduction to solids L V Azaroff ,Tata McGraw Hill
5) Crystal growth B R Pamplin, Pergamon press