SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2019-20
M. Sc. (Applied Physics)

SEMESTER-III

Course Code: PT03CAPC01 Quantum Effects in Solids

UNIT – 1
Quantum mechanics in electron moving in a one-dimensional potential well, three-dimensional potential well, quantum state and degeneracy, the density of states, Fermi-Dirac statistics, effect of temperature on Fermi distribution function, the electronic specific heat, the electrical conductivity of metals, relaxation time and mean free path, Mathiessen rule, Wiedemann Franz-Lorentz law, quantum Hall effect, quantum confinement: quantum well, quantum wire and quantum dot.

UNIT-2
Periodic potential and Bloch theorem, the Kronig-Penny model, construction of Brillouin zones, symmetry properties of the energy function, extended, reduced and periodic zone schemes, effective mass of an electron, the nearly free electron model, tight binding approximation, Orthogonalized Plane Wave (OPW) method, the pseudopotential method, conductors, semiconductors and insulators.

UNIT- 3
Luminescence: Introduction, Excitation and emission, The Franck-Condon principle, Radiationless transitions, Temperature dependence of luminescence, Decay mechanisms-Temperature independent exponential decay, Temperature dependent exponential decay, powerlaw decay, Thermo luminescence and glow curves, Thallium activated alkali halides, emission spectra, concentration dependence of the luminescence efficiency, The sulphide phosphors,electroluminescence, The Gudden-Pohl effect, The Destriau effect, carrier injection, luminescence, Applications.

UNIT- 4
Superconductivity-its occurrence and experimental survey, Meissner effect, Heat capacity, energy gap, Microwave and infrared properties, Isotope effects, Theoretical survey, Thermodynamics of superconducting transition and London equation, Coherence length, BCS theory of superconductivity, Flux quantization in a superconducting ring, Type II superconductors, single particle tunneling and Josephson superconductor tunnelling, SQUIDS, High Temperature superconductivity.

Basic Text & Reference Books:
1. Introduction to Solid State Physics by C. Kittle (John Wiley & Sons)
2. Elements of Solid State Physics by J.P. Srivastava (Prentice Hall of India)
3. Solid State Physics: Structure and Properties of Materials by M. A. Wahab
4. Solid State Physics (Theory, Applications and problems) by S. L. Kakani & C. Hemrajani (Sultan Chand & Sons, New Delhi)
5. Principles of Solid State Physics by R. A. Levy (Academic Press)
6. Elementary Solid State Physics by M. A. Omar (Addison-Wesley Publishing Company).

Course Code: PT03CAPC02 Optical and Magnetic Properties of Solids

UNIT – 1

General Properties of Optical Constant: Material Parameter, response to Longitudinal and Transverse Fields. Optical properties: Propagation of light in conducting media, Anomalous skin effect, Drude model, absorption processes, exciton absorption, free carrier absorption, absorption processes involving impurities, photoconductivity, response time and gain factor, p-n junction photovoltaic cells, characteristics and applications, photovoltaic detectors. Dielectrics: Polarizability and its dependence on frequency, dielectric constant and dielectric loss, effect of alternating fields, complex dielectric constants of non-polar solids, dipolar relaxation, energy absorption and losses, some important insulating materials.

UNIT: 2

Classification of Polaritons, LST relation, Electron-electron interaction, electron-phonon interaction: polarons, optical reflectance, Kramers-Kroning relations, electronic interband, transitions, Excitions, Frenkel excitons and Wannier-Mott exciton, Raman effect in crystals. Ferroelectric, electric displacive transition: Polarization catastrophe, 'Frozen in' Transverse Optical Phonons, Thermo dynamic theory of ferroelectric transition, ferroelectric domain, Piezoelectric, piezoelectric co-efficient, simple application with respect to piezoelectric slab.

UNIT: 3

Magnetism: Ferromagnetic order, Curie point, temperature dependence of saturation magnetization, magnons, thermal excitation of magnon, neutron magnetic scattering, ferrimagnetic order, Curie temperature and susceptibility of ferrimagnets, anti-ferromagnetic order, susceptibility below Neel temperature, anti-ferromagnetic magnons, Magneto-Achostic effect.

UNIT: 4

Resonances: Magnetic resonance, paramagnetic resonance, resonance with relaxation, nuclear magnetic resonance, line width, hyperfine splitting, Knight Shift, nuclear quadruple resonance, ferromagnetic resonance, anti-ferromagnetic resonance, spin wave resonance, electron paramagnetic resonance, cyclotron resonance and size effect, the de Haas-Van Alphen effect.

Basic Text & Reference Books:

1. Solid State Physics by C. Kittel
2. Solid State Physics by A. J. Dekker
3. Principles of theory of Solids by J. M. Ziman
4. Introduction to Semiconductor theory by A .I. Anselm
5. Solid State Physics by Streetman
6. Principle of Solid State Physics by R.A. Levy
7. Solid State Physics by S.O. Pillai
8. Solid State Physical Electronics by Aldert van der Ziel.
9. Molecular Structure and Spectroscopy by G. Aruldhas
10. Electrodynamics of Solis: Optical Properties of Electrons in Matter-Martin Dressen and Geoge Gruner, Cambridge Press-2002.

Course Code: PT03CAPC03 Non Destructive Testing Techniques

UNIT-1
Introduction to NDT, selection of NDT methods; defects in materials, selection of method and instrumentation, reliability in NDT. Visual Optical methods, Introduction to Dye Penetrant testing, Penetrants and their application, penetrant removal, Drying, developing, inspection, equipments and control checks.

UNIT-2
Magnetic particle testing: Basic theory of magnetism, Magnetization methods, Field indicators, Particle application, Inspection. ferromagnetic, Paramagnetic materials - magnetisation by means of direct and alternating current - surface strength characteristics - Depth of penetration factors, Direct pulsating current typical fields, advantages - Circular magnetisation techniques, field around a strength conductors, right hand rule field - Prods technique, current calculation - Longitudinal magnetization.Eddy current testing: Principle, instrumentation, techniques, sensitivity, applications and limitations.

UNIT-3
Ultrasonic testing: Basics of ultrasonic waves, Pulse and beam shapes, Ultrasonic transducers. Test method, Distance and Area calibration, and Weld inspection by UT.
Nature of sound waves, wave propagation - modes of sound wave generation - Various methods of ultrasonic wave generation - Principle of pulse echo method, through transmission method, resonance method - Advantages, limitations - contact testing, immersion testing, couplants - Data presentation.

UNIT-4
Radiography: Principle, radiation sources, attenuation in the specimen, radiographic imaging, inspection techniques, applications and limitations, real time holography, and safety. Image formation, Image quality, Digital Radiography, Image interpretation, Radiation Shielding, Tomography.
Acoustic emission testing: Basic principle, Sources of acoustic emission, Source parameters, Kaiser-Felicity theory, Equipment and Data.

Basic Text & Reference Books:

1. Raghavan V. Material Science and Engineering Prentice Hall, India 1998
2. Krautkramer J. and Krautkramer H. Ultrasonic Testing of Materials Springer-Verlag
3. Shull P.J., Nondestructive Evaluation: Theory, Techniques, and Applications, Marcel Dekker
4. Hellier, C., Handbook of Nondestructive Evaluation, McGraw-Hill
5. Bray, D.E. and R.K. Stanley; Non-destructive Evaluation: A Toolfor Design, Manufacturing and Service CRC Press
6. Practical Non destructive testing: Baldev Raj, T. Jayakumar, M. Thavasimuth, Narosa
7. NDE Handbook, Non-destructive examination methods: Knud G. Boving, Jaico Publishing House.

Course Code: PT03EAPC01 Surface Science and Thin Film Technology

UNIT: 1
Surface and Interface: physico-chemical properties of surfaces, Thermodynamics of surfaces, Surface tension, contact angle, Wetting of solid surfaces, Experimental techniques for characterization of surface, forces between interface, Foams and antifoams, Application of surface modification using surface modifying agents.

UNIT: 2
Structure and properties of surface active surface active molecules, solution of surfactants-Micellization, Structure of micelles, Critical Micelle Concentration, Phase diagram of surfactant systems, Reverse Micelles, Microemulsion, Colloidal dispersion, Electrophoresis, Electro kinetic phenomena and zeta potential, Application of surfactant in detergency and enhanced oil recovery.

UNIT: 3
Physics and chemistry of evaporation, evaporation rate, vapour pressure of elements, evaporation of compounds, evaporation of alloys, Deposition technology, Thermal deposition in vacuum, kinetic theory of gases and emission condition, distribution of deposit, resistance heating, thermal evaporation, flash evaporation, multi evaporation sources, RF and Induction heating, electron beam method, sputtering-ion surface interactions, sputter yield, sputtering of alloys, cathodic sputtering, glow discharge sputtering, low pressure sputtering, reactive sputtering.

UNIT: 4
Hybrid and modified PVD processes: Ion plating, reactive evaporation processes, Ion beam assisted deposition processes, Ionized cluster beam deposition. Introduction to chemical vapour deposition and its reaction types: Pyrolysis, reduction, oxidation, compound formation, disproportionation, reversible transfer, Optical methods of measuring thin film thickness: FET, FECO, VAMFO, step gauges, ellipsometry, Mechanical methods for measuring thin film thickness: Stylus profilometry, weight measurement, Quartz crystal oscillators.

Basic Text & Reference Books:

1. Handbook of thin film technology by L.I. Maissel and R. Glang (McGraw-Hill).
2. The Materials Science of thin films by Milton Ohring (Academic press).
3. Thin film fundamentals by A. Goswami (New age international limited publishers)
4. Thin Film Phenomena by K. L. Chopra (McGraw-Hill).
5. Surface Science: An Introduction By K. Oura, V.G. Lifshitz, A. A. Saranin, A. V. Zotov and M. Katayama, Springer-Verlag, 2003.
6. Surfactants and Interfacial Phenomena, Milton, J. Rosen, Wiley Interscience Publication, New York.
7. Surface Chemistry of Surfactants and Polymers, Bengt Kronberg, Krister Homberg, Bjorn Lindman, Wiley, 1st Edition. _
8. Colloid and Interface Science, Pallab Ghosh, PHI Learning Private Limited. _
9. Physics and Chemistry of Interface, Hans-Jurgen Butt, Karlheunz Graf, MiCael Kappl, Wiley VCH, 2nd Edition.
10. Surfactant Science and Technology, Drew Myers, VCH Publishers, 2nd Edition. _

Course Code: PT03EAPC02 Solar Energy & Geothermal Energy

UNIT - 1
Introduction and application of solar energy, Essential subsystem in a solar energy plants. Solar energy routes and their prospects Terms and definitions, Units of solar power and solar energy, Merits and limitations of solar energy conversion and utilization, Phenomenon of light an energy, Energy from Sun. Solar constant, Power density for various wavelength of sunlight, Clarity index, solar insolation, Tilt angle of the fixed flat plate collector, solar calculations, Local apparent time.

UNIT - 2
Solar thermal collectors, Parabolic through collectors, Paraboloidal dish collectors, Fresnel lens point focus collector and heliostate with central receiver, Heat transfer fluid, Thermal energy storage. Solar distributed collector thermal power plants, Solar boiler/steam generator with large reflector and a central receiver, Solar pond, Solar thermo-electric converter, Introduction to Photovoltaic systems, Merits and limitations of solar PV system, Prospects of solar PV system. Principle of a photovoltaic cell, V-I characteristics of a solar cell, Interconnections of solar cells.

UNIT – 3
Efficiency of a solar cell and spectral response, Configuration of a solar PV panel, Small solar PV system for residence - typical ratings of small PV systems, Large solar PV systems – PV cell technology, Selective surfaces – basic requirements and basic principles – Types of selective surfaces. Applications of selective coatings to the flat plate collector.

UNIT - 4
Introduction to the Geothermal energy Applications, Geothermal energy resources, Origin of geothermal resources, Non-uniform geothermal gradients, hydrogeothermal resources, Geopressure geothermal resources, Hot dry geothermal resources, Geothermal fluids for electrical power plants, Principles of photoelectrochemical solar cell.

Basic Text & Reference Books:
1. Energy Technology (Non conventional, Renewable and conventional) By S. Rao and Dr. P. B. Perulkar
2. Solar Energy conversion, An introductory course By A. E. Dikon and J. D. Loslie
3. Photoelectrochemical Solar Cells By Suresh Chandra
4. Principles of Energy Conversion By Archie W. Cupl Jr.

Course Code: PT03CAPC04 EXPERIMENTAL METHODS-V

Sr.No.	Title of Experiment
1	Characteristics of the pressure transducer
2	Characteristic of Reverse Recovery time of diode
3	Counting statistics of Beta ray absorption coefficient
4	Inverse square law verification by Gamma ray detection using GM counter
5	Measurement of magnetic susceptibility of a liquid by quincke's method
6	Characteristics of the Linear Variable Differential Transducer (L.V.D.T)
7	Study of the Doppler Radar system/ Antenna system
8	Experimental demo on Spectrofluorophotometer

Course Code: PT03CAPC05 EXPERIMENTAL METHODS-VI

Sr. No.	Title of Experiment
1	Study of the strain gauge characteristics
2	Evaluation of Materials strength using Nondestructive techniques
3	Bandgap, extinction coefficient and unknown concentration determination of given samples by absorbance spectra
4	Study of Electron diffraction: ring pattern and spot pattern
5	To calculate the beam divergence and spot size of the given laser beam
6	Thermo gravimetric (TGA) and differential scanning calorimetric (DSC) analysis of Calcium oxalate sample.
7	Determination of Lattice parameter using XRD diffractogram
8	Experimental demo and measurement of Particle size using dynamic light scattering and surface charge using zeta potential

Course Code: PT03CAPC06 COMPREHENSIVE VIVA