SAURASHTRA UNIVERSITY

RAJKOT

(ACCREDITED GRADE "A" BY NAAC)

FACULTY OF SCIENCE

Syllabus for

M.Sc. (APPLIED PHYSICS) INTEGRATED NANOSCIENCE & ADVANCED MATERIALS

Choice Based Credit System

With Effect From: 2016-17

Department of Nanoscience and Advanced Materials

Saurashtra University, Rajkot

Programme and Course Outcome

B.Sc. / M.Sc. (Applied Physics) programme started in June 2016 in Department of Nanoscience and Advanced Materials, Saurashtra University, Rajkot, is a unique FIVE years programme having dual degree (B. Sc. / M. Sc.) opportunity for the benefit of students.

Programme Outcome

PO 1

Train Manpower for industry:

This programme is designed to fulfil the requirement of manpower development needed for teaching Physics and Applied Physics at various levels of study and also for the creation of new trained manpower required for ceramic, composite and materials related industries of the Saurashtra and Gujarat state.

PO 2

Knowledge of Applied Physics, Nanoscience and Nanotechnology:

In addition, the programme will benefit the students of Saurashtra and Gujarat state, to undertake Applied Physics, Nanoscience and Nanotechnology as the way of life.

Programme Specific Outcome

PSO 1

Understand the fundamental aspects of Applied Physics

PSO 2

Understand the application of Nanoscience and Nanotechnology in day to day life by studying specialized subjects.

PSO 3

Understand the concept by performing fundamental and applied experiments.

PSO 4

Understand the way of research by applied physics projects.

Course Outcome

Under the B.Sc. / M.Sc. (Applied Physics) programme, the students have to undergo various courses during TEN semester duration.

CO 1

Applied Physics – I and II courses at semesters- I and II level are helpful for understanding the basic concepts in Physics for applications.

CO 2

Modern Physics – I and II courses at semesters- II and III are highly useful for students to gain knowledge about the latest development in Modern Physics of 20^{th} Century.

CO 3

Also, courses, such as, Plasma Physics and Electrodynamics and Applied Nuclear Physics at semesters III and IV are useful for the latest knowledge in the field of Nuclear energy generation and Fusion technology.

CO 4

Courses on Nanoscience and Nanotechnology, Material Science are useful for the students to know about the industrial and medical applications of various materials.

CO 5

At M.Sc. (Applied Physics) semesters VII and VIII level, students are exposed to Applied Materials and Application course and course on Mathematical Methods in Physics, which are very useful for shaping their career as good physics researcher.

CO 6

In addition, students undertake experimental projects at semester V and VI (i.e. B.Sc. III year) on various aspects of Applied Physics. This helps them in getting trained in practical understanding of the subject.

Course Structure - B.Sc. / M.Sc. Applied Physics

Subject Code	Title of the Course	Cource Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Markes	Duration of Semester End Exam in Hrs.
	Sem-I						
0030491001	Foundation Course (Communication skills)	3	3	30	70	100	2.5
0030491002	Fundamental of Mathematics	6	6	30	70	100	2.5
0030491004	Applied Physics- I	6	6	30	70	100	2.5
0030491006	Applied Physics- II	6	6	30	70	100	2.5
0030491003	Fundamental of Mathematics- Practical	3	3	15	35	50	3
0030491005	Applied Physics- I - Practical	3	3	15	35	50	3
0030491007	Applied Physics- II - Practical	3	3	15	35	50	3
	Sem-II						
0030492001	Environmental Studies	3	3	30	70	100	2.5
0030492002	Applied Mathematics	6	6	30	70	100	2.5
0030492004	Modern Physics- I	6	6	30	70	100	2.5
0030492006	Basic Electronics	6	6	30	70	100	2.5
0030492003	Applied Mathematics - Practical	3	3	15	35	50	3
0030492005	Modern Physics- I - Practical	3	3	15	35	50	3
0030492007	Basic Electronics - Practical	3	3	15	35	50	3

	Sem-III						
0030493001	Non-Conventional Energy Resources	3	3	30	70	100	2.5
0030493002	Applied Electronics	6	6	30	70	100	2.5
0030493004	Basic Nuclear Physics	6	6	30	70	100	2.5
0030493006	Modern Physics- II	6	6	30	70	100	2.5
0030493003	Applied Electronics - Practical	3	3	15	35	50	3
0030493005	Basic Nuclear Physics - Practical	3	3	15	35	50	3
0030493007	Modern Physics- II - Practical	3	3	15	35	50	3
	Sem-IV						
0030494001	Modern Computational Techniques and Programming	3	3	30	70	100	2.5
0030494002	Applied Nuclear Physics	6	6	30	70	100	2.5
0030494004	Fundamental of Material Science	6	6	30	70	100	2.5
0030494006	Electrodynamics and Plasma Physics	6	6	30	70	100	2.5
0030494003	Applied Nuclear Physics - Practical	3	3	15	35	50	3
0030494005	Fundamental of Material Science - Practical	3	3	15	35	50	3
0030494007	Electrodynamics and Plasma Physics - Practical	3	3	15	35	50	3
	Sem-V						
0030495001	Statistical Physics	3	3	30	70	100	2.5
0030495002	Advanced Electronics	6	6	30	70	100	2.5
0030495004	Applied Condensed Matter Physics	6	6	30	70	100	2.5
0030495006	Applied Physics Projects	6	6	30	70	100	2.5
0030495003	Statistical Physics - Practical	3	3	15	35	50	3
0030495005	Advanced Electronics - Practical	3	3	15	35	50	3
0030495007	Applied Condensed Matter Physics - Practical	3	3	15	35	50	3
	Sem-VI						
0030496001	Elements of Nanoscience and Nanotechnology	6	6	30	70	100	2.5
0030496003	Experimental Techniques in Physics	6	6	30	70	100	2.5
0030496005	Digital communication and Electronics	6	6	30	70	100	2.5

0030496007	Applied Physics Projects	3	3	30	70	100	2.5
0030496002	Elements of Nanoscience and Nanotechnology - Practical	3	3	15	35	50	3
0030496004	Experimental Techniques in Physics - Practical	3	3	15	35	50	3
0030496006	Digital communication and Electronics - Practical	3	3	15	35	50	3
	Sem-VII						
0030497001	Mathematical methods in Physics	4	4	30	70	100	2.5
0030497003	Applied Quantum Mechanics	4	4	30	70	100	2.5
0030497005	Semiconductor Devices and Applications	4	4	30	70	100	2.5
0030497007	AdvancedMaterials and Applications	4	4	30	70	100	2.5
0030497009	General Practicals of Applied Physics-I	4	4	-	100	100	2.5
00304970010	General Practicals of Applied Physics-II	4	4	-	100	100	2.5
	Sem-VIII						
0030498001	Vacuum Technology and Thin film	4	4	30	70	100	2.5
0030498002	Nano materials –I: Synthesis and Types	4	4	30	70	100	2.5
0030498003	Signal Processing and Communication	4	4	30	70	100	2.5
0030498004	Advanced Experimental Techniques for Materials Characterization	4	4	30	70	100	2.5
0030498005	General Practicals of Applied Physics-I	4	4	-	100	100	2.5
0030498006	General Practicals of Applied Physics-II	4	4	-	100	100	2.5
	Sem-IX						
0030499001	Nano Materials –II: Properties and Applications	4	4	30	70	100	2.5
0030499002	Numerical Techniques for computational Analysis	4	4	30	70	100	2.5
0030499003	One from Elective	4	4	30	70	100	2.5

	Groups A, B, C, D						
0030499004	One from Elective Groups A, B, C, D	4	4	30	70	100	2.5
0030499005	Advanced Practicals of Applied Physics -I	4	4	-	100	100	2.5
0030499006	Advanced Practicals of Applied Physics -II	4	4	-	100	100	2.5
	Sem-X						
00304910001	Nano structuring with Ion beams	4	4	30	70	100	2.5
00304910002	Nano Technology and Environment	4	4	30	70	100	2.5
00304910003	One from Elective Groups A, B, C, D	4	4	30	70	100	2.5
00304910004	One from Elective Groups A, B, C, D	4	4	30	70	100	2.5
00304910005	Experimental or Theoretical Projects related to Advanced Materials and Nano Materials (Project Work)	8	8	-	200	200	-

Semester – I

Paper Code: 0030491001

Paper I: Foundation Course (Communication Skills)

Course Outcome:

CO 1: Useful for basic communication skill in English language.

CO 2: To develop the writing and reading skill in English language.

Unit I: Communication

Definition and its Process, Channels of Communication, Barriers of Communication, 7 C's of Communication

Books: (1) Business Communication, (2) Business Correspondence and Report Writing

Author: (1) Asha Kaul, (2) R. C. Sharma and Krishna Mohan

Pub.: (1) PHI, (2) McGraw-Hill Education

Unit II: Listening Skills

Types of Listening, Barriers of Listening, Chapter – The Letter by Dhumketu, Chapter – The Nightingale and the Rose by Oscar Wilde
Books: (1) Business Communication, (2) Business Correspondence and Report Writing
Author: (1) Asha Kaul, (2) R. C. Sharma and Krishna Mohan
Pub.: (1) PHI, (2) McGraw-Hill Education

Unit III: Speaking Skills

Dialogue : Introduction, Dialogue : Meeting People, Exchanging Greetings and Taking Leave, Dialogue : Making Inquires at the Bank, Airport, Railway Station, Bus Station, Dialogue : Sharing Likes and Dislikes
Books: (1) Business Communication, (2) Business Correspondence and Report Writing
Author: (1) Asha Kaul, (2) R. C. Sharma and Krishna Mohan
Pub.: (1) PHI, (2) McGraw-Hill Education

Unit IV: Reading Skills and Grammer

Purpose and Process of Reading, Comprehension, Word Formation, Tense
Books: (1) Business Communication, (2) Business Correspondence and Report Writing
Author: (1) Asha Kaul, (2) R. C. Sharma and Krishna Mohan
Pub.: (1) PHI, (2) McGraw-Hill Education

Unit V: Writing Skills

Essay Writing, Letter Writing – Ordering of the Goods, Cancellation of the Goods, Inquiring about the Goods, Job Application – Covering Letter and Preparing Resume, Notice and Minutes
Books: (1) Business Communication, (2) Business Correspondence and Report Writing
Author: (1) Asha Kaul, (2) R. C. Sharma and Krishna Mohan
Pub.: (1) PHI, (2) McGraw-Hill Education

Semester – I

Paper Code: 0030491002

Paper II: Fundamental of Mathematics

Course Outcome:

CO 1: To develop a strong base in fundamental of mathematics and its use in applied physics.

CO 2: To understand the basic principles, theorems and calculations in mathematics.

Unit I: Determinants and Matrices

Introduction, Types of Matrices, Elementary row and column operations on a matrix, Matrix Operation (Addition, Subtraction and Multiplication with scalar), Multiplication of Matrices, Determinant of 3x3 Matrix, Rank of Matrix, Adjoint and Cofactor of Matrix, Inverse of Matrix, Solution of Simultaneous Equations(up to three variables)

Books: Elementary Engg. Mathematics
Author: B.S. Grewal
Pub.: Khanna Publishers

Unit II: Complex Number

Introduction, Conjugate of Complex number, Modulus, Polar Form, Properties, Square root of Complex Number, Cube Root of Unity, De Movre's Theorem.

Books: Elementary Engg. Mathematics
Author: B.S. Grewal
Pub.: Khanna Publishers

Unit III: Functions, Limits and Concept of Differentiation and Integration

Introduction to Limits and Function, Theorem on Limits, Continuity, Discontinuity, Types of Function.

Introduction to Differentiation, Standard Formulae, Working Rules, Chain Rule for Differentiation.

Introduction to Integration, Standard Formulae, Working Rules, Integration by substitution method, Integration by parts, Definite Integral and its Properties, Reduction Formula.

Books: Elementary Engg. Mathematics
Author: B.S. Grewal
Pub.: Khanna Publishers

Unit IV: Vector Analysis

Introduction to Scalar and Vector, Magnitude and Direction of vector, Properties, Addition and Subtraction of vectors, Dot product, Cross Product, Box product, Angle between two vectors, Triple Products, Gradient, Divergence, Curl.

Books: Elementary Engg. Mathematics
Author: B.S. Grewal
Pub.: Khanna Publishers

Semester – I

Paper Code: 0030491004

Paper III: Applied Physics – I

Course Outcome:

CO 1: To understand the fundamental in the mechanics, fluid dynamics and heat in applied physics.

CO 2: To gain the knowledge about various types of vibration in applied physics.

Unit I:

1. **Units & Dimensions:**
   Introduction, Rules for writing units, systems of units Definitions, practical units, fundamental of derived units, Dimensions of Physical Quantity, Conversion of Units, Limitations.
2. **Force & Motion:**
   Introduction, Unit of Force, Graphical representation, Various Laws of forces, Newton's Laws of Motion, Force of friction.
3. **Motion in two dimensions:**
   Circular motion & Projectile motion, Uniform circular motion, non-uniform circular motion, centrifugal forces, inertial and non-inertial frames, projectile motion, various cases of projectile motion.

Unit II:

1. **Elasticity:**
   Elastic behavior, some definitions, Young modulus, bulk modulus & modulus of rigidity, relation between elastic constants.
2. **Fluids:**
   Characteristics of fluids, thrust & Pressure, Pascal's principle, surface tension, capillarity, experimental determination of surface Tension, Viscosity, Stokes Law, Streamline and turbulent flow, Bernoulli's theorem.

Unit III:

1. **Temperature & its measurements**
   Temperature & Thermometry, scale of temperature, types of thermometer, other thermometers.
2. **Transfer of transmission of heat**
   Thermal conductivity, its application, convention, Radiation, provosts theorem, perfect black body, Kirchhoff's law, Stefan's law, Wien's displacement law, Newton's law of cooling.

Unit IV:

1. **Waves and Vibrations:**

Types of Waves, characteristics of waves, Simple Harmonic Motion (SHM), Equations of Simple Harmonic Motion, Free-Forced and resonant vibrations, Sound of Light waves.

Semester – I

Paper Code: 0030491006

Paper IV Applied Physics –II

Course Outcome:

CO 1: Useful in understanding basic and application of sound and wave mechanics.

CO 2: To gain the knowledge about DC electricity and electrostatic useful in day to day life.

Unit I:

1. **Sound Waves**

   Longitudinal Waves in fluid, Velocity of Sound Wave in medium (Solid, Liquid, &Gases), factors affecting velocity of sound waves, superposition of waves, stationary wave, interference, beats, vibration of string, laws of transverse vibrations of string, vibrations of air columns,Meld's Experiments.

2. **Acoustics**

   Architectural acoustics, Reverberation Derivation and Reverberation time, Absorption Coefficient, Acoustic designs & Acoustic materials.

3. **Ultrasonic's**

   Definitions, Production & Detection of Ultrasonic's, Application of Ultrasonic's.

Unit II:

1. **Electrostatic**

   Electrical Charge, Coulomb's law, Electric field, electric field due to point charge, electric lines of force, Electric Flux, Gauss's Law, Electric Potential, Electric Potential Energy.

Unit III:

1. **Direct Current Electricity**

   Electric Current, Electro Motive Force (e.m.f), ohms Law, resistance & resistivity, conductance and conductivity

   Types of resistance, color codes,classification of substances according to resistivity, Kirchhoff's Law, combination of resistances, potentiometer, Galvanometers, Ammeters & Voltmeters.

Unit IV:

1. **Electromagnetic Induction**

Magnetic Flux, Faradays laws of Electromagnetic Induction, motional EMF, Eddy Currents, types of electromagnetic inductions (Self & Mutual Induction).

Reference Books for Semester I & II:

1. Applied Physics (Theory &Practical's)byS.L. Kakani&ShubhraKakani, Pub:Viva Books, 2015, edu.
2. Concept of Physics by H. C.Verma, Bharti Bhavan Publication
3. Modern Physics by Kenneth Krane, Second Edition, Wiley India
4. Principles of Physics, International Student Version, by Halliday Resnick and Jearl Walker, Wiley India

Semester – II

Paper Code: 0030492001

Paper V: Environmental Studies

Course Outcome:

CO 1: To gain the basic knowledge about environment around us.

CO 2: To understand the effects of water, air and sound pollution on human life.

Unit-I:

Environmental Studies:Multidisciplinary Approach

Definition, Scope & Importance

Public Awareness about environmental studies

Unit II:

Renewable & Nonrenewable resources

Forest Resources, Water Resources, Mineral Resources, Food Resources, Energy Resources and Land Resources

Unit III:

Ecosystems: Concept, Structure and Functions of Ecosystems

Energy flow in ecosystems: Types of Ecosystems: Forest, Grassland, Deserts, Aquatic

Unit IV:

Environmental Pollution:Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution & Nuclear Hazards

Solid Waste Management

Disaster Management: Floods, Earthquakes, Cyclone and Landslides

Unit V:

Field Work

Visit to Local Areas to document environmental assets – river/ forest/ grasslands/ hill/ mountains

Visit to local polluted site – Urban/rural/industrial/agricultural

Study of Simple ecosystems → Pond, river, hill-slopes etc.

Book: Textbook for Environmental Studies (For Undergraduate Coursesof all Branches of Higher Education) by ErachBharucha, University Grants Commission (2004)

Semester – II
Paper Code: 0030492002

Paper VI: Applied Mathematics

Course Outcome:

CO 1: This course will be useful for using mathematics and its tools to understand the various applied physics aspects.

CO 2: This course will help the students to apply their knowledge of mathematics for problem solving in applied physics.

Unit I: Differential Equations and their Applications

Differential equations of first order and first degree, Variable separable form, Homogeneous differential equations, Bernoulli's and exact differential equations, examples of nonhomogeneous equations, Condition for exactness, Integrating factor, rules of finding integrating factors, Linear differential equations with constant coefficients, Differential equations of first order and first degree solvable for x, solvable for y, solvable for p. Clairaut's and Lagrange's forms. Newton's law of Cooling, Kirchhoff's law of electrical circuits, motion under gravity, simple harmonic motion.

Books: (1) Elementary Engg. Mathematics, (2) A Course of Mathematical Analysis
Author: (1) B.S. Grewal, (2) Shanti Narayan and P.K. Mittal
Pub.: (1) Khanna Publishers, (2) S. Chand

Unit II: Partial Derivatives

Partial derivatives, total differential, Euler's theorem for homogeneous functions, Maxima & Minima of functions of two variables, Lagrange's method of undetermined multipliers, Jacobians, Partial derivatives of implicit functions.

Books: (1) Elementary Engg. Mathematics, (2) A Course of Mathematical Analysis
Author: (1) B.S. Grewal, (2) Shanti Narayan and P.K. Mittal

Pub.: (1) Khanna Publishers, (2) S. Chand

Unit III: Partial Differential Equations

Formation of PDE, Equations solvable by direct integration, Lagrange's linear equation, Nonlinear equations of first order, Homogeneous linear equations with constant coefficients, Method of separation of variables, Vibrations of a stretched string-Wave equation, One dimensional heat flow.

Books: (1) Elementary Engg. Mathematics, (2) A Course of Mathematical Analysis
Author: (1) B.S. Grewal, (2) Shanti Narayan and P.K. Mittal
Pub.: (1) Khanna Publishers, (2) S. Chand

Unit IV: Differential Calculus & Integral Calculus

Rolle's Theorem, Lagrange's Mean Value theorem, their geometrical interpretation, Cauchy Mean Value Theorem, Taylor's theorem, Taylor's series and Maclaurine's series, Series expansion of exp(x), cos(x), sin(x), log(1+x), (1+x)n etc. Double integrals, evaluation of double integrals, Change of order of integration for two variables, Triple integrals, evaluation of triple integral, Jacobians and change of variables, Applications to areas and volumes.

Books: (1) Elementary Engg. Mathematics, (2) A Course of Mathematical Analysis
Author: (1) B.S. Grewal, (2) Shanti Narayan and P.K. Mittal
Pub.: (1) Khanna Publishers, (2) S. Chand

SEMESTER II:
Paper Code: 0030492004

PAPER VII MODERN PHYSICS I

Course Outcome:

CO 1: By learning this course student will get knowledge about fundamentals of atoms, its structure and energy levels.

CO 2: This course will be useful in understanding the use of atoms and molecules in various applications in modern physics.

Unit I: Rutherford's Atom Model, Bohr's Theory of H-atom, Spectral Series of H-atom, Drawbacks of Bohr's model, Somerfield's Atomic Model, Types of Spectra – emission and absorption spectra, Fluorescence and Phosphorescence, Frank-Hertz Experiment

Books: (1) Modern Physics (Second Edition), (2) Concepts of Modern Physics
Authors: (1) S.L. Kakani & Shubra Kakani, (2) Arthur Beiser
Pub.: (1) Viva Books, (2) Mc Graw Hill Education

UnitII: Inadequacy of Classical Mechanics,Experimental basis of Quantum Mechanics,Electromagnetic (EM) Waves,Blackbody Radiation,Planck's Radiation Formula,Photoelectric Effect,Quantum Theory of Light,X-ray production, Compton Effect

Books: (1) Modern Physics, (2) Concepts of Modern Physics
Authors: (1) G. Aruldhas &P. Rajagopal, (2) Arthur Beiser
Pub.: (1) PHI, (2) Mc Graw Hill Education

Unit III: Space Quantization, Spinning Electron, Angular momentum and Magnetic Momentum, Electron Spin & Spin Quantum number, Magnetic Quantum Number, Coupling Schemes, Selection Rules, Electronic configuration of Atom.

Books: (1) Modern Physics, (2) Concepts of Modern Physics
Authors: (1) G. Aruldhas &P. Rajagopal, (2) Arthur Beiser
Pub.: (1) PHI, (2) Mc Graw Hill Education (India) Pvt.Ltd

Unit IV: Stern- Gerlach Experiment, Davisson - Germer Experiment, Zeeman Effect (normal & anomalous Zeeman Effect), Paschen - Bach Effect, Stark Effect, G.P. Thompson's Experiment

Books: (1) Modern Physics, (2) Concepts of Modern Physics
Authors: (1) G. Aruldhas & P. Rajagopal, (2) Arthur Beiser
Pub.: (1) PHI, (2) Mc Graw Hill Education (India) Pvt. Ltd.

Semester – II

Paper Code: 0030492006

Paper VIII: Basic Electronics

Course Outcome:

CO 1: By learning this course, students will understand the basic principles of electronics.

CO 2: Students will use the basic electronic devices in applied circuits.

Unit 1 SEMICONDUCTOR PHYSICS

Introduction to Electronics, Semiconductor–Bonds in semiconductors–Crystals– Commonly used semiconductors –Energy band description of semiconductors–Effect of temperature on semiconductors–Hole current–Intrinsic semiconductor–Extrinsic semiconductor–n-type semiconductor–p-type semiconductor–Charge on ntype and p-type semiconductors– Majority and minority carriers–pn-junction–Properties of pn-junction–Applying D.C. voltage across–pn junction–Volt-ampere characteristics of pn-junction– Important terms–Limitations in the operating conditions of pn-junction.

UNIT 2 SEMICONDUCTOR DIODES AND APPLICATIONS

Semiconductor diode–Crystal diode as a rectifier– Resistance of crystal Diode–Equivalent circuit of crystal diode–Crystal diode equivalent circuits– lmportant terms–Crystal diode rectifiers–Half-wave rectifier–Output frequency of Half-wave rectifier– Efficiency of half-wave rectifier–Full-wave rectifier– Centre-tap full-wave rectifier–Full-wave bridge rectifier–Output frequency of full-wave rectifier–Efficiency of full-wave rectifier–Faults in centre-tap full-wave rectifier–Nature of rectifier output– Ripple factor–Comparison of rectifiers–Filter circuits–Types of filter circuits– Voltage multipliers–Half-wave voltage doubler–Voltage stabilisation–Zener diode–Equivalent circuit of zener diode–Zener diode as voltage stabiliser– Solving zener diode circuits–Crystal diodes versus vacuum-diodes.

UNIT 3 SPECIAL-PURPOSE DIODES AND TRANSISTORS

Zener diode–Light-emitting diode (LED)–LED voltage and current–Advantages of LED–Multicolor LEDs–Applications of LEDs–Photo-diode–Photo-diode operation– Characteristics of photo-diode–Applications of Photodiodes–Optoisolator–Tunnel diode–Tunnel diode oscillator–Varactor diode–Application of varactor diode– Shockley diode. Transistor–Naming the transistor terminals–Some facts about the transistor–Transistor action–Transistor symbols–Transistor as an amplifier–Transistor connections–Common base connection– Characteristics of common base connection– Common emitter connection–Measurement of leakage current–Characteristics of common emitter connection–Common collector connection–Comparison of transistor connections– Commonly used transistor connection–Transistor as an amplifier in CE arrangement–Transistor load line analysis–Operating point–Practical way of drawing –CE circuit–Output from transistor amplifier–Performance of transistor amplifier–Cut off and saturation points–Power rating of transistor– Determination of transistor configuration–Semiconductor devices numbering system–Transistor lead identification–Transistor testing–Applications of common base amplifiers–Transistors versus vacuum tubes

UNIT 4 TRANSISTORS BIASING AND AMPLIFIERS

Faithful amplification–Transistor biasing–inherent variations of transistor parameters–Stabilization–Essentials of a transistor biasing circuit–Stability factor–Methods of transistor biasing–Base resistor method–Emitter bias circuit–Circuit analysis of emitter bias–Biasing with collector feedback resistor Voltage divider bias method–Stability factor for potential divider bias–Design of transistor biasing circuits–Mid-point biasing–Which value of β to be used–Miscellaneous bias circuits –Silicon versus germanium–Instantaneous current and voltage waveforms—Summary of transistor bias circuits. Single stage transistor amplifiers and its applications, Multistage transistor amplifier and Audio amplifiers.

Text Book:

1. Principles of Electronics by V.K.Mehta &Rohit Mehta, S.Chand Publications

Reference Books:

1. Electronic Devices by Thomas L. Floyd, PHI Publications
2. Electronic Principles by Malvino A.P., McGraw-Hill Higher Education; 7th edition
3. Basic Electronics by Grob Bernard, McGraw-Hill Inc.,US; 8th Revised edition edition
4. Basic Electronics by Thareja B.L., S. Chand Publications
   Fundamentals of Microelectronics by BehzadRazavi

SEMESTER III

Paper Code: 0030493001

PAPER IX –Non- Conventional Energy Resources (Revised)

Course Outcome:

CO 1: At the end of this course students will be able to identify energy demand and relate with available energy resources.

CO 2: Students will understand the importance of energy resources and how to preserve them.

CO 3: Students will be able to understand use of solar energy, wind energy, bio-energy and geo- thermal energy.

Unit - 1

Human energy requirement, Energy use pattern in different parts of the world and its impact on the environment; Energy use pattern in India;

Wind Energy: Wind power, Harnessing of wind energy, Power generation – wind mills, wind characteristics, environmental considerations; Wind energy potential in India

Unit – 2

Solar Energy Sun as source of energy: Solar radiation – absorption, reflection, scattering and diffusion in the atmosphere, Harnessing of solar energy, Solar collectors and concentrators, Solar thermal energy, Solar electricity generation, Solar heaters, dryers and cookers; Photovoltaic

Unit – 3

Biomass Energy Biomass composition and types; Conversion processes – pyrolysis, charcoal production; Energy plantation; Biogas – production and uses, anaerobic digestion; Environmental constrains; Energy from solid wastes – Sources and types

Energy from water: Principles of generation of hydroelectric power, environmental impacts, Energy from oceans- OTEC, Tidal energy.

Unit – 4

Geothermal energy: Sources – Earth's Crust, high temperature aquifers,; Harnessing of geothermal energy and its problems; Geothermal energy prospect in India.

Nuclear energy: Fission and fusion energy, Nuclear fuels, Nuclear reactors and radioactive waste; Fuel cells, Future perspectives.

References:

1. Remote Sensing and GIS - M. Anji Reddy.
2. Environmental Remote Sensing - F. Mark Danson.
3. Principles of GIS for Land - Burrough P.A. Resources Assessment.
4. Renewable Energy Environment and Development, Maheswar Dayal Konark Publishers pvt. Ltd.
5. Renewable Energy Programmes in India : some recent developments , Sinha P.C., Natural Resource Forum, 18(3), 1994.
6. Renewable Energy Resources: Basic Principles and Applications Tiwari, G.N., Narosa Publishing House.
7. Conventional and Non-Conventional Energy Sources G. D Rai.
8. Andrew R.W., Jackson & Julie M. Jackson, "Environmental Science – The Natural Environment and Human Impact", Addison Wesley Longman Limited, 1996.
9. S.C. Santra, "Environmental Science", 2nd Edition, New Central Book Agency (P) Ltd, Kolkata, India, 2005.
10. Flowler, John M., "Energy and the Environment", 2nd Edition, McGraw Hill, New York, 1984.
11. Carless, Jennifer, "Renewable Energy: A Concise Guide to Green Alternative", Walker, New York, 1993.

SEMESTER III

Paper Code: 0030493002

PAPER X - APPLIED ELECTRONICS (Revised)

Course Outcome:

CO 1: By learning this paper, students will be benefited in starting their own start-up related to electronics and instrumentation.

CO 2: Students will be trained to design and fabricate useful domestic and industrial circuits for various applications.

Unit I: Field Effect Transistors

FET: Construction and characteristics of JFETs, transfer characteristics, Types of MOSFETs: Depletion type & Enhancement type, Introduction to VMOS and CMOS

FET biasing: Fixed biased configuration, self-bias, voltage divider bias,

Book: Electronic Devices and circuit theory - By: Robert L. Boylestad – Louis N

PHI publication.

Unit II: Application based devices

Two terminal devices:

Schottky barrier (hot carrier diodes), Varactor diodes, Power diodes, Tunnel diodes, Photodiodes, Photoconductive cells, IR emitters, LCD,Solar cells, Thermistors

Book: Electronic Devices and circuit theory -By: Robert L. Boylestad – Louis N..

Unit III:Special Purpose Devices :

Introduction, Uni Junction Transistor (UJT), Silicon Controlled Rectifier

(SCR), DIAC, TRIAC– Construction, working, Characteristics and applications

Book: Electronic Devices and circuit theory -By: Robert L. Boylestad – Louis N.

Unit IV :Digital Electronics

Digital systems and binary numbers, Boolean algebra and logic gates, gate level minimization, combinational logic, synchronous sequential logic, registers and counters

Book: Digital Design By M. Morrismano - PHI Publication

SEMESTER III

Paper Code: 0030493004

PAPER XI - BASIC NUCLEAR PHYSICS (Revised)

Course Outcome:

CO 1: This course will be useful for the students to understand basic aspects of nuclear physics.

CO 2: This course will help the student to gain knowledge about various properties of nucei such as, radio activity, nuclear reactions, etc, useful in getting jobs in nuclear establishments.

Unit I: Nucleus

Constituents of nuclei, Nuclear size, Binding Energy, Semi-empirical mass formula, Magic numbers, Nuclear shell model, Exercise

Books: Page Nos: 322-337

Modern Physics By G. Aruldhas, P. Rajagopal, PHI, New Delhi

Unit II: Radioactivity and Radio Active decay

Discovery of Radioactivity, Rate of decay, Half-life, Mean life, Conservation law in radioactive decay, Radioactive equilibrium, Radioactive dating, Alpha decay, Theory of alpha decay, Beta decay, Electron Emission, Positron Emission, Electron Capture, Theory of Beta decay, Gamma decay, Exercise

Books: Page Nos: 344-361

Modern Physics By G. Aruldhas& P. Rajagopal, PHI, New Delhi

Unit III: Nuclear Reactions

Kinds of Nuclear reactions, Conservation laws, Nuclear reaction kinematics, Q equation, Solution of Q equation, Introduction of Nuclear fission and fusion

Books: Page nos: 373-377, 524, 534

Nuclear Physics By D. C. Tayal, Himalaya publication House

Books: Page nos: 91-97

Nuclear Physics By S. B. Patel, New Age International Publishers

Unit IV: Nuclear Reactors

General aspects of a reactor design {Fuel, Moderators and reflectors, Reactor coolants, Control materials, Reactor shielding}, Classification of a reactor, Production reactors, Power reactors.

Books: Page nos: 564- 577

Nuclear Physics By D. C. Tayal, Himalaya publication House

Books: Page nos: 524-529

Modern Physics By R. Murugeshan, S. Chand Publications

SEMESTER III

Paper Code: 0030493006

PAPER XII - MODERN PHYSICS II (Revised)

Course Outcome:

CO 1: This course will help the students to understand various techniques in modern physics.

CO 2: It will be useful for students to know about particle accelerators and their use in advanced research in materials science and nuclear physics.

Unit I: Basics of Quantum Mechanics: De Broglie Waves, Phase and Group velocity, Uncertainty Principle, Basic Postulates of Wave mechanics, Time Dependent and Time Independent Schrödinger's equations, Properties of Wave Function, Applications of Wave equation - particle in a box (infinite square well potential),potential step, Harmonic oscillator.

Books: Page Nos 169-199 : Modern Physics (Revised Edition)
By R.Murugeshan & Er.Kiruthiga Sivaprashath, S.Chand

Page Nos 101-127 : Concepts of Modern Physics
By Arthur Beiser, Shobit Mahajan & S.Rai Choudhuri
Mc Graw Hill Education (India) Pvt.Ltd pub.

Page Nos 58-73 : Modern Physics By G.Aruldhas & P.Rajagopal Phi Pub.

Unit II: Statistical Mechanics: Introduction, microscopic and macroscopic systems, Phase space, Maxwell – Boltzmann Distribution Law, Law of Equitation of Energy, Quantum Statistics, Bose Einstein Statistics, Fermi Dirac Statistics, distribution functions

Books: Page Nos 146-159 : Modern Physics By G.Aruldhas & P.Rajagopal
PHI Learning Pvt.Ltd, Eastern Economy Edition

Page Nos 339-352 : Concepts of Modern Physics
By Arthur Beiser, Shobit Mahajan & S.Rai Choudhuri
Mc Graw Hill Education (India) Pvt. Ltd publication

Unit III:LASER : Introduction, Absorption and Emission, Radiative and non radiative transitions, population inversion, pumping methods, Einstein's coefficient, Types of LASERs, Characteristics of LASER, Applications of LASER

Books: Page Nos 280-303 : Modern Physics By G.Aruldhas&P.Rajagopal PHI pub.

Page Nos 303-308 : Modern Physics (Revised Edition) By R.Murugeshan & Er.Kiruthiga Sivaprashath, S.Chand Pub.

Unit IV: Fundamental Forces/ Interactions in nature, Mesons, Mediators of Interactions, Particles and Antiparticles, Classification of Elementary Particles, Conservation Laws

Books: Page Nos 394-405 : Modern Physics
By G.Aruldhas & P.Rajagopal, PHI Learning Pvt. Ltd,

Page Nos 540-547 : Modern Physics (Revised Edition)
By R.Murugeshan & Er.Kiruthiga Sivaprashath, S.Chand

SEMESTER IV

Paper Code: 0030494001

PAPER XIII - MODERN COMPUTATIONAL TECHNIQUES AND PROGRAMMING (Revised)

Course Outcome:

CO 1: By learning this course, the students will be able to develop basic programs useful in physics applications.

CO 2: This course will help the student to gain knowledge about various programming languages and skill development in computers.

Unit I : Introduction to numerical computing and Computing Concepts : Numeric data, Analog computing, digital computing, process of numerical computing, characteristics of numerical computing, computational environment, new trends in numerical computing, mathematical background, Introduction to computers and computing concepts: Evolution of numerical computing and computers, types of computers, computing concepts, Computer organization, Software and programming languages, interactive computing, algorithms, flow charts, structuring the logic.

Page Nos 1- 39

Unit II :Computer Codes and Arithmetic : Introduction, Decimal system, Binary system, Hexadecimal system , Octal system, Conversion of Numbers, Representation of Numbers, Computer Arithmetic, Errors in Arithmetic, Laws of Arithmetic.

Page Nos 40-60

Unit III :Roots of non-linear Equations I - Introduction, methods of solution, iterative methods , starting and stopping an Iterative process, evaluation of polynomials, bisection method, false position method, Newton-Raphson method.

Page Nos 121-151

Unit IV :Roots of non-linear Equations II - Secant method, fixed point method, determining all possible roots, systems of nonlinear equations, roots of polynomials, multiple roots by Newton's method, complex roots by Bairstow method, Muller's method

Page Nos 151-205

Text Book : Numerical methods By E. Balagurusamy (TMH pub)

SEMESTER IV

Paper Code: 0030494002

PAPER XIV APPLIED NUCLEAR PHYSICS (Revised)

Course Outcome:

CO 1: By studying this course, the students will understand about various nuclear reactors and their applications.

CO 2: This course will help the student to understand the concept of fusion and fission of nuclei and its use in nuclear energy production.

Unit I: ParticleDetectors and Particle accelerators

Ionization chamber, Geiger Counter, Scintillation counter, Semiconductor junction detector, Cloud Chamber, Bubble chamber, other detectors, Van-de-graph generator, Cyclotron, Synchrocyclotron, Synchrotron, linear Accelerator

Books: Page Nos: 382-393
Modern Physics By G. Aruldhas, P. Rajagopal, PHI, New Delhi
Books: Page Nos: 415-445
Modern Physics By Murugeshan, S. Chand Publications

Unit II: Elementary Particles

Leptons, Hadrons, Quarks, Color, Flavor, Field Bosons, The Standard Model, Conservation laws

Books: Page Nos : 531, 535, 541, 545, 546, 548, 550
Concepts of Modern Physics By A. Beiser, S. Mahajan, S. R. Chaudhary
McGraw Hill Publications
Books: Page Nos : 1415-1422
Modern Physics By S.L. Kakani and SubhraKakani, Viva Books Pvt. Ltd.

Unit III: Applications of Nuclear Energy

Mossbauer Spectroscopy, Positron Emission Tomography, Magnetic Resonance Imaging(MRI), Gamma Knife, Environmental Impact

Books: Page Nos : 416-422, 425-427
Basics of Nuclear Physics By Hari Agrawal, PHI Pvt. Ltd.
Page Nos : 788-808 Introduction to Nuclear Physics By Kenneth S.Krane Wiley Pub.

Unit IV:Cosmology

The Big Bang, Dark Matter and Dark energy, Elementary Particles and their applications, Van Allen belt, Evolution of Stars, Cosmic rays

Books: Page Nos: 563-573

Concepts of Modern Physics By A. Beiser, S. Mahajan, S. R. Chaudhary

McGraw Hill Publications

Books: Page Nos: 420-424

Modern Physics By G. Aruldhas, P. Rajagopal, PHI, New Delhi

SEMESTER IV

Paper Code: 0030494004

PAPER XV FUNDAMENTALS OF MATERIALS SCIENCE (Revised)

Course Outcome:

CO 1: This course will be useful for the students to understand various processes involved in ceramic industries and metal alloys related manufacturing unit.

CO 2: Students will get knowledge about the phase formation in various materials and its applications in industries.

Unit I: Introduction to Materials World, Classification of Materials, Advanced Materials, Levels of Structure, Atomic Structure and Chemical Bonding, Equilibrium & Kinetics: Stability and Metastability, Basic Thermodynamic Functions

Books: Page Nos 01-14 & 53-76 : Materials Science & Engineering: A First Course (Vth Edition)

By V. Raghavan (Eastern Economy Edition, PHI Publication)

Page Nos 01-33 : Callister's Materials Science & Engineering

By Balasubramanian (Wiley India Publication)

Unit II: Phase Diagrams: Solubility Limit, Phases, Phase Equilibria, Phase Rule, Single Component Systems, Binary Phase Diagrams, Interpretation of Phase Diagrams, Microstructural Changes in Isomorphopus Alloys , Lever Rule, Binary Eutectic System

Books: Page Nos 148-163 : Materials Science & Engineering : A First Course (Vth Edition)

By V. Raghavan (Eastern Economy Edition, PHI Publication)

Page Nos 170-193 : Callister's Materials Science & Engineering

By R. Balasubramanian (Wiley India Publication)

Unit III: Phase Transformations in Solids - Basic Concepts, Time Scale for Phase Changes, Nucleation and Growth, Homogeneous & Heterogeneous Nucleation, Transformation in Steel, Precipitation Process, Solidification & Crystallization, The Glass transition, Recovery, Recrystallization & Grain Growth.

Books: Page Nos 201-232 : Materials Science & Engineering : A First Course (V^{th} Edition)

By V. Raghavan (Eastern Economy Edition, PHI Publication)

Page Nos 229-240 : Callister's Materials Science & Engineering

366-378 By R. Balasubramanian (Wiley India Publication)

Unit IV: Ceramic Materials: Types, Properties and Applications of Ceramics, Clay Products, Refractories, Abrasives, Cements, Advanced Ceramics, Glass Ceramics: Types, Properties & Applications, Heat Treatment of Glasses & Glass Ceramics

Books: Page Nos 431-460 : Callister's Materials Science & Engineering

By R. Balasubramanian (Wiley India Publication)

SEMESTER IV

Paper Code: 0030494006

PAPER XVI ELECTRODYNAMICS & PLASMA PHYSICS (Revised)

Course Outcome:

CO 1: This course is designed for the students to understand the basics of electrodynamics and its applications in various topics in physics.

CO 2: By learning the fundamentals and applications of plasma, the students will be trained to appear for jobs, training programs in Institute for Plasma Research, Gandhinagar.

Unit I: Coulomb's law and field intensity, Field due to continuous charge distributions, electric flux density, Gauss's Law- Maxwell's Equation, Electrical Potential, Relationship between E and V – Maxwell's Equation, Concepts of An electric dipole and energy density in electrostatic fields Convention and Conduction currents, conductors, polarization in dielectrics, dielectric constant and strength, continuity equation, Boundary Conditions Poisson's and Laplace's equations

Book Page nos. 104-146 : Elements of Electromagnetics by Matthew N. O. Sadiku
Page nos. 162-182: Oxford University Press

Unit II: Biot Savart's law, Ampere's circuit law, Magnetic Flux density, Maxwell's equations for static EM fields ,Concept of Magnetization in materials, magnetic boundary conditions, Magnetic Energy,Maxwell's Equations: Faraday's law, Transformer and Motional EMF's, Displacement current, Maxwell's Equation in Final Forms , Power and the pointing vector, Concept of Reflection of a plane wave at Normal and oblique incidence

Book Page nos. 263-283 : Elements of Electromagnetics by Matthew N. O. Sadiku
Page nos. 323,330,339 Oxford University Press
Page nos. 369-384,435-451

Unit I & II REFRENCE BOOKS :

1.Introduction to Electrodynamics by David J. Griffiths, PHI publication
2.Engineering Electromagnetics by William H. Hyat, TMH Publication
3.Electromagnetics with applications by Kraus/Flesich, McGraw Hill publication

Unit III: Definition of PLASMA, Occurrence of PLASMA, concept of Temperature, Production of PLASMA, Debye Shielding, PLASMA parameters, Criteria for PLASMA, Properties of PLASMA, Applications of PLASMA

Books: Page Nos 1-17 : Introduction to Plasma Physics & Controlled Thermonuclear Fusion By F.F.Chen Plenum Press (N.Y.)
Page Nos 26-40 : Textbook of Plasma Physic By Suresh Chandra CBS Publishers
Page Nos 474-493 : Fundamentals of Solid State Physics BY Saxena, Gupta, Saxena Pragati Publication, Meerut

Unit IV: Charge Particle Motion under - uniform B, nonuniform B, Curved B, grad B // B (magnetic mirror effect), Plasma as Fluid, Plasma waves/Oscillations in Plasma (Concept & Physical interpretation)

Books: Page Nos 19-38 : Introduction to Plasma Physics & Controlled Thermonuclear Fusion By F.F.Chen Plenum Press (N.Y.)
Page Nos 60-84 : Textbook of Plasma Physics, By Suresh Chandra CBS Publishers

SEMESTER V

Paper Code: 0030495001

PAPER XVII– Statistical Physics

Course Outcome:

CO 1: This course will be useful for the students to understand basic aspects of statistical physics and its use in basic physics.

CO 2: This course will help the student to gain knowledge about various mechanisms related to sub-atomic particles and its use in advanced physics courses.

Unit I: Classical Statistical Mechanics - I

Ensembles: Micro canonical, canonical, Grand canonical Ensembles, Uses of Ensembles, Statistical Equilibrium, Thermal Equilibrium, Mechanical Equilibrium, Particle Equilibrium, Microstates and Macro states, Sterling's theorem

Page Nos. : 83-86, 96-99, 103-105
Book: Statistical Mechanics
Author: S. L. Gupta and V. Kumar
Pub: Pragati Prakashan

Unit II: Classical Statistical Mechanics - II

Thermodynamic Probability, General Statistical distribution law, Most Probable distribution, Division of Phase space into cells, Principle of Equipartition of Energy, Connection between partition function and thermodynamic quantities

Page Nos. : 105-109, 119-121, 123-124
Book: Statistical Mechanics
Author: S. L. Gupta and V. Kumar
Pub: Pragati Prakashan

Unit III: Quantum Statistical Mechanics - I

Ideal Bose Systems: Photon gas, Einstein's derivation of Planck's law, Bose Einstein Condensation, Specific heat from lattice vibrations, Debye's model of Solids: Phonon gas

Page Nos. : 146-162
Book: Fundamentals of Statistical Mechanics
Author: B. B. Laud
Pub: New Age international Publishers

Unit IV: Quantum Statistical Mechanics - II

Ideal Fermi Systems: Fermi energy, An alternate derivation of Fermi energy, Fermi gas in Metals, Atomic nucleus as an Ideal Fermi gas, White Dwarfs and Chandrasekhar Mass limit

Page Nos. : 167-171
Book: Fundamentals of Statistical Mechanics
Author: B. B. Laud
Pub: New Age international Publishers

SEMESTER V

Paper Code: 0030495002

PAPER - XVIII - ADVANCED ELECTRONICS

Course Outcome:

CO 1: By learning this course, students will be able to develop electronic kits of higher level useful in industrial application.

CO 2: This course will help the student to gain knowledge about various integrated circuits and different amplifiers in the day-to-day applications.

Unit I: Operational Amplifiers

Introduction, Differential Amplifier Circuits, BiFET, BiMOS and CMOS Differential Amplification Circuits, Op- Amp Basics, Practical Op-Amp Circuits, Op-Amp Specifications—DC Offset Parameters, Op-Amp Specifications—Frequency Parameters, Op-Amp Unit Specifications, Differential and Common-Mode Operation

Books: Pg No. 621-658 Electronic Devices and circuit theory (11th Edition)

By: Robert L. Boylestad – Louis N.

Unit II: Op-Amp Applications

Constant-Gain Multiplier, Voltage Summing, Voltage Buffer, Controller Sources, Instrumentation Circuits, Active Filters

Books: Pg No. 669-687 Electronic Devices and circuit theory (11th Edition)

By: Robert L. Boylestad – Louis N.

Unit III: Power Amplifiers

Introduction—Definitions and Amplifier Types, Series-Fed Class A Amplifier, Transformer-Coupled Class A Amplifier, Class B Amplifier Operation, Class B Amplifier Circuits, Amplifier Distortion, Power Transistor Heat Sinking, Class C and Class D Amplifiers

Books: Pg No. 700-732 Electronic Devices and circuit theory (11th Edition)

By: Robert L. Boylestad – Louis N.

Unit IV: Linear-Digital ICs

Introduction, Comparator Unit Operation, Digital-Analog Converters, 555 Timer IC, Voltage-Controlled Oscillator IC 566, Phase-Locked Loop (PLL) IC 565

Books: Pg No. 741-764 Electronic Devices and circuit theory (11th Edition)

By: Robert L. Boylestad – Louis N.

SEMESTER V

Paper Code: 0030495004

PAPER XIX– Applied Condensed Matter Physics

Course Outcome:

CO 1: By learning this course, students will get basic and applied knowledge about structural and electrical properties of solid crystalline materials.

CO 2: Basic and applied concepts in condensed matter physics will be clear to the students.

Unit 1: Crystal Structure and its Determination

Basic definitions, Symmetry elements, Types of diffractions, Experimental methods of XRD, Some common crystal structures
Page Nos.: (1)1-15, 71-85, (2) 1-28
Books: (1) Applied Solid State Physics, (2) Solid State Physics
Author: (1) Rajnikant, (2) Srivastava
Pub.: (1) Wiley, (2) PHI

Unit II: Defects in Solids
Types of defects**,** Vacancy defects, Schottky and Frankel defects, Color centers, Line defects and Plane defects
Page Nos.: (1)233-245, (2) 354- 360
Books: (1) Applied Solid State Physics, (2) Solid State Physics
Author: (1) Rajnikant, (2) Srivastava
Pub.: (1) Wiley, (2) PHI

Unit 3: Band Theory of Solids
Concept of energy band, Bloch Theorem, Kronning Penny model, Origin of energy gap, Concept of effective mass, Metals, Insulators and Semiconductors, Experimental techniques for Band Structure study.
Page Nos.: (1)373-395, (2) 183-197
Books: (1) Applied Solid State Physics, (2) Solid State Physics
Author: (1) Rajnikant, (2) Srivastava
Pub.: (1) Wiley, (2) PHI

Unit 4: Superconductivity and Magnetism

Superconductivity: Definition, Discovery, Properties of Superconductors, Types of Superconductors, Meissener effect, BCS theory of Superconductors (Qualitative approach)

Magnetism: Basic definitions, Classification of magnetic materials, Diamagnetism, Para magnetism in rare earth and iron group ions, Ferromagnetism and its applications, Antiferromagnetism and Ferrimagnetism

Page Nos.: (1)495-506, 399-417 (2) 468-491, 387-450

Books: (1) Applied Solid State Physics, (2) Solid State Physics

Author: (1) Rajnikant, (2) Srivastava

Pub.: (1) Wiley, (2) PHI

Suggested Readings: (1) Solid State Physics by Wahab and (2) Selected Topics in Solid state physics by D.G. Kuberkar.

SEMESTER V

Paper Code: 0030495006

PAPER XIX– Applied Physics Projects

Course Outcome:

CO 1: By undertaking one project related to applied physics, the student will perform practical related to new developments in the topic of their choice.

CO 2: This course will develop confidence in students to carry out independent project under the assigned guide in the field of applied physics.

Every student will have to complete one experimental or theoretical Applied Physics Projects under the guidance of faculties of the department. The project work may be completed either using the departmental facilities or facilities of any Industry / Other University / National Institutes. There will be a presentation of the project work to be completed at the end of semester. Project may be allotted individually or in group.

SEMESTER VI

Paper Code: 0030496001

PAPER XXI- Elements of Nanoscience and Nanotechnology

Course Outcome:

CO 1: This course will be give knowledge to the students related to basic aspects of nanoscinece, nanomaterials and their applications.

CO 2: This course will help the student to understand various techniques of growing nanomaterials and to study their properties.

Unit I: Introduction to Nanoscience and Nanotechnology

Basic definitions, Historical Developments, Classification of Nanomaterials, Special Nanomaterials

Page Nos.: (1)01-25, (2)03-12

Books: (1) Nanotechnology The Science of Small, (2) Nano: The Essentials

Author: (1) M.A. Shah and K.A. Shah, (2) T. Pradeep

Pub.: (1) Wiley, (2) McGraw-Hill Education

Unit II: Synthesis of Nanomaterials

Top Down Processes (Physical Methods) - Ball milling, Lithography, Arc Discharge, LASER ablation, Bottom Up Processes (Chemical Methods) - Homogenous Nucleation, Chemical Vapor Deposition(CVD), Molecular Beam Epitaxy (MBE), Sol-Gel, Hydrothermal growth, Microwave method.

Page Nos.: 61-83

Books: Nanotechnology The Science of Small

Author: M.A. Shah and K.A. Shah

Pub.: Wiley

Unit III: Characterization of Nanomaterials

X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Photoluminescence (PL) Spectroscopy, Raman Spectroscopy, Photoelectron Spectroscopy (PES).

Page Nos.: (1)84-117, (2)15-81

Books: (1) Nanotechnology The Science of Small, (2) Nano: The Essentials

Author: (1) M.A. Shah and K.A. Shah, (2) T. Pradeep

Pub.: (1) Wiley, (2) McGraw-Hill Education

Unit IV: Applications of Nanoscience & Nanotechnology

Electronic Applications, Optical Applications (nanophotonics), Energy Applications, Computing Applications, Nanomedicines, Agriculture & Food applications, Nanotechnology and Environment.

Page Nos.: (1)118-139, (2) 263-315

Books: (1) Nanotechnology The Science of Small, (2) Nano: The Essentials

Author: (1) M.A. Shah and K.A. Shah, (2) T. Pradeep

Pub.: (1) Wiley, (2) McGraw-Hill Education

SEMESTER VI

Paper Code: 0030496003

PAPER XXII- Experimental Techniques in Physics

Course Outcome:

CO 1: By learning this course, the students will be able to understand fundamental of optical and spectroscopic techniques for material characterizations.

CO 2: This course will help the student to gain knowledge about basic principles about the interferrometry, polarometry, atomic and molecular spectroscopy.

OPTICS

Unit I: Interferometry

Michelson's interferometer and its applications, Multiple beam interferometer, Fabry Perot Interferometer and Etalon, Lummer Gehrcke Plate.

Books: Optics and Spectroscopy
Author: R. Murugeshan and Kiruthiga Sivaprashatha
Pub: S. Chand

Unit II: Polarimetry

Polarization by Double refraction, Nicol's Prism, Anisotropic Crystals, Calcite Crystal, Huygen's explanation of Double Refraction, Phase Difference between e-ray and o-ray, Superposition of waves linearly polarized at right angles, Types of polarized light, Retarders or wave plates, Analysis of polarized light, Babinet compensator (only construction), Artificial double refraction, LCDs.

Books: Optics and Spectroscopy
Author: R. Murugeshan and Kiruthiga Sivaprashatha
Pub: S. Chand

SPECTROSCOPY

Unit IV: Atomic Spectroscopy

The spinning electron, Space quantization, Quantum numbers and their physical interpretations, Zeeman effect and experimental study of Zeeman effect, Classical interpretation of Normal Zeeman effect, Vector atom model and Normal Zeeman effect, Vector atom model and Anomalous Zeeman effect [Quantitative approach], Paschen-Back effect, Stark effect.

Books: Atomic Physics
Author: J. B. Rajam
Pub: S. Chand

Unit V: Molecular Spectroscopy

Introduction, Theory of pure rotational Spectra, Theory of rotational vibrational Spectra, Theory of electronic band Spectra, Raman effect, experimental study, Applications of the Raman effect in Physics.

Books: Atomic Physics
Author: J. B. Rajam
Pub: S. Chand

SEMESTER VI

Paper Code: 0030496005

PAPER XXIII – Digital Communication and Electronics

Course Outcome:

CO 1: By learning this course, the students will understand various digital communication methods.

CO 2: This course is designed for the students to gain knowledge about electronic circuit useful in digital communications.

Unit I: Introduction to Digital Communication

History, An overview of digital communication , Electromagnetic spectrum, ranges and application areas, Channel Types, characteristics and modeling, Analog and Digital communications – A comparison

Books: Digital Communication
Author: B.P. Lathi
Pub: TMH Publication

Unit II: Probability in Communication Signals

Introduction, Basics of probability, Conditional probability, Random variable

Books: Digital Communication
Author: B.P. Lathi
Pub: TMH Publication

Unit III: Waveform Coding

Introduction, Sampling and Quantization, Pulse Code Modulation, Delta Modulation

Books: Digital Communication
Author: B.P. Lathi
Pub: TMH Publication

Unit IV: Digital Communication

Digital baseband signaling, Bandpass digital signaling, Information theory and source coding

Books: Digital Communication
Author: B.P. Lathi
Pub: TMH Publication

SEMESTER VI

Paper Code: 0030496007

PAPER XXIV– Applied Physics Projects

Course Outcome:

CO 1: By undertaking one project related to applied physics, the student will perform practical related to new developments in the topic of their choice.

CO 2: This course will develop confidence in students to carry out independent project under the assigned guide in the field of applied physics.

Every student will have to complete one experimental or theoretical Applied Physics Projects under the guidance of faculties of the department. The project work may be completed either using the departmental facilities or facilities available in any Industry / Other University / National Institutes. There will be presentation of the project work to be completed at the end of semester. Project may be allotted individually or in group.

SEMESTER VII

Paper Code: 0030497001

CORE – I: PAPER - I MATHEMATICAL METHODS IN PHYSICS

Course Outcome:

CO 1: By learning this course, the students will understand how to use various mathematical methods in solving physics problems.

CO 2: This course will be useful to the students to understand various mechanisms underlying physics using various mathematical tools.

Unit I: Vector Analysis and Curved Coordinates

Elementary Approach, Scalar or Dot Product, Vector or Cross Product, Triple Scalar and Vector Product, Gradient, Divergence, Curl, Vector Integration, Gauss's Theorem, Stoke's Theorem, Potential Theory, Gauss's Law and Poisson's Equation, Dirac Delta Function.Rectangular, Cylindrical and Polar Coordinates.

Unit II: Complex Variables

Complex Algebra, Cauchy-Riemann Condition, Cauchy's Integral Theorem, Cauchy's Integral Formula, Laurent Expansion, Mapping, Singularities, Calculus of Residues

Unit III: Fourier series and Integral Transform

General Properties, Advantages and Uses of Fourier series, Complex Fourier Series, Properties of Fourier Series

Fourier Transform, Inversion Theorem, Fourier Transform and Derivatives, Convolution Theorems, Application.

Elementary Laplace's Transform, Laplace's Transform and Derivatives, Convolution Theorems, Inverse Laplace's Transform

Unit IV: Ordinary Differential Equations and Useful Polynomials

Solution of First and Second Order Differential Equation, Series Integration Method, Legendre's, Hermit's, Bessel's and Laguerre's (Differential Equation, Polynomial, Generating Functions, Recurrence Relation and other Properties)

Reference Books: Mathematical Methods for Physicists By Weber and Arfken

Mathematical Methods in the Physical Sciences By Mary L. Baos

Mathematical Physics By B. S. Rajput

SEMESTER VII

Paper Code: 0030497003

CORE – II: PAPER - II APPLIED QUANTUM MECHANICS

Course Outcome:

CO 1: This course will help the students to know about the various phenomena in quantum mechanics.

CO 2: This course will be useful to the students to understand about the various electronic energy levels and its use in the solving problems of fundamental physics.

Unit I: The Schrodinger Equation and Stationary States

Introduction- A free particle in one dimension- Generalization to three dimensions- The operator correspondence and the Schrodinger equation for a particle subject to forces- Physical interpretation and conditions on Ψ- Normalization and probability interpretation- Non-normalizable wave functions and Box normalization- Expected values: Ehrenfest's theorem- Admissibility conditions on the wave function-Stationary states: The time dependent Schrodinger equation- Problems

Unit II: General Formalism of Wave Mechanics

Introduction- The Schrodinger equation and the probability interpretation for an N particle system- The fundamental postulates of wave mechanics- The adjoint of an operator and self-adjointness- The eigen value problem: Degeneracy- Eigen values and Eigenfunctions of self adjoint operators- The Dirac Delta function- Observables: completeness and normalization of eigenfunctions- Problems

Unit III: Exactly Soluble Eigenvalue Problems

Introduction- The Schrodinger equation and energy eigenvalues- The energy eigenfunctions- Properties of stationary waves- The angular momentum operators- The eigenvalue equation for L^2 ; separation of variables- Admissibility conditions on solutions; Eigenvalues- The eigenfunctions: Spherical harmonics- Physical interpretation- Parity- The Hydrogen atom- Problems.

Unit IV: Aprroximation Methods for Stationary States

PERTURBATION THEORY FOR DISCRETE LEVELS: Equations in various orders of perturbation theory- The non-degenerate case- The degenerate case: Removal of degeneracy- The effect of an electric field on the energy levels of an atom(stark effect)- Two electron atoms
THE WKB APPROXIAMATION: The one dimensional Schrodinger equation- The Bohr sommerfeld quantum condition- WKB solution of the Radial wave equation. Problems

Reference Books:

A textbook of Quantum Mechanics
P. M. Mathews, K. Venkatesan (McGraw Hill) Second Edition
Introduction to Quantum Mechanics
David J. Griffiths (Pearon) Second Edition
Quantum Mechanics, Concepts and Applications
Nouredine Zettili (Wiley) Second Edition
Quantum Mechanics
V. Murugan (Pearson)
Quantum Mechanics: theory and applications
Ajoy Ghatak, S Loknathan (Macmillan India Limited)

SEMESTER VII

Paper Code: 0030497005

CORE – III : PAPER - III SEMICONDUCTOR DEVICES AND APPLICATIONS

Course Outcome:

CO 1: By learning this course, students will be trained to use various power electronic devices in industrial applications.

CO 2: This course will be useful for students to use semiconductor devices such as, thyristors, diac, etc., in electronic instrumentation.

Unit I: Introduction and History of Semiconductor Power Devices

Applications of power electronics, Power semiconductor devices, Control characteristics of power devices, characteristics and specifications of switches, Types of power electronic circuit, design of power electronic equipment.

Power Semiconductor Diodes and Circuits

Semiconductor basics, diode characteristics, reverse recovery characteristics, power diode types, silicon carbide diodes, series and parallel connected diodes

Unit II: Power Electronics Devices

Diode Rectifiers

Single phase: half wave rectifiers, full wave rectifiers, Multiphase star rectifiers, Three phase bridge rectifiers and further analysis

Power Transistors

Bipolar junction transistors, power MOSFETs, COOLMOS, SITs,IGBTs, Service and parallel operations

Unit III: DC to DC Converters

DC-DC Converters

Principles of step down and step up operation, step down with RL load, Step up with resistive load, Converter classification, switching mode regulators comparison of regulators, chopper circuit design

Unit IV: Thyristors

Thyristor characteristics, Turn ON, Turn OFF, Types of Thyristors – Phase controlled, BCT,Fast switching etc..

TEXT BOOK:

Power electronics – Circuits, devices and applications By M.H. Rashid, Pearson Education

SEMESTER VII

Paper Code: 0030497007

CORE – IV : PAPER – IV ADVANCED MATERIALS AND APPLICATIONS

Course Outcome:

CO 1: Students will be trained to use various advanced materials such as, manganites, ferrites, composites in various applications.

CO 2: By studying this course, students will be able to seek jobs in industries related to polymers, plastics, composites, ceramics etc.

Unit I: Functional Materials – I

CMR Manganites – Structure and properties of Mixed valent Manganites, Magnetoresistance (MR): concept and types, Zener Double Exchange and Jahn Teller Effect in Manganites, Applications of manganites

High Tc Superconductors (HTSC) – Discovery, families, salient features of HTSC, synthesis of Y123 (YBCO), structure -property correlations, Role of Cu and Oxygen, Applications of HTSC

Unit II: Functional Materials – II

Multiferroics (MF)–Basic concepts, types of MFs, Magnetoelectric (ME) effect, $BiFeO_3$ MF: structure & properties, Applications of MFs

Ferrites – Fundamentals, synthesis methods, soft and hard ferrites, Applications of ferrites

Unit III: Composites

Basic concepts, Particle -Reinforced Composites, Fiber-Reinforced Composites : conventional fiberglass,advanced composites, wood - natural composite, Polymer – Matrix Composites, Metal-Matrix Composites, Ceramic – Matrix Composites, Carbo-Carbon Composites, Hybrid Composites, mechanical properties, processing of composites, Applications of composites

Unit IV: Polymers

Introduction, Polymerization, Structural features of Polymers, Thermoplastic and Thermosetting Polymers, Additives, Polymer processing, Mechanical behaviour of Polymers, Crystallization, Melting and Glass transition phenomena in Polymers, Polymer types, Polymerization, Polymer Additives,Applications of Polymers

Reference Books:

1. Materials Science for engineers By J.F.Shackelford and M.K.Murlalidara Pearson Education Pub
2. Callister's Materials Science and Engineering Adapted by R. Balasubramaniam Wiley India Pub.
3. The New Superconductors By Owens and Poole , Plenum Pub.
4. CMR manganites By C N R Rao, CMR MANGANITES : Study Notes
5. Multiferroics: Study Notes
6. Ferrites Magnetic Materials

SEMESTER VIII

Paper Code: 0030498001

CORE - V: PAPER- V VACUUM TECHNOLOGY & THIN FILMS

Course Outcome:

CO 1: This course will give the knowledge about fundamental of vacuum science useful in laboratory and industry.

CO 2: The students will get knowledge about various techniques of thin film depositions.

UNIT-I : Vacuum Techniques-I

Vacuum principles: Basic terms and concepts; Gas Laws, Continuum and Kinetic gas theory; Pressure ranges; Types of flow; Conductance, Source of Gas (Gas load) in Vacuum Chamber. Vacuum generation: Vacuum pumps – a survey; Diaphragm pump, Rotary vane pump, Diffusion Pump, Turbo molecular Pump (TMP), Sorption pumps: Ti-Sublimation pumps, Sputter-ion pumps; Cryo Pumps

UNIT-II: Vacuum Techniques-II

Theory, Principle of pressure measurement; Advantages and limitations of following guage: (i)Thermal conductivity vacuum gauges, Pirani Gauge (ii) Cold Cathode Ionization vacuum gauges (iii) Hot Cathode Ionization vacuum gauge, (iv) Bayerd-Alpert Ionization gauge, Analysis of gas at low pressures: Residual gas analyzers, Quadrupole mass spectrometer, Leak Detection, Helium Leak Detector Principle and Application Basic Setups of Different Pumping Systems

UNIT-III: Thin Films Techniques-I

Thin Film Nucleation and its Growth: Film formation and structure; Thermodynamics of nucleation, Nucleation theories: Capillarity model – homogeneous and heterogeneous nucleations, Atomistic model – Walton-Rhodin theory; Post-nucleation growth; Deposition parameters; Epitaxy; Thin film structure; Structural defects and their incorporation.

UNIT-IV: Thin Films Techniques-II

Thin Films Preparation methods: Electrochemical Deposition (ECD); Spin coating; Physical Vapor Deposition (PVD)- thermal evaporation, electron beam evaporation, rf-sputtering; Pulsed Laser deposition (PLD); Chemical Vapor Deposition (CVD), Plasma-Enhanced CVD (PECVD), Atomic Layer Deposition (ALD), Molecular Beam Epitaxy (MBE), Thickness measurement by (i) Optical interference, (ii) microbalance, (iii) quartz crystal methods.

Text Books:

1. Thin Film Phenomena; Chopra; McGraw-Hill; 1969.
2. Handbook of Thin Film Technology; Maissel & Glang; McGraw-Hill; 1970.
3. Thin Film Fundamentals; Goswami; New Age International Pvt. Ltd; 2007.
4. Vacuum Science and Technology, by Rao, Ghosh and Chopra; Allied Publishers, 1998.

Other Books:

1. Materials Science of Thin Films; Milton Ohring; Academic Press; 2001.
2. Thin Films; Heavens; Dover Publications Inc.; 1991.
3. Thin-Film Deposition: Principles and Practice; Smith; McGraw-Hill; 1995.
4. Thin Film Processes I; Vossen & Kern; Elsevier Science & Technology Books; 1978.
5. Thin film processes II; Vossen & Kern; Academic Press; 1991.
6. Handbook of Vacuum Science and Technology, by Hoffman, Singh and Thomas; Academic; 1998.
7. Vacuum Technology, by Roth; North Holland, 1990.
8. Fundamentals of Vacuum Technology; Umrath; Leybold, 1998
9. A User's Guide Vacuum Technology, John F. O'Hanlon, 2003
10.Modern Vacuum Practice; Nigel S. Harris, McGraw-Hill

SEMESTER VIII

Paper Code: 0030498002

CORE–VI : PAPER- VI NANOMATERIALS – I : SYNTHESIS AND TYPES

Course Outcome:

CO 1: Students will understand how to synthesize various nanomaterials, such as, nanoparticles, nanofiber, nanotubes, etc.

CO 2: By learning this course, students will able to develop own their own, few new nanomaterials for specific applications.

Unit I:Zero-dimensional Nano structures

Nano particles synthesis through Homogeneous Nucleation: Synthesis of Metallic Nano particles, Synthesis of Semiconductor Nano particles, Synthesis of Oxide Nano particles.

Nano particles synthesis from Homogeneous Nucleation: using micro emulsion, Aerosol synthesis, growth termination, spray pyrolysis, template based synthesis.

Unit II: One-dimensional Nano structures – Nano wires & Nano rods

Spontaneous growth, Evaporation – Condensation growth, Vapour – Liquid – Solid (VLS) growth, Template based synthesis, Electrospinning, Lithography

Unit III: Two-dimensional Nano structures

Fundamentals of film growth, Physical Vapour Deposition (PVD), Chemical Vapour Deposition (CVD), Atomic Layer Deposition (ALD), Super Lattices, Self-Assembled Monolayers (SAM), Sol-gel films.

Unit IV: Prime Nanomaterials

Metallic Nano particles, Oxide Nano particles, Carbon Nano structures, Semi-conducting Nano particles, Advanced Nano Composites, Advanced Nano Ceramics, Nanomaterials in consumer products

Reference Books:

- Nanostructures and Nanomaterials by Guozhong Cao (Imperial College Press)
- Nanotechnology: Basic Calculations for Engineers & Scientists by Louis Theodore (Wiley Publishers)
- Nano: The Essentials by T. Pradeep (McGraw Hill Education)

SEMESTER VIII

Paper Code: 0030498003

CORE - VII: PAPER VII SIGNAL PROCESSING AND COMMUNICATION

Course Outcome:

CO 1: This course will help the students about the basics of signal processing and method used.

CO 2: By studying this course, students will get knowledge about various types of modulations used in radio and TV communications.

Unit 1: Introduction to signals

Introduction to signals and systems, Classifications of signals, deterministic and non deterministic signals, periodic and aperiodic signals, Even and odd signals, Energy and power signals, Elementary signals, Transformation of independent variables

Unit 2 : Introduction to systems

Systems – Basic system properties, Order of a system, Interconnection of systems Linear Time Invariant Systems (L.T.I.)Introduction, Time domain representation of LTI, Characterization of LTI, continuous time Response, convolution, properties of LTI.

Unit 3 : Communication systems

Introduction to electronic communication, modulation and demodulation, bandwidth and information capacity, Transmission modes, Circuit arrangements, Signal analysis, mixing, noise analysis, Signal generators Introduction to Oscillators, Phase Locked Loops, Frequency synthesizers

Unit 4: Modulation

Different types of basic modulation techniques, Amplitude modulation and demodulation, Frequency modulation and demodulation, Phase modulation and demodulation

Text Book : Signals and Systems – Sanjay Sharma – Pub: SK Kataria & Sons (KATSONs)

Text Book: Electronic Communication systems – Wayne Tomasi 3rd Ed.
Pub: Pearson Education

SEMESTER VIII

Paper Code: 0030498004

CORE-VIII -PAPER - VIII

ADVANCED EXPERIMENTAL TECHNIQUES FOR MATERIALS CHARACTRIZATION

Course Outcome:

CO 1: This course is specially designed for the students to gain knowledge about few advanced techniques, such as, XRD, SEM, etc. for structural and micro structural characterization of materials.

CO 2: This course will help the students to understand techniques of characterization useful in studying electrical and magnetic properties of materials.

UNIT-I : Structural & Microstructural Analysis

X-Ray diffraction: Phase identification, indexing and lattice parameter determination, fitting of various models. Neutron diffraction: Reflexion High Energy Electron Diffraction (RHEED), Low Energy Electron Diffraction (LEED), Scanning Electron Microscope (SEM), Tunneling Electron Microscope (TEM), Rutherford Back Scattering (RBS), Atomic Force Microscope (AFM)

UNIT-II : Thermal Analysis Techniques

Differential thermal analysis (DTA), Differential scanning calorimetry (DSC), Thermogravimetric Analysis (TGA)

UNIT-III : Electrical & Magnetic Characterization

Electrical resistivity in bulk and thin films (two & four probes), Hall effect, Magnetoresistance, M-H loops, temperature dependent magnetization, time dependent magnetization, measurements using AC & DC susceptibility.

UNIT-IV : Optical Characterization Techniques:

UV-Vis Spectroscopy, Fourier Transform Infrared spectroscopy (FTIR), Raman Spectroscopy, X-Ray photoelectron spectroscopy (XPS).

Reference Books:

1) Elements of X-Ray diffraction, B.D. Cullity & S.R. Stock, Prentice Hall Inc.
2) Characterization of Materials (Material science and technology: A comprehensive treatment Vol. 2A & 2B VCH
3) Semiconductor material and device characterization, D.K, Schroders, Wiley-IEEE Press
4) Characterization of Nanophase materials, Ed. Z.L. Wang, Willet - VCH
5) Experimental Techniques in Material science and mechanics, C. Suryanarayana, CRC Press
6) Physics of Semiconductor devices, D.K. Roy, University Press

SEMESTER IX

CORE - IX : PAPER- IX

NANOMATERIALS II: PROPERTIES AND APPLICATIONS

Course Outcome:

CO 1: This course is designed for master students to study the properties and applications of few selected nanomaterials.

CO 2: Students will be able to synthesize and characterized interesting nanomaterials for desired applications.

UNIT-I:

(a) Chemical Properties:

Examples of nanostructures in chemistry, Effect of nanomaterials on chemical reactivity, Effect of chemistry on nanostructures

(b) Optical Properties:

Refractive index, Absorption coefficient, Reflection, Color centers (Photocromy), Luminescent glasses.

UNIT-II: Magnetic and electron transport properties

Microstructure, Magnetic Properties, Electrical transport properties, Giant Magneto Resistance (GMR) property, Electrical conduction in Bi-Se glasses & nanoparticles, DC conduction of nanoparticles, Correlation between electronic conduction and magnetic data.

UNIT-III:

- **Magnetic and structural properties**:
  Particle size variation and distribution, Effect of particle size on magnetic properties, Solvated Metal atom dispersion technique (SMAD).
- **Mechanical Properties**:
  Nanocrystalline metals and alloys, Super plasticity- High temperature properties.

UNIT-IV: Applications of nanomaterials

Nanotribology : Nanotribometer, Surface force apparatus, Quartz crystal microbalance (QCM), Super lubricity, Hard disk capacity, Micro-electromechanical system (MEMS), **Nano sensors :** Nano scale organization, self-assembly, Quantum size effects, Electrochemical sensors, Nano-Biosensors, Future prospects, **Nanomedicine :** Developments, Various nano systems in use, Diagnostic and therapeutic applications, **Nanobiology :** Biological Imaging, Biomarker, Immunogold labeling, Targeted drug delivery, Nanobiotechnology.

Text Books:

1. Nanomaterials : Synthesis, Properties & Applications- Ed. by A. S. Edelstein & R. C. Cammarata J.Y. Bottero, Institute of Physics, UK, 1998.
2. Nanomaterials – A. K. Bandyopadhyay, New age international publishers, New Delhi, 2009.
3. Nano : The Essentials – T. Pradeep, McGraw-Hill Education, New Delhi, 2009.

SEMESTER IX

ID – 1 : PAPER- X

NUMERICAL TECHNIQUES FOR COMPUTATIONAL ANALYSIS

Course Outcome:

CO 1: By studying this course, the students will be able to make use of numerical methods suitable for the computational analysis.

CO 2: It will be useful to understand the various numerical techniques for fitting large data using existing models and theories.

UNIT-I: Roots of Nonlinear Equations

Introduction, Method of solution, interactive methods starting & stopping an interactive process, Evaluation of polynomial, bisection method, false position method (lineal interpolation method), Newton - Raphson method, secant method, fixed point method.

UNIT-II: Curve fitting: Interpolation

Introduction, Polynomial form, Lines interpolation, Lagrange interpolating polynomials, Newton interpolating polynomials, divided difference table, Spline interpolation.

UNIT-III: Curve fitting: Regression

Introduction, Fitting lineal equation, Fitting Transcendental fitting, polynomial function, multiple lineal regression.

UNIT-IV:

- **Numerical Differentiation**:
  Need & Scope, Differentiation continuous function, Differentiation tabulated function, Richardson extrapolation.
- **Numerical Integration**:
  Need & Scope, Newton-cotes method, Trapezoidal rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Romberg's integration, Gaussian Integration.

Text Book:

1. Numerical Methods by E Balagurusamy, TATA McGraw HILL PUB

SEMESTER IX

ELECTIVE GROUP C - 1: PAPER XI

PHYSICS OF ACCELERATORS

Course Outcome:

CO 1: This elective paper will give knowledge to the students about the fundamentals of accelerator physics.

CO 2: This course will help the students to understand the different parts of particle accelerators and their applications.

UNIT I: Introduction to Accelerators

History and basic principle of various particle accelerators, DC Accelerators, Cyclic Accelerators, Linear Accelerators, Synchrotrons and High energy Accelerators, Ion Sources and types

UNIT II: Beam Theory and Optic elements

Vacuum System, Beam Theory, Beam Acceleration, Beam Optics Calculations, Magnets, Beam Sterrers, Quadrupoles, Profile Meters etc.

UNIT III: Control of Accelerators

Control Systems, Devices communication, Fiber Optics communication, Power Supplies (Low and High Voltage, Low and High Currents)

UNIT IV: Application of Accelerators

Accelerators in daily life, Semiconductors, Health Sciences, Industry applications etc.

Reference Book:

1. The physics of particle accelerators: an introduction by Klaus Wille, Oxford Press USA, 2000.
2. Accelerator physics by S.Y. Lee, World Scientific Publishing Company, Year: 2004
3. Particle Accelerator physics by H. Wiedemann, Springer, Year: 2007

SEMESTER IX

ELECTIVE GROUP C - 2: PAPER XII

MATERIAL MODIFICATIONS WITH LOW ENERGY ION BEAMS

Course Outcome:

CO 1: This course is specially designed to understand the effect of low- energy ion beams (<2MeV) in material modifications.

CO 2: Various method used in low energy ion beam irradiation will be explained to the students.

UNIT I: Ion -Solid interaction- I: Fundamentals

Interaction of Charged Particles with Matter: Basic ion bombardment processes in solids- general phenomenon, ion penetration and stopping, ion range parameters, energy loss mechanisms;

Electronic and nuclear energy loss, classical stopping power equation for electronic energy-loss, behavior of electronic energy-loss curve as a function of ion velocity.

UNIT II: Ion -Solid interaction-II: Theory

Coulomb explosion and thermal spike models, concept of energy straggling and range straggling and their correlation; Basic ion beam simulation programs: SRIM; TRIM, channeling; sputtering process and ion beam mixing.

UNIT III: Doping, Diffusion and Defects in Ion –Implanted Si

Junctions and transistors, defects, laws of diffusion, diffusion mechanisms, irradiation – enhanced diffusion

UNIT IV: Crystallization and Regrowth of Amorphous (A) - Si

Introduction, epitaxial growth of implanted amorphous Si, ion beam induced enhanced crystallization, laser annealing of Si

Reference Book:

1. Ion Implantation and Synthesis of Materials by Michael Nastasi, J. W. Mayer, Springer-2006.
2. 2. Swift Heavy Ions for Materials Engineering and Nano structuring, Springer, Awasthi, D. K., and Mehta, G. K.
3. Physics of Ion Implantation Phenomena, Mathur D, Springer Verlag, 1991.

SEMESTER X

CORE - X : PAPER- XIII

ION BEAMS IN MATERIAL SCIENCE

Course Outcome:

CO 1: This core paper will be useful to the students to understand various ion beam interaction with mater.

CO 2: This course will help the students to study about the nanostructuring by ion beams and various methods used.

UNIT I: Ion interaction with matter

Ion stopping, energy losses, effective charge of moving ion, high energy and low energy losses, Fermi- Teller model, Firsov and Linhard Scharff model, ion range and distribution, straggling, ion backscattering, concept of ion channeling and ERDA

UNIT II: Ion beam processes

Radiation damage and structure change: defects formation under ion implantation, points defects, line defects, columnar defects; sputtering, phase transformations, ion beam mixing, radiation enhanced diffusion, impurity incorporation, ion induced epitaxial crystallization

UNIT III: Nano-structuring by Ion beams

Synthesis of nanostructured materials under electronic excitation and nuclear energy loss, nanostructures within ion track and at the surface by self-organization, high energy sputtering of nanomaterials, nano-pattering: ripple formation, nano-dot formation.

UNIT IV: Ion beam-based techniques for material analysis

Rutherford backscattering spectrometry (RBS): Principle, Kinematics, instrumentation, backscattering spectrum, Depth Profiles and applications, Elastic recoil detection analysis(ERDA): Principle, Kinematics, instrumentation and applications, Secondary ion mass spectroscopy (SIMS): Principle, instrumentation working and applications, Nuclear reaction analysis (NRA): Principle, instrumentation, working and applications.

Reference Book:

1. Introduction to High Energy Physics (2nd edition) by D. H. Perkins.
2. Swift Heavy Ions for Materials Engineering and Nano structuring, Springer,
Awasthi D. K. andMehta, G. K.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
4. Introduction to Experimental Nuclear Physics by R. M. Singru
5. Materials Science with ion beam, Harry Bernas, Springer 2010

SEMESTER X

ID - 2 : PAPER- XIV

NANOTECHNOLOGY AND ENVIRONMENT

Course Outcome:

CO 1: This course is specially designed to understand the use of nanotechnology in the environmental protection.

CO 2: By studying this course, the students will know about various applications of nanomaterials in environmental issues, such as, ground water remediation, soil strength and absorption, etc.

UNIT-I: Nanotechnology as a tool for sustainability

Nanotechnology for sustainable and cleaner environment, reducing the impact of greenhouse gases, energy harvesting, sustain biodiversity.

UNIT-II: Potential impacts of nanomaterials

Toxicological impacts of Nanomaterials: Introduction, Fullerenes, Single-walled carbon nanotubes, Multi-walled carbon nanotube, Carbon based materials, Titanium dioxides, Iron oxides, Cerium dioxides, Copper nanoparticles, quantum dots, Environmental impact.

Ecotoxicological impacts of nanomaterials: Introduction, Microorganisms, Ecotoxicity, Bioavailability and Cellular uptake of nanoparticles, interaction with microbial cell, Antibacterial activity

UNIT-III: Environmental applications of nanomaterials

Nanomaterials for ground water remediation: Introduction, Reactivity, Fate and Life time, Delivery and transport issues, Targeting.

Membrane Processes: Overview of membrane processes, Transport principles for membrane processes, membrane fabrication using nanomaterials, Nanoparticle membrane reactors, Active membrane systems.

Nanomaterials as Adsorbents: Introduction, Adsorption at the oxide nanoparticles/solution interface, Nanomaterial-based adsorbents for water and waste water treatments

UNIT-IV: Nanotechnology for Environmental Burden Reduction, Waste Treatment and Pollution control

Introduction, Environmental burden reduction, Treatment of industrial and agriculture wastes, Nanomaterials for non-point source pollution control.

Text Books:

4. Emerging Trends of Nanotechnology in Environment and sustainability – Karthiyayini Sidharan, Springer, Switzerland, 2018.
5. Environmental Nanotechnology- M. R. Wiesner, J.Y. Bottero, McGraw-Hill, New York-2007.

SEMESTER X

ELECTIVE GROUP C - 3 : PAPER XV

SWIFT HEAVY IONS FOR MATERIAL MODIFICATIONS

Course Outcome:

CO 1: This elective paper will help to know about the effect of swift heavy ions (>5MeV) in the modifications of material properties.

CO 2: This course will be useful to understand the effect of swift heavy ions on the properties of functional oxides useful in practical applications.

UNIT I: Fundamentals

Range distribution, Atomic and lattice planes and disorders, Energy and particles, Bohr velocity radius, Cross section: angular, Energy transfer differential Scattering cross section, Reduced cross section, computer simulations of surface scattering

UNIT II: Instrumentation

Instrumentation for ion technology, ion sources, accelerators, beam lines, experimental stations and sample handling, energy stabilization, energy calibration, implanters and their applications, detectors and Data acquisition, data reduction and handling

UNIT III: Swift heavy ions for synthesis and modifications of nanostructured materials

Introduction, Synthesis of nanostructured materials under electronic excitation, nanostructures using self organization, modification in metal-dielectric nanocomposite films, tailoring mechanical and optical properties of nanostructures

UNIT IV: Effect of swift heavy ions on functional oxides

Introduction to functional oxides and effects of swift heavy ions (SHI) irradiation on the properties of functional oxides

Effect of SHI irradiation on the properties of High T_c – superconductor: structure, microstructure and transport properties

Effect of SHI irradiation on the properties of CMR manganites: structure, microstructure and transport properties

Reference/Text books

1) Ion implantation and synthesis of Material, M Nastasi and J W Mayer, Springer 2006.
2) Handbook of Radiation effects, 2nd Edition, Andrew Holmes Siedel and Len Adans2002.
3) Material Science with Ion Beam, Harry Bernas, Springer 2010.
4) Ion Bombardment modification of Surface Fundamentals &Application, Orlando Auciello and Roger Kelly Elsevier, 1984.
5) Nano Fabrication by Ion Beam Sputtering, T Som and D Kanjilal
6) Swift heavy ions for materials engineering and nanostructuring, D.K. Avasthi and G.K. Mehta, Capital publishing company, New Delhi (2011)

SEMESTER X

ELECTIVE GROUP C - 4: PAPER XVI

NANOSTRUCTURING WITH ION BEAMS

Course Outcome:

CO 1: This is highly specialized elective course designed for final year master student to gain knowledge about the use of ion beam in the synthesis of nanostructures and nanopatterns.

CO 2: This course will be useful to students to take up the ion beam studies as the topic of their advanced research.

UNIT I: Introduction to ion implantation and basic crystallography studies:

Ion implantation and its applications, Lattices, Crystal systems, Symmetry, Primitive and non primitive cells, Lattice directions and planes, Crystal structure, Atom sizes and coordination, Stereographic projection

UNIT II: Interaction of energetic ions with solids:

Stopping cross sections, Ion ranges, Energy transfer to the surface, Displacement cascades and generation of defects: Bulk damage, Formation of surface vacancies and adatoms, extended surface damage

Sputtering from elemental targets: Linear collision cascade, Sputtering from single crystals, Composition changes in multicomponent materials, Preferential sputtering, Surface binding energies of alloys, Processes effecting composition changes

UNIT III: Regimes of ion induced pattern formation and Surface evolution:

Ion-induced orientation: Bradley-Harper (B-H) instability regime; Surface-induced orientation: Ehrlich Schwoebel (E-S) instability regime; thermal ion-induced patterns and kinetic roughening; Nonroughening behaviour

Morphology-dependent sputter yield and the B-H instability; Defect diffusion and other mechanisms; Diffusion on isotropic surfaces: Mullins and Herring approach; Diffusion on stepped surfaces; Mobile defect species; Roughening kinetics induced by surface diffusion; Radiation enhanced viscous flow; Ballistic diffusion

UNIT IV: Ion beam directionality in patterning and Nanoscale functionalization of patterned surfaces

Bradley-Harper linear instability model: Curvature-dependent sputtering and smoothing via thermal diffusion; Experiments and simulations of patterning in the BH instability regime: Time evolution of ripple wavelength and amplitude; Exponential growth rate of the ripples; Ripple travelling velocity; Energy dependence; Temperature and flux dependences of ripple wavelength and growth rate

Application of patterned semiconductor surfaces: Plasmonics, thin film/nanoscale magnetization, light trapping, cold cathode electron emission; Application of patterned oxide surfaces: Resistive switching.

Books:

1) Ion implantation and synthesis of Material, M Nastasi and J W Mayer, Springer 2006.
2) Handbook of Radiation effects, 2nd Edition, Andrew Holmes Siedel and Len Adans2002.
3) Material Science with Ion Beam, Harry Bernas, Springer 2010.
4) Ion Bombardment modification of Surface Fundamentals &Application, Orlando Auciello and Roger Kelly Elsevier, 1984.
5) Nano Fabrication by Ion Beam Sputtering, T som and D Kanjilal
6) Swift heavy ions for materials engineering and nanostructuring, D.K. Avasthi and G.K. Mehta, Capital publishing company, New Delhi (2011)