

MSC PHYSICS
Regulation -2019

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks.

70 Marks

M.E. / M. Tech / M.Sc. REGULAR

REGULATIONS 2019

SALA4001	INTELLECTUAL PROPERTY LAW	L	T	P	Credit	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- This course is intended to introduce the different categories of Intellectual Property, the minimum standard to identify the items of protection.
- Bundle of rights conferred to the right holder and remedies available in the case of infringement are also examined.

UNIT 1 INTRODUCTION

8Hrs

Meaning and concept of intellectual Property and the need for protection - The world Intellectual property Organization (WIPO) Convention - Origin and functions of World Trade Organisation (WTO) - Trade Related Intellectual property Rights (TRIPS) Agreement of WTO and its effects on Intellectual Property law in India; Dispute Settlement Mechanism.

UNIT 2 COPYRIGHT ACT

12Hrs

The Copyright Act (1957) and recent amendments-works in which copyright subsist-Authorship And Ownership-Different Rights-Registration of copyright-Term of copyright-Administration of copyright law-Performer's rights-Broadcaster's rights-Collective administration of copyrights-Moral rights-Copyright infringements-Remedies-Composition of Copyright Board.

UNIT 3 TRADEMARK & DESIGNS ACT

12Hrs

The Trade Mark Act (1999), object, definitions, salient features- Distinctiveness, deceptive similarity- Assignment and transmission - Registration: Procedure-Term-Effects-Grounds for refusal- Powers and functions of Registrar- collective marks-certification marks-Trade mark agents - Appellate board - Infringement action, passing off action -Well known marks- The designs Act 2000; definitions, registration of designs, copyright in registered designs, piracy of registered designs, remedies, powers and duties of Controller - Semi conductor integrated circuit layout-Trade secrets.

UNIT 4 LAW OF PATENTS

12Hrs

The Patents Act (1970):object definitions, salient features-Invention: patentable and non- patentable inventions-product and process patents- -Rights of patentees-assignment and transmission-term of patent-Registration-opposition to grant of patent, anticipation-Revocation of patents- Compulsory licences- Exclusive marketing rights-Infringement- exclusive marketing rights- Patent office and power of Controller, patents of addition-Patenting of biotechnology-Nanotechnology.

UNIT 5 FARMERS AND BREEDERS RIGHT & GEOGRAPHICAL INDICATION

12Hrs

The Protection of Plant Varieties And Farmers' Rights Act, 2001: object definitions, salient features The Geographical Indications Of Goods (Registration And Protection) Act, 1999- object definitions, salient features

COURSE OUTCOME:

- CO1:** The course is designed to introduce fundamental aspects of Intellectual property Rights.
- CO2:** The course introduces all aspects of the IPR Acts.
- CO3:** The course is intended to explain the basic principles of patents, trademarks, geographical designs, industrial designs, and copyright.
- CO4:** The course follows an international perspective and examines the international IP legal regime rather than focusing solely or predominantly on the national framework.
- CO5:** This course revolves around the protection of plant varieties and farmers right act and This Course will equip the students with the required Professional Skills.

TEXT BOOKS

1. V.K. Ahuja, Law Relating to Intellectual Property Law, Lexis Nexis, 2nd ed., 2013.
2. N.S. Gopalakrishnan & T.G. Ajitha, Principles of Intellectual Property, Eastern Book Company, 2nd ed., 2014

REFERENCE BOOKS

1. B.L. Wadhera, Law Relating to Intellectual Property, Universal Law Publishing, 5th ed., 2014.
2. S. Narayan, Intellectual Property Law in India, Gogia Law Agency, Hyderabad, 3rd ed., 2005.
3. Holyoak & Torremans, Intellectual Property Law, Oxford University Press, New York, 2010.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100

Exam Duration : 3 Hrs.

PART A : 5 Questions of 6 marks each-No choice

30 Marks

PART B : 2 Questions from each unit with internal choice, each carrying 14 marks

70 Marks

M.E. / M. Tech / M.Sc. REGULAR

REGULATIONS 2019

SCCA9501	INDUSTRY 4.0	L	T	P	Credits	Total Marks
		2	-	2	2	100

UNIT 1 ADVANCED TECHNOLOGY AND MATERIALS**7 Hrs.**

Advanced electro-optical sensing technology-active, passive multi-spectral and hyper spectral imaging; electronic beam steering; vacuum technology, surface and coating technology, health care technology, Nanotechnology- Nanomechanics, Nano optoelectronics; energy storage technology-next generation Li-based Batteries, Hydrogen storage, solar photovoltaics, Flexible electronics. Intellectual Property Rights - case studies governing/pertaining to Materials/Technology.

UNIT 2 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT**7 Hrs.**

Introduction – Technological developments in Architectural, Engineering and Construction (AEC) - Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT) – Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – Concrete 3D printing - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond, Ecosan systems- Recent developments in Waste water Management, Air pollution control, waste disposal, public health issues-improving water management in surface and overhead irrigation- Integration of energy, water and environmental systems for a sustainable development

UNIT 3 SMART MANUFACTURING**8 Hrs.**

Smart factories and interconnection, Smart Manufacturing – automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self propelled vehicles, e mobility, Green fuels, drones – unmanned aerial vehicles(UAVs), aerodynamics. Robotic Automation and Collaborative Robots – Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies – Frugal Innovations –Intellectual Property Rights (IPR): Case Studies.

UNIT 4 SMART WORLD**8 Hrs.**

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, 5G Technology, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in transistor technology: Processor, Intellectual Property Rights- Case Studies.

UNIT 5 CYBER PHYSICAL SYSTEMS**8 Hrs.**

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR) : CaseStudies.

Course Outcomes:

Upon successful completion of this course, students should be able to:

CO1: Understand the advanced Materials/Technology

CO2: Acquire knowledge about environmental systems for a sustainable development

CO3: Covers many different technologies from Smart Manufacturing

CO4: Effectively learning the smart technology

CO5: Understand various modeling formalisms for CPS, such as hybrid automata, state-space methods, etc

TEXT / REFERENCE BOOKS

1. William D. Callister, "Materials Science and Engineering, An Introduction, John Wiley and Sons Inc. Singapore, 2001.
2. V. Raghavan, "Physical Metallurgy: Principle and Practice, Prentice Hall India Pvt Ltd, 2006.
3. FlavioCraveiro, Jose Pinto Duarte, Helena Bartolo and Paulo Jorge Bartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103, pp. 251-267, 2019.
3. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
4. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016
5. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016

END SEMESTER EXAMQUESTION PAPER PATTERN**Max. Marks: 100****PART A:** 5 Questions of 6 mark each - No choice.**Exam Duration: 3 Hrs.****30 Marks**

SPHA5103	MATERIALS SCIENCE	L	T	P	Credits	Total Marks
		3	0	0	3	100

PART A: 5 Questions of 6 mark each - No choice.

30 Marks

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks.

70 Marks

M.E. / M. Tech / M.Sc. REGULAR

REGULATIONS 2019

COURSE OBJECTIVE

- To acquire enveloping knowledge of physics, chemistry, metallurgy and mathematics to know wider field of materials science this is an interdisciplinary subject.
- Also to motivate the students to pursue research in the field of materials science.

UNIT 1 CHARACTERISATION OF MATERIALS

12 Hrs.

Introduction, **Structural characterization** - X-ray diffraction, Laue's method, Bragg's law, Determination of crystal structure by Bragg's Spectrometer and powder X-ray diffractometer (Debye Scherrer camera) with principle, construction and working. **Microstructural characterization** - electromagnetic lens system, Determination of surface morphology by Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM) with principle, construction, working. **Microhardness testing** - Determination of microhardness by Vickers hardness test and Knoop hardness test with principle construction, working, formula. **Nanohardness test** - Determination of nanohardness by AFM.

UNIT 2 METALS ALLOYS

12 Hrs.

Introduction, Classification of metal alloys-Ferrous and Non Ferrous Alloys, **Ferrous Alloys**- classification, composition, properties and applications; **Synthesization of alloy steels** - construction and working of Electric Furnace process (Heroult furnace); **Phase diagram**- definition and its significance; micro structure-definition, types of micro structures-ferrite, cementite, pearlite, austenite, martensite with diagrams; Iron-Carbon Alloy Phase diagram - graphical description and explanation with all the necessary parameters. **Non-Ferrous Alloys** - Aluminum, Copper, Titanium, Magnesium alloys - composition, properties and applications. **Shape Memory Alloys** - Shape memory effect- mechanism and transformation temperature types of SMA - one way and two way shape memory effect; characteristics of SMA- hysteresis, pseudo-elasticity, super elasticity; characterization of shape memory alloys - explanation with reference to Differential Scanning Calorimetry, resistivity, transformation temperature, tensile test; Advantages and disadvantages of SMA, General applications.

UNIT 3 CERAMICS, COMPOSITES AND POLYMERS

12 Hrs.

Ceramics: Structural features - Types of ceramics, Production techniques - Mechanical properties - Industrial ceramics like tungsten carbide, silica-alumina, zirconia, silicon carbide and sialons. **Composites:** Definition of composites - Continuous and Discontinuous fiber composites-Polymer and matrix-based composites - Examples of commercial composites. Structural features of polymer materials - Mechanisms of polymerisation and types of polymers- Thermoplastics - rubbers and elastomers - mechanical, physical and chemical properties - Cellular plastics - Liquid crystal polymers.

UNIT 4 ELECTRONIC MATERIALS

12 Hrs.

Introduction Purification of electronic materials - Crystal growth and doping techniques (an overview) - Epitaxial growth - Impurity diffusion - Ion implantation - Junction formation - Metallisation - Lithography (an overview) - Contact formation.

UNIT 5 NANO MATERIALS

12 Hrs.

Introduction, Top down and bottom up approach, synthesis and properties, Nanomagnetic-OMR, GMR, TMR, Nano semiconductors-quantum cascade laser, quantum dot-optical memory, Blockade device, quantum well.

Max. 60 Hours

Course Outcomes:

Having successfully completed this course, students will be able to

CO1: Characterize the materials by AFM, TEM, SEM, XRD etc.

CO2: Describe the nature and types of alloys and understand its applications

CO3: Develop the system by using ceramics, composites and polymers to the modern society

CO4: Understand the Crystal growth and Lithography techniques

CO5: Apply Nano materials in appropriate application.

TEXT / REFERENCE BOOKS

1. J.C. Anderson, K.D. Leaver, R. D. Rawlings and J.M. Alexander, Materials Science, 4th Edition, Chapman-Hall, London, 1990.
2. V. Raghavan, Materials Science and Engineering, 3rd Ed. Prentice-Hall India, New Delhi, 1993.
3. C. M. Srivastava and C. Srinivasan, Science of Engineering Materials, Wiley-Eastern Ltd., New Delhi, 1987.
4. G. K. Narula, K. S. Narula and V. K. Gupta, Materials Science, Tata McGraw-Hill, 1988.
5. Z. D. Jaberezki, The Nature and Properties of Engineering Materials, Wiley Eastern.
6. R. K. Gupta Editor, Physics of Particles, Nuclei and Materials - Recent Trends New Horizons of Physics Series, Narosa, New Delhi, 2002.
7. M.A. Wahab, Solid State Physics, Structure and properties of materials, second edition, Narosa publishing house, 2005

END SEMESTER EXAM QUESTION PAPER PATTERN

SPHA5301	CONDENSED MATTER PHYSICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

**M.E. / M. Tech / M.Sc. REGULAR
COURSE OBJECTIVE**

REGULATIONS 2019

- To provide depth of knowledge and to improve the understanding capability about crystal structure.
- It is intended to describe the bonding nature, optical and dielectric properties of solids.
- Also to motivate the students to pursue research in the field of condensed matter physics.

UNIT 1 CRYSTAL BINDING**12 Hrs.**

Force between atoms-cohesive energy-calculation of cohesive energy bonding in solids-ionic, covalent, metallic, and molecular –hydrogen bonded crystals-binding energy of ionic crystals-Madelung constant- Lattice Energy - Born Mayer potential –Thermo chemical Born-Haber cycle. Crystal Defects: Point, line, surface and volume defects.

UNIT 2 LATTICE DYNAMICS**12 Hrs.**

Direct and Reciprocal lattice.Vibration modes of mono and diatomic lattices- upper and lower branches, Born-von Karman cyclic condition, quantization of lattice vibration-phonon momentum.Lattice vibrations and specific heats for three dimensional lattices, Inelastic scattering of neutrons by phonons-neutron diffraction, Density of Phonon modes in 1D and 3D, Lattice heat capacity, Thermal resistivity, Normal and Umklapp process.

UNIT 3 BAND THEORY OF SOLIDS**12 Hrs.**

Origin of energy bands – periodic potential in 1D - Bloch's theorem, Kronig-Penney 1D model-Limitation - construction of Brillouin zones-extended, reduced and periodic zone schemes-effective mass of an electron-nearly free electron model, Distinction between conductors, semiconductors and insulators, E-k curve, Born cyclic condition and number of electrons per band

UNIT4 ATOMIC MOLECULAR STRUCTURE**12 Hrs.**

Central field approximation-Thomas Fermi model and its application-Hartree and HartreeFock equations hydrogen molecules-Heitler London model-LCAO –Hybridization.

UNIT 5 FERMİ SURFACE**12 Hrs.**

Fermi surface and Brillouin zones-Harrison's method of constructing Fermi surface in 2D electron, hole and open orbits-characteristics of Fermi surface-effects of electric field on the Fermi surface-effect of magnetic field on the Fermi surface-quantisation of electron orbits-experimental study of Fermi surface (dHVA method)

Max. 60 Hours**Course Outcomes:**

After the end of this course, the students will be able to;

CO1: Understand the basic physics behind the various crystal structure.

CO2: Understand the concept of phonons

CO3: Understand the basic concepts to classify the solids based on the electron transport properties.

CO4: Understand in depth concept of atomic structure

CO5: Understand the importance and Fermi surface and classify it.

TEXT /REFERENCEBOOKS

1. C.Kittel, Introduction to solid state Physics 7 thEdn, Wiley Eastern, 1996.
2. A.K.Chandra, Quantum Chemistry, Prentice Hall, 1990.
3. R.E.Hummel, Electronic properties of materials, 2nd Edn, A Narosa, 1993.
4. S.Raimes, The wave mechanics of electrons in metals, 3rd Ed, Amsterdam: North Holland Pub.co, 1967.
5. Michael P. Marder, Condensed Matter Physics, Wiley, 2010.
6. C.P.Smyth, Dielectric behavior and structure, McGraw Hill, New York, 1965
7. M.A.Wahab, Solid State Physics, Structure and properties of materials, second edition, Narosa publishing house,

END SEMESTER EXAMQUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 mark each - No choice.**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 marks.**70 Marks**

SPHA5305	INTRODUCTION TO RESEARCH METHODOLOGY IN MASTER PROGRAMME	L	T	P	Credits	Total Marks
		2	0	0	2	100

M.E. / M. Tech / M.Sc. REGULAR

REGULATIONS 2019

Course Objectives:

- To understand the research techniques involved in a successful research.
- To develop the required skills about data analysis and application of software's

UNIT 1 Introduction of Research Methodology:

Design, Process and Methodology - Concept of research and its applications: characteristics features, objectives, scope, reliability and validity of research, Scientific process: Steps involved in research process, a brief history of scientific process - defining problem, preparing research design analysis and interpretation of data, Basic Principles of Experimental Techniques. Importance and relevance of ethics and values in science and technology, Primary and secondary sources of literature survey. Advantage of working in a research group.

UNIT 2 Data Analysis, Statistical Modeling and Error Evaluation:

Introduction – Accuracy and Precision, Standard deviation, Relative standard deviation, Methods of reporting analytical data, Statistical evaluation of data-indeterminate errors. Correlation and regression, spectral analysis. Error analysis: Absolute and relative errors. Type of errors in experimental data. Determinate (systematic), indeterminate (random) and gross sources of error and their effects upon the analytical results. Statistical description of data - Mean, variance, skewness, median, mode – Distributions: Binomial, Poisson and Gaussian distributions – Student's t-test, F-test, Least-squares, Chi-square test – Linear and rank correlations.

UNIT 3 Presentation of Research Findings - Methods of presentation - Oral, Communication to conferences, journals in a prescribed template – graphical abstract – ORIGIN software – case studies, contents of power point presentation. Motive, aim, objective, methodology, novelty, originality, usefulness to the society, Paper Writing and preparation of Dissertation: Basic concepts of paper writing - Steps of paper writing, Precautions in preparing the research Dissertation – Concepts of bibliography and annexure, Discussion of results, drawing conclusions, Giving suggestion and recommendation of concerned persons.

UNIT 4 Quality of Research

Web of Science, Scopus, UGC, ICI Indexed Journals. Blind reviewed journals, Importance of peer reviewed journals, Plagiarism, Clarivate analytics, Indexing – i – index, h-index, citation index, Collaborative research work, Intellectual property rights – Patents – types-process-filing, publishing, registered patents, product, and commercialization. Improving the research career – INSPIRE Fellowships, CSIR NET Exam, GATE, JEST, etc – Funding opportunities – JRF, SRF in various government funded research agencies, Online courses – MOOC, NPTEL. Attributes of the research scholar – Keen observation, Passion for Knowledge, Spirit of enquiry, Insight etc, Possible approaches to be followed by research scholar.

UNIT 5 Introduction to Word processing package

Creating and Editing a word document, creating a research paper, creating a cover letter and a resume, Creating a document with a title page, table, chart and watermark, Creating a webpage using word, Mail Merge, creating a professional newsletter. MS-office – Excel, PPT, Word etc.

Course outcome: At the end of the course, the students will be able to

CO1: Understand the structure of the individual research topic

CO2: Enhance their analytical mind.

CO3: Bring out the hidden skills

CO4: Make them aware of updation in their research area.

CO5: Identify the future research problems and Improve their ability as a researcher in a new field.

END SEMESTER EXAMQUESTION PAPER PATTERN

Max. Marks: 100

PART A: 5 Questions of 6 mark each - No choice.

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks.

Exam Duration: 3 Hrs.

30 Marks

70 Marks

SPHA7403	ENERGY MATERIALS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT 1 Indian Energy Scenario: Role of energy in economic development and social transformation, Various types of energy sources: Energy sources and overall energy demand, Availability of energy sources. Non Renewable Energy sources: Coal, Oil, Natural gas, Nuclear power, Hydroelectricity, Renewable Energy sources: Solar, Wind, Biomass, Tidal, Ocean wave, Ocean thermal, Geothermal and other. Energy consumption and its impact on environmental climatic change. Future Energy Option: Sustainable development, Energy crisis, Transition from carbon free technologies, Parameters of transition, Carbon credits.

UNIT2 Solar Photovoltaics (SPV) Solar Photovoltaics (SPV) Conversion: Basic principles, Types of solar cell materials, Fabrication of solar photovoltaic cells, solar cell parameters and characteristics, Modules. Block diagram of general SPV conversion system and their characteristics, Different configurations, Application (such as street light, water pumps, Radio/TV, Small capacity power generation) Solar Photovoltaic (SPV) Systems Designing : Load estimation, selection of inverters, battery sizing, array sizing.

UNIT 3 Hydrogen Energy: Hydrogen Fuel : Importance of Hydrogen as a future fuel, Sources of Hydrogen, Fuel of vehicles. Hydrogen production : Production of Hydrogen by various methods, Direct electrolysis of water, Direct thermal decomposition of water, Biological and biochemical methods of hydrogen production. Hydrogen storage : Gaseous, Cryogenic and Metal hydride. Utilization of hydrogen : Fuel cell – Principle, construction and applications.

UNIT 4 Wind Energy : Wind Energy : Introduction, Basic principle of wind energy conversion, Extraction of maximum power from wind and its dependence on various parameters. Wind Mills : Types of wind mills, Vertical axis and Horizontal axis wind mills their performance, Merits and Demerits, Limitations of wind energy conversions.

UNIT 5 Bio Energy: Biomass, Generation and utilization, Property of biomass, Agriculture crop and Forestry residues used as fields. Physical, Chemical and biological conversion of biomass into useful form of energy. Gasification, Biomass gasifiers and types. Biogas : Introduction , Generation of biogas, Aerobic and anaerobic bioconversion process. Substances used to produce biogas (Cow dung, Human and other agricultural waste, Municipal waste etc.), Digesters and their designs, Pyrolysis and gasification, Fermentation process. Biofuels: Types of biofuels, Production processes, Biofuel applications.

COURSE OUTCOMES:

CO1: Understanding of Indian Energy Scenario. They know about the energy sources in India.

CO2: construct the solar photovoltaics cell

CO3: understanding about the production and applications of hydrogen energy

CO4: Design and implement systems of wind energy and wind mills.

CO5: Understand and utilization of Bio energy and bio fuel applications.

REFERENCE BOOKS:

1. Climatological and Solar data for India, Seshadri. (Sarita Prakashan), 1969.
2. Solar Energy Utilization, G.D. Rai, 9Khanna Publishers), 1995.
3. Energy technology, S. Rao and B.B. Parulekar (Khanna Publishers), 1995
4. Terrestrial Solar Photovoltaics, Tapan Bhattacharya, (Namsa: Publication House, New Delhi)
5. Solar Cells-operating Principles, technology and System Applications, Martin A. Green (Prentice Inc. USA).
6. Solar Thermal Engineering, J.A. Duffie (Academic Press)
7. Renewable Energy Sources and Conversion Technology, N.K. Bansal, M. Kleeman and S.N. Sreivas Tata Energy Research Institute, New Delhi), 1996.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks: 100

Exam Duration: 3 Hrs.

PART A: 5 Questions of 6 mark each - No choice.

30 Marks

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks.

70 Marks

M.E. / M. Tech / M.Sc. REGULAR

REGULATIONS 2019

SPHA7405	INTRODUCTION TO COMPUTATIONAL MATERIAL SCIENCE	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To provide depth of knowledge and to improve the understanding capability about crystal structure.
- It is intended to describe the bonding nature, optical and dielectric properties of solids.
- Also to motivate the students to pursue research in the field of condensed matter physics.

UNIT 1 CRYSTAL BINDING**12 Hrs.**

Force between atoms-cohesive energy-calculation of cohesive energy bonding in solids-ionic, covalent, metallic, and molecular –hydrogen bonded crystals-binding energy of ionic crystals-Madelung constant-Born Heber cycle.

UNIT 2 LATTICE DYNAMICS**12 Hrs.**

Reciprocal space: Brilliouin Zones-vibration modes of mono and diatomic lattices-quantization of lattice vibration-phonon momentum-scattering of neutrons by phonons-neutron diffraction.

UNIT 3 DIELECTRICS**12 Hrs.**

Different types of polarization-internal field and its calculation-Clausius-Mossotti equation-dielectric in a.c. field-dielectric loss-ferroelectric materials and their behaviour.

UNIT 4 OPTICAL PROPERTIES**12 Hrs.**

Index of refraction-damping constant –characteristic penetration depth-absorbance-reflectivity and transmissivity-point defect-color centers-luminescence-exciton-polaron-interband-intra band transitions-dispersion relation.

UNIT 5 ATOMIC MOLECULAR STRUCTURE**12 Hrs.**

Central field approximation-Thomas Fermi model and its application-Hartree and Hartree-Fock equations-hydrogen molecules-Heitler-London model-LCAO –Hybridization.

Max. 60 Hours**Course Outcomes:**

At the course end, the students will be able to

CO1: Understand the structural properties of the solid and to calculate the cohesive energy bonding in solid

CO2: Understand the crystal lattice and lattice vibration

CO3: Explain the dielectric properties of solids

CO4: Describe the luminescence of solid and other optical properties of solids

CO5: Learn about atomic molecular structure and especially, could explain the fine structure in the spectra of hydrogen

TEXT / REFERENCE BOOKS

1. C.Kittel, Introduction to solid state Physics 7th Edn, Wiley Eastern, 1996.
2. A.K.Chandra, Quantum Chemistry, Prentice Hall, 1990.
3. R.E.Hummel, Electronic properties of materials, 2nd Edn, A Narosa, 1993.
4. S.Raimes, The wave mechanics of electrons in metals, 3rd Ed, Amsterdam: North Holland Pub.co, 1967.
5. Michael P. Marder, Condensed Matter Physics, Wiley, 2010.
6. C.P.Smyth, Dielectric behavior and structure, McGraw Hill, New York, 1965

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 5 Questions of 6 marks each-No choice****30 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 14 marks****70 Marks**

M.E. / M. Tech / M.Sc. REGULAR

REGULATIONS 2019

SPHA7406	THIN FILM TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT 1 VACUUM TECHNOLOGY 12 Hrs.

Fundamentals of vacuum, basic definition and pressure regions of vacuum, kinetic theory of gases mean free path, types of flow, conductance, vacuum pumps and systems, rotary mechanical pump, roots pump, diffusion pump, turbo molecular pump, sputter ion pump, measurement of vacuum, concept of different gauges, capacitance gauges, Pirani gauge, ionization gauge and penning gauge, vacuum system components and operation.

UNIT 2 PHYSICAL METHODS OF THIN FILM DEPOSITION 12 Hrs.

Thermal evaporation, resistive heating, flash evaporation, laser evaporation, rf-heating, coevaporation, electron bombardment heating, sputtering plasma, discharges and arc, sputtering variants, sputtering yield low pressure sputtering, rf-sputtering, reactive sputtering, magnetron sputtering, magnetron configurations, bias sputtering, evaporation versus sputtering.

UNIT 3 CHEMICAL METHODS OF THIN FILM DEPOSITION 12 Hrs.

Electrodeposition, electrolytic deposition, electro less deposition, anodic oxidation, spray pyrolysis, spin and dip coating, chemical vapor deposition (CVD), homogenous and heterogeneous process, CVD reactions, pyrolysis, hydrogen reduction, halide disproportionation, transfer reactions, CVD processes and systems, low pressure CVD, laser enhanced CVD, metalorganic CVD (MOCVD).

UNIT 4 GROWTH OF THIN FILMS AND THICKNESS MEASUREMENTS 12 Hrs.

Introduction: nucleation and early stages of film growth, thermodynamic aspects of nucleation, capillary theory, thin film growth modes Volmert, Weber (VW) growth, Frank-van der Merwe (FM) growth, Stranski-Krastanov growth, thickness measurement, electrical methods, microbalance monitors, quartz crystal monitor, mechanical method (stylus), optical interference methods, ellipsometry, interference fringes.

UNIT 5 CHARACTERIZATION METHODS OF THIN FILMS 12 Hrs.

X-ray diffraction (XRD), scanning electron microscopy, transmission electron microscopy, energy dispersive analysis, Auger electron spectroscopy, X-ray photoelectron spectroscopy, Rutherford backscattering spectroscopy, secondary ion mass spectrometry.

Max. 60 Hours**Course Outcomes:**

At the course end, the students will be able to

CO1: Understand the Vacuum process and they can know how to create

CO2: Identify the physical synthesis of thin film methods

CO3: identify the chemical synthesis of thin film methods

CO4: analyse the Basic sciences behind the thin film growth and the thickness factor

CO5: Characterize the thin film in various methods.

TEXT /REFERENCE BOOKS:

1. Maissel and Glang, Hand Book of Thin Film Technology
2. K.L. Chopra, Thin Film Phenomena
3. Dupuy and Kachard, Physics of Non-Metallic Thin Films –
4. S. Dushman and J.M. Lafferty, Scientific Foundations of Vacuum Technology
5. M. Ohring, Materials Science of Thin Films: Deposition and Structure, 2nd Ed., Academic Press, 2002.
6. S. Campbell, The Science and Engineering of Microelectronic Fabrication, 2nd Ed., OUP, 1996. 3. Kaufmann, Characterization of Materials, 2nd Ed., Wiley, 2003.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks: 100****PART A:** 5 Questions of 6 mark each - No choice.**Exam Duration: 3 Hrs.****30 Marks**

SPHA7408	PHYSICS OF DIELECTRICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To acquire knowledge concerning the electrical behaviour of dielectric materials (polar and non polar).
- To Learn the different theories of static and complex permittivities
- To familiarize with the experimental investigation methods of dielectrics.
- To study applications of dielectric spectroscopy.

UNIT 1 INTRODUCTION TO PHYSICS OF DIELECTRICS**12 Hrs**

Permanent dipole moment. Induced dipole moment. Polarization and dielectric constant. Types of polarization, Electron polarization, Atomic polarization, Orientation polarization. Ionic polarization. Dipole moments and electrostatic problems. Polarizability. Polarization and energy. Internal field Langeven function. Non-polar dielectrics. Lorentz's field. Clausius-Massotti formula.

UNIT 2 THEORIES OF DIELECTRICS**12 Hrs**

Reaction field. Debye's Theories, Polar molecules in nonpolar solvent. Onsager's theory. The dielectric properties of polar non-associative liquids. Kirkwood-Frohlich's theory, the dipole-dipole interaction, the correlation factor of Kirkwood. The static dielectric permittivity of strong polar associative liquids. The modern theories of the static dielectric permittivity (Böttcher, Nienhuis and Deutch, Ramshaw, Wertheim etc).

UNIT3 THEORIES OF DIELECTRIC RELAXATION**12 Hrs**

The theory of linear response. The time dependent fields. The dielectric response function. The dielectric relaxation theory. Frequency and Time Domain. The complex dielectric permittivity. Dielectric losses and dispersion. The distribution functions of the relaxation times. Cole-Cole distribution. Cole-Davidson distribution. Havriliak-Nehamy and Johnsher distributions The dipole correlation function. The relationship between the complex dielectric permittivity and the dipole correlation function. Short-range and long range correlation functions. Fulton's Theory. The memory function. Kohlrausch-Williams-Watts (KWW) non-exponential behavior in complex systems.

UNIT 4 EXPERIMENTAL METHODS OF DIELECTRIC SPECTROSCOPY**12 Hrs**

Dielectric Spectroscopy. Classification of the experimental methods. Frequency methods: Bridges, Resonance methods, Coaxial lines, Waveguides, Transient methods, Strip lines, Slot lines, etc. Broad Band Dielectric Spectroscopy. A frequency response analyzer (10^{-5} Hz - 10^6 Hz), automatic radio - frequency bridge (10 Hz - 10^7 Hz) coaxial line reflectometer (10^6 Hz - 10^9 Hz) and coaxial vector network analyzer (10^7 Hz - 10^{11} Hz). Time Domain Dielectric Spectroscopy. The single reflection and transition methods. Multiple reflection, transition, lumped capacitance methods. Non uniform sampling. Fourier transform and the time domain treatment

UNIT 5 APPLICATIONS OF DIELECTRIC SPECTROSCOPY**12 Hrs**

Application of DS to Pure liquids and Solutions. Glass forming liquids. Dielectric relaxation of water. Dielectric relaxation of ice. The dielectric properties of heterogeneous substances. Emulsions and Micro emulsions. Polarization of Maxwell Wagner. Dielectrics with conductive paths. Percolation Phenomena. Dielectric properties of biological materials.

Course Outcomes:

At the course end, the students will be able to know

CO1: Different polarization mechanisms

CO2: Various theories of static and complex permittivities

CO3: Various theories on dielectric mechanisms

CO4: Experimental methods of dielectric spectroscopy

CO5: Applications of dielectric spectroscopy to pure liquids and solutions, emulsions and biological molecules

TEXT / REFERENCE BOOKS

1. Boetcher. C. J. F, Theory of Electric Polarization 2nd Edition, Elsevier Scientific Publication Company, 1973.
2. H. Fröhlich, Theory of Dielectrics, Oxford University/Clarendon Press, 1950 reprinted 1992.
3. Mansel Davies, Dielectric and Related Molecular Processes volume 3, Royal Society of Chemistry, 1972.
4. J.B. Hasted, Aqueous Dielectrics, Chapman and Hall, 1973.
5. N.E. Hill, Dielectric properties and Molecular Behaviour, Van Nostrand Reinhold; 1st edition, 1969.
6. C.H. L. Goodman, Physics of Dielectrics Solids, Institute of Physics, 1980.
7. S. Takashima, Electrical Properties of Biopolymers and Membranes 1st edition, CRC Press, 1989.
8. E.H. Grant, R.J. Sheppard and G.P. South, Dielectric Behaviour of Biological Molecules in Solutions, Oxford Univ. Press, 1978.
9. S. Bone and B. Zaba, Bioelectronics, John Wiley and Sons Ltd, 1992.
10. V. Raicu and Yu. Feldman, Dielectric Relaxation in Biological Systems: Physical Principles, Methods, and Applications, Oxford University Press, 2015.

END SEMESTER EXAMQUESTION PAPER PATTERN

Max. Marks: 100

PART A: 5 Questions of 6 mark each - No choice.

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks.

Exam Duration: 3 Hrs.

30 Marks

70 Marks

SPHA7411	RADIATION PHYSICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course Objectives:

- The aim and objective of the course on Radiation Physics is to expose the students of M.Sc. class to the relatively advanced topics Radiation Physics and nuclear reactions.
- They understand the details of the underlying aspects and can use the techniques if they decide to be radiation or nuclear physicists in their career.

UNIT 1 INTERACTION OF ELECTROMAGNETIC RADIATIONS WITH MATTER 12 Hrs.

Different photon interaction processes viz. photoelectric effect, Compton scattering and pair production. Minor interaction processes, Energy and Z dependence of partial photon interaction processes. Attenuation coefficients, Broad and narrow beam geometries. Multiple scattering.

UNIT 2 INTERACTION OF CHARGED PARTICLES WITH MATTER 12 Hrs.

Elastic and inelastic collisions with electrons and atomic nucleus. Energy loss of heavy charged particles. Range-energy relationships, Straggling. Radiative collisions of electrons with atomic nucleus.

UNIT 3 NUCLEAR DETECTORS AND SPECTROSCOPY 12 Hrs.

General characteristics of detectors, Gas filled detectors, Organic and inorganic scintillation detectors, Semi-conductor detectors [Si(Li), Ge(Li) HPGe]. Room temperature detectors, Gamma ray spectrometers. Gamma ray spectrometry with NaI(Tl) scintillation and semiconductor detectors.

UNIT 4 NUCLEAR SPECTROMETRY AND APPLICATIONS 12 Hrs.

Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g-factors and hyperfine fields.

UNIT 5 ANALYTICAL TECHNIQUES 12 Hrs.

Principle, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis (NAA) techniques. Theory, instrumentation and applications of electron spin resonance spectroscopy (ESR). Experimental techniques and applications of Mossbauer Effect, Rutherford backscattering. Applications of elemental analysis, Diagnostic nuclear medicine, Therapeutic nuclear medicine.

Max. 60 Hours

COURSE OUTCOMES:

- CO1: Understand various modes of interaction of electromagnetic radiations and charged particles with matter.
 CO2: Distinguish various types of radiations based on their interaction with matter.
 CO3: Learn and understand about different detectors and their use for spectroscopy.
 CO4: Use different analytical technique such as XRF, PIXE, neutron activation analysis and electron spin resonance spectroscopy.
 CO5: Understand various analysis techniques and way to apply the materials in suitable manner

TEXT/REFERENCE BOOKS:

1. The Atomic Nucleus: R.D. Evans, Tata McGraw Hill, New Delhi.
2. Nuclear Radiation Detectors: S. S. Kapoor and V. S. Ramamurthy, New Age, International, New Delhi.
3. Radiation Detection and Measurements: G. F. Knoll, Wiley & Sons, New Delhi.
4. Introductory Nuclear Physics: K. S. Krane, Wiley & Sons, New Delhi.
5. An Introduction to X-ray Spectrometry: Ron Jenkin, Wiley.
6. Techniques for Nuclear and Particle Physics Experiments: W. R. Leo, Narosa Publishing House, New Delhi.
7. Introduction to experimental Nuclear Physics: R.M. Singru, Wiley & Sons, New Delhi

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks: 100

PART A: 5 Questions of 6 mark each - No choice.

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks.

Exam Duration: 3 Hrs.

30 Marks

70 Marks