

**SARDAR PATEL UNIVERSITY  
VALLABH VIDYANAGAR**



**SYLLABUS EFFECTIVE FROM: 2017-18**

**Course: M.Sc.**

**Subject: Materials Science**

**Semester : II**

**Subject Code:** PS02CMTS21

**Total Credit: 04**

**Subject Name:** Semiconducting and Superconducting Materials

| Unit | Unit Title                                                                                                                                                                                                                                                                                                                                   | Weight-age (%) |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| 1    | Role of valence electrons, electrons in a field free crystal, electron gas approximation, behavior of electrons in applied electric field, drift velocity and its calculation, phonon scattering of electrons, temperature dependence of resistivity.                                                                                        | 25%            |
| 2    | <b>Formation of electron energy bands in solids</b><br>Insulators, semiconductors and conductors, electrons and positive holes, mobility, generation and recombination of electron positive hole pairs.                                                                                                                                      | 25%            |
| 3    | <b>Intrinsic semiconductors</b><br>n and p type (extrinsic) semiconductors, p-n junction, current flow through p.n junction, (junction characteristics), Junction transistor, Field effect Transistor. Semiconductor purification, crystal growth and doping, epitaxial growth, Chemical Vapor Deposition technique, Molecular Beam Epitaxy. | 25%            |
| 4    | Introduction to superconductivity, electrical properties, magnetic properties, Meissner effect, two types ( type I and type II) superconductors. Normal to superconductive transition, intermediate state, mixed state, surface superconductivity, boundary energy, tunneling, Applications of superconductors.                              | 25%            |

**Reference Books :**

Materials Science for Engineers- J.C.Anderson, K.D. Leaver, P. Leavers, R.D.Rawlings

Basic Electronics and circuits-N.N.Bhargava,D.C.Kulshreshtha and S.C.Gupta

Materials Science and Engineering An Introduction-William D.Callister Jr.

Semiconductors and Electronic Devices- Adir Bar-Lev.

**SARDAR PATEL UNIVERSITY****Course: M.Sc.****Subject: Materials science****Semester : II****Subject Code: PS02CMTS22****Total Credit: 04****Subject Name: SPECTROSCOPY**

| <b>Unit</b> | <b>Unit Title</b>                                                                                                                                                                                                                                                                                                           | <b>Weight-age (%)</b> |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>1</b>    | Atomic absorption and flame emission spectroscopy. uv, visible and photoelectron spectroscopy introduction, theoretical consideration, application.                                                                                                                                                                         | <b>25%</b>            |
| <b>2</b>    | Introduction of microwave spectroscopy, rigid rotors, microwave spectra of diatomic and linear triatomic molecules, numerical problems. Harmonic and anharmonic oscillation in presence of IR, group frequency concept and its limitation, classical theory of Raman effect, selection rule for IR/Raman active vibrations. | <b>25%</b>            |
| <b>3</b>    | Principle of NMR spectroscopy, chemical shift, local contribution to chemical shift, neighbour anisotropic contribution to chemical shift, ring current effect, spin-spin splitting and effect of spin-spin splitting on the spectrum. spin decoupling techniques, molecular structure studies by NMR.                      | <b>25%</b>            |
| <b>4</b>    | Mossbauer spectroscopy, resonance absorption in solids, the mossbauer effect, experimental set up, factors affecting the MB spectra, applications. Development of masers and lasers, principle of masers action and types of masers, laser-generation of coherent radiation, type of lasers, application of lasers.         | <b>25%</b>            |

**Reference Books**

Fundamentals of Molecular Spectroscopy by C. N. Banwell.

Physical Methods in Chemistry by R. s. Drago.

Applications of Absorption Spectroscopy of Organic Compounds by J. R. Dyer.

Solid State physics – Saxena, Gupta &amp; Saxena, Pragati prakashan.

Mossbauer Spectroscopy by G. M. Bancroft.

**SARDAR PATEL UNIVERSITY****Course: M.Sc.****Subject: Materials science****Semester : II****Subject Code: PS02CMTS23****Total Credit: 04****Subject Name: MICROSTRUCTURE CONTROL AND METALLIC PROCESSING**

| <b>Unit</b> | <b>Unit Title</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Weight-age (%)</b> |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>1</b>    | <b>Metals and extractive metallurgy</b> , Deformation, Strain Hardening, Annealing, hot working, deformation & bonding process, superplastic forming, Solidification and grain size strengthening, microstructure and its relation to the properties. Homogeneous and heterogeneous nucleation, growth, types of growth, solidification time, casting, solidification defects, control of casting structure, solidification and metal joining.                                                                                | <b>25%</b>            |
| <b>2</b>    | Phase and the Unary phase Diagram, solubility and solutions, Hume Rothery's rules of solid solubility, solid solution strengthening, isomorphous phase diagram, strength and phase diagram, solidification of solid solution alloys, equilibrium and non equilibrium solidification, segregation, castability.                                                                                                                                                                                                                | <b>25%</b>            |
| <b>3</b>    | Principles of dispersion strengthening, intermetallic compounds, three phase reactions, eutectic phase diagram, eutectic system, peritectic reactions, monotectic reaction, ternary phase diagram, nucleation and growth in solid state reactions, alloys strengthening by exceeding solubility limit. Age hardening or precipitation hardening. Nucleation & growth in solid state reaction, eutectoid reaction, Control of eutectoid reactions, age hardening, G.P. Zones, controlling the transformation, Heat treatments. | <b>25%</b>            |
| <b>4</b>    | Fe-Fe <sub>3</sub> C phase diagram, pearlite, bainite, mortensite, cementite, heat treatments processes, classification of steels and their applications. Aluminium alloys, magnesium alloys, copper alloys, nickel, cobalt, zinc alloys, titanium alloys, refractory metals.                                                                                                                                                                                                                                                 | <b>25%</b>            |

**Reference Books :**

The science &amp; Engineering of Materials by Donald R. Askeland PWS-Kent Publishing

Materials Science &amp; Metallurgy by V.D. Kodgire Everest Publishing House. Physical Metallurgy by V.Raghavan.

Materials Science by Manas Chanda

**SARDAR PATEL UNIVERSITY****Course: M.Sc.****Subject: Materials Science****Semester : II****Subject Code: PS02EMTS21****Total Credit: 04****Subject Name: (Elective 01) DEFFECT STRUCTURES AND PROPERTIES OF MATERIALS**

| <b>Unit</b> | <b>Unit Title</b>                                                                                                                                                                                                                                                                                                                        | <b>Weight-age (%)</b> |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>1</b>    | Fundamental concepts, Crystal lattice, Unit Cell, Bravais lattice, Lattice planes and direction, Seven crystal systems, Miller Indices, Chemical bonding, Bond Energy, Bond length, Types of Bonds                                                                                                                                       | <b>25%</b>            |
| <b>2</b>    | Vacancies and interstitials, Formation of point defects, Schottky and Frenkel defects, Diffusion in solids, Fick's law. Edge, Screw and mixed, Dislocation Forces between dislocation, Forces on dislocation, Origin of Dislocation, Frank Read source, Grain boundaries, Twin boundaries, Observation of dislocation.                   | <b>25%</b>            |
| <b>3</b>    | Classification of growth processes, Bridgman-Stockbarger technique, Czochralski technique, zone-melting technique, zone-movement technique, other crucibleless techniques. Growth by vapour – sublimation – condensation, direct and indirect vapour transport, Flame-fusion technique Rotary crystallizer, Holden's rotary crystallizer | <b>25%</b>            |
| <b>4</b>    | Growth of some industrially important crystals, Diamond – HPHT and metastable techniques. Zeolites – Hydrothermal technique, Semiconductors and superconducting materials – Flux growth, and LPE                                                                                                                                         | <b>25%</b>            |

**Reference Books :**

Materials Science for Engineers by L.H. Van Vlack

Crystal Growth by J. C. Brice.

Introduction to dislocations by D. Hull.

Fundamentals of solid physics by B. S. Saxena, R. C. Gupta &amp; P. N. Saxena

Materials Science – Manas Chanda

The Science and Engineering of Materials by Donald R. Askeland PWS-Kent publishing

**SARDAR PATEL UNIVERSITY****Course: M.Sc.****Subject: Materials Science****Semester : II****Subject Code: PS02EMTS22****Total Credit: 04****Subject Name: (Elective 02) SOLAR ENERGY**

| <b>Unit</b> | <b>Unit Title</b>                                                                                                                                                                                                                                                                                                                                                                               | <b>Weight-age (%)</b> |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>1</b>    | The nature of solar energy, terrestrial solar radiation, solar constant, air mass, solar energy conversion types and devices.                                                                                                                                                                                                                                                                   | <b>25%</b>            |
| <b>2</b>    | Band pictures of solids, metals, semiconductors and insulators, intrinsic and extrinsic semiconductors, charges carriers in semiconductors. Semiconductor p-n junction, potential barrier and barrier height, photovoltaic conversion, photovoltaic solar cells, p-n junction solar cells, photo electro chemical solar cells.                                                                  | <b>25%</b>            |
| <b>3</b>    | Optical absorption processes, direct inter-band optical transitions, indirect inter-band transitions, optoelectronic processes, generation and recombination phenomena.                                                                                                                                                                                                                         | <b>25%</b>            |
| <b>4</b>    | Construction and theory of p-n junction solar cells, important parameters of solar cell, factors affecting cell efficiency, heterojunction, heterojunction solar cells, examples of heterojunction solar cells, fabrication and advantages. Thin film deposition methods and materials, anti-reflection coatings, advantages and disadvantages of thin film solar cells, optical concentration. | <b>25%</b>            |

**Reference books:**

Photoelectrochemical Solar Cells : Suresh Chandra

Solar Energy : S. P. Sukhatme

Physics of Semiconductor Devices : S. M. Sze

**SARDAR PATEL UNIVERSITY**

**Course: M.Sc.**

**Subject: Materials Science**

**Semester : II**

**Subject Code: PS02CMTS24**

**Total Credit: 04**

**Subject Name: Practical I**

| <b>Unit</b> | <b>Unit Title</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Weight-age (%)</b> |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
|             | <ul style="list-style-type: none"><li>• Four probe method Determination of resistivity of Germanium crystal at different temperature and estimation of energy band gap.</li><li>• Determination of specific resistivity of discs of arbitrary shape by Van der PAUW method.</li><li>• Determination of reverse saturation current <math>I_0</math> and material constant, ideality factor.</li><li>• Determination of temperature coefficient of junction voltage and energy band gap.</li></ul> <p>Study of depletion capacitance and its variation with reverse bias.<br/>Study of Hall effect and estimation of Hall coefficient <math>R_H</math>, carrier density (<math>n</math>) and carrier mobility of<br/>Germanium sample n-type<br/>Germanium sample p-type<br/>Indian Arsenide (In As)</p> <ul style="list-style-type: none"><li>• Crystallisation of alkali halide (NaCl) by aqueous solution method.</li><li>• Direct observation of dislocations in alkali halide crystals by etching method.</li><li>• Determination of ultrasonic velocity in liquids</li></ul> | <b>100%</b>           |

**SARDAR PATEL UNIVERSITY****Course: M.Sc.****Subject: Materials Science****Semester : II****Subject Code: PS02CMTS25****Total Credit: 04****Subject Name: Practical II**

| <b>Unit</b> | <b>Unit Title</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Weight-age (%)</b> |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>1</b>    | <p>Determination of percentage of nitrogen by Kjeldhal's method in the given sample</p> <p>Determination of Percentage of acetyl groups in the given sample</p> <p>Determination of Molecular weight by steam distillation method of the given sample</p> <p>Determination of Hydrolyzable chlorine content of resin.</p> <p>Determination of gel time, peak exotherm temp. using dynamic &amp; isothermal curing processes for thermosets.</p> <p>Determination of Oxirane oxygen content &amp; molecular wt of epoxy resin.</p> <p>Determination of Aluminium in the given solution</p> <p>Determination of Nickel in the given solution</p> <p>Determination of iron in FeCl<sub>3</sub> solution</p> <p>Determination of strength of silver in silver nitrates solution</p> <p>Determination of Calcium in the unknown solution</p> <p>Determination of chloride content in water.</p> <p>Determination of Hardness of water.</p> <p>Analysis of different constituents present in the given solution.</p> <ul style="list-style-type: none"><li>Experiments can be added or deleted depending upon current advancements.</li></ul> | <b>100%</b>           |

**SARDAR PATEL UNIVERSITY**

**Course: M.Sc.**

**Subject: Materials Science**

**Semester : II**

**Subject Code: PS02CMTS26**

**Total Credit: 01**

**Subject Name: Comprehensive Viva**

| <b>Unit</b> | <b>Unit Title</b> | <b>Weight<br/>-age<br/>(%)</b> |
|-------------|-------------------|--------------------------------|
|             |                   | <b>100 %</b>                   |