SURENDRANAGAR UNIVERSITY

FACULTY OF SCIENCE

Syllabus for

M. Sc. (PHYSICS)

With Effect From: 2021-22

.Sc. Physics Program

Program outcomes

PO1: Developing analytical, logical, problem solving skills using mathematical/computational tools.

PO2: Obtaining knowledge of technologies like nuclear technology, space technology, communication technology and nano-technology and their applications

PO3: Getting knowledge to synthesize various technologically important materials and characterize them by different modern experimental tools.

PO4: Achieving experimental skill through laboratory practice.

PO5: Ability to build up electronic circuits on printed circuit boards through laboratory practice

PO6: Achieving knowledge of certain interdisciplinary subjects to correlated the knowledge of Physics to other disciplines.

M.Sc. Physics Program
Program Specific outcomes

PSO1: Acquiring knowledge in fundamental Physics and also employability/ entrepreneurship/skill developments

PSO2: Achieving skill / ability to do project work leading to mini research work

PSO3: Ability obtained in developing and designing simple electronic equipments through electronic projects.

PSO4: Achieving ability to present project work results in form of posters and oral presentations in national/state level seminars and symposia.

M. Sc. (Physics) Program
Choice Based Credit System
(CBCS)
Semester-I to IV

The Master of Science (M.Sc.) PHYSICS programme with Choice Based Credit System (CBCS) comprises of total **16 theory papers** classified as TWELVE core (compulsory) theory papers, FOUR elective (optional) theory papers to be selected out of 12 elective papers. It is to be noted that out of the 12 core compulsory papers, two papers *"Physics and Chemistry of nano-materials"* and *"Experimental Techniques with interdisciplinary applications"* are of *interdisciplinary nature* so that the students of Chemistry, Bio-sciences, Electronics and Pharmaceutical sciences can take these courses. The students will get a choice to select any two elective theory papers out of a set of six elective theory in semester-3 and two elective theory papers in semester-4 out of the six offered elective papers. However, the Department will offer a set of elective papers at the beginning of third and fourth semester depending upon the availability of teachers in the Department. In each semester, there will be 4 theory papers and one Practical course. Examination in each theory paper will be of 2½ hours duration and will carry 70 marks and each practical and/or project examination of 3 hours duration and of 200 marks. This 200 marks will consist of 150 marks for the practicals and/or project and 50 marks for Viva-voce.

As regards the Practicals, the students shall perform general practicals during Semester-I to IV. The students may also be allowed to perform Project work in Semester-IV which can be experimental or theoretical. The students can also take-up in-depth and detailed study of a specific topic in Physics as a project work. In case of project work the students are required to submit a dissertation (project report) at the end of Semester-IV and also required to make presentation of the project work during practical examination. In Semester-IV for the students taking up projects, the bifurcation of marks for practicals examination will be as follows: Practical (75 marks) + Project work (75 marks) + Viva voce (50 marks) = 200 marks.

The educational tour will be conducted for the students for exposure to the advanced technology, equipments and research facilities in national laboratories, institutes and industries in accordance with their study of elective papers, interdisciplinary papers and projects upon receiving proposal for educational tour from the concerned teachers.

The M. Sc. (Physics) CBCS Course is full time and is divided into 4 semesters (2 years) Grant of term (admission to examination) will be based on satisfactory attendance as per the University rules. The Course Structure of the M. Sc. (Physics) CBCS Program Semester-I to IV is summarized as follows:

The Course Structure of the M.Sc. (Physics) Program Semester-I to IV
M.Sc. Physics Four Semester course: Total Credits: 96 Total marks: 2400

Semester I	**Course**	**No. of hrs/wk**	**Credits**	**Marks**
THEORY (includes lectures, tutorials and assignments)	Core Theory Courses - 1 – 4	16	16	400
PRACTICALS	Practical Course – 1 (includes experimental work, data analysis, library work and viva-voce preparation)	08	08	200
	Total	**24**	**24**	**600**

Semester II	**Course**	**No. of hrs/wk**	**Credits**	**Marks**
THEORY (includes lectures, tutorials and assignments)	Core Theory Courses - 5 – 8	16	16	400
PRACTICALS	Practical Course – 2 (includes experimental work, data analysis, library work and viva-voce preparation)	08	08	200
	Total	**24**	**24**	**600**

Semester III	**Course**	**No. of hrs/wk**	**Credits**	**Marks**
THEORY (includes lectures, tutorials and assignments)	Core Theory Course - 9	04	04	100
	Core Theory Course - 10	04	04	100
	Elective Courses 1 - 2	08	08	200
PRACTICALS	Practical Course – 3 (includes experimental work, data analysis, library work and viva-voce preparation)	08	08	200
	Total	**24**	**24**	**600**

Semester IV	**Course**	**No. of hrs/wk**	**Credits**	**Marks**
THEORY (includes lectures, tutorials and assignments)	Core Theory Course-11	04	04	100
	Core Theory Course-12	04	04	100
	Elective Courses 3 - 4	08	08	200
PRACTICALS AND PROJECTS	Practical Course – 4 (includes Practicals and/or Project work)	08	08	200
	Total	**24**	**24**	**600**
		Total	**96**	**2400**

Theory Papers

The titles of the core theory papers and elective theory papers are given below. The core theory papers (CT-1 to CT-12) are compulsory for all the students.

The Department shall announce a set of six Elective theory papers to be offered on the beginning of Semester-III and IV. A student can choose any two elective theory papers out of a set of six elective papers in Sem-3 and similarly two elective papers out of a set of six elective papers. However, number of elective theory papers will be offered depending upon the availability of expert faculty members.

A student shall study total 16 theory papers during the M.Sc. Physics four semester programme.

Titles of Core Theory Courses CT1 – CT12 (Compulsory for all students) and Elective papers (ET1 to ET12).

Semester: 1

CT1	Mathematical Physics and Classical Mechanics
CT2	Solid State Electronic Devices and Circuits
CT3	Quantum Mechanics - 1
CT4	Electrodynamics and Plasma Physics

Semester: 2

CT5	Quantum Mechanics - 2 and Statistical Mechanics
CT6	Atomic and Molecular Physics
CT7	Space Physics
CT8	Solid State Physics

Semester: 3

CT9	Nuclear and Particle Physics
CT10	Physics and Chemistry of Nanomaterials

Six Elective Theory Papers: (a student has to select any two out of the following)

ET1	Synthesis of Materials
ET2	Physics of ionosphere-magnetosphere system
ET3	Space Technology
ET4	Analog and Digital Systems
ET5	Nuclear Radiation Detectors & Accelerators
ET6	Neutron Physics and Nuclear Reactor Theory

Semester: 4

CT11	Numerical Analysis and Computer Programming
CT12	Experimental Techniques with interdisciplinary applications

Six Elective Theory papers: (a student has to select any two)

ET7	Materials Characterization
ET8	Functional Materials
ET9	Remote sensing and Applications
ET10	Pulse & Microwave Electronics
ET11	Electronic Communications
ET12	Nuclear Reactions, Nuclear Energy and Nuclear Models

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-I

Core Paper: CT-1: Mathematical Physics and Classical Mechanics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Mathematical Physics and Classical Mechanics (CT-1)
Course (Paper) Unique Code: 1603010102010100
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	1	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:
CO1: Ability developed to solve homogeneous and inhomogeneous differential equation
CO2: Ability developed to solve integral and inverse Fourier and Laplace transforms
CO3: Ability developed to use integral and differential equations of orbits to different astronomical and scattering problems
CO4: Ability achieved to apply canonical transformations and Hamilton Jacobi equation to various Physical problems, i.e., harmonic oscillator, etc.
CO5: In depth knowledge of pseudo forces, i.e., Coriolis Force, etc., and their existence due to rotation of Earth and related phenomenon observed on Earth.

Semester-1

Course Content

Unit 1 **07 hrs**

Ordinary Differential Equations

Introduction, Solution of Second Order Differential with Variable Coefficients (1) Homogenous Equations (2) Inhomogeneous Equations

Series Integration Method of the Solution of Linear Differential Equations (Frobenius' Method)

Unit 2 **11 hrs**

Laplace and Fourier Transforms

Integral transform, Laplace transform, some simple properties of Laplace transforms (a) linearity property (b) shifting properties, first & second shifting (c) change of scale property

Laplace Transform of Derivatives & Integral, Inverse Laplace Transform by Partial Functions

Fourier Series and Applications. Fourier Transform, Fourier Sine & Cosine Transform Simple Application of Fourier Transform

Unit 3 **08 hrs**

The Equation of Motion and First Integrals

Differential Equation for the Orbit, Condition for Closed Orbits, Bertrand's Theorem, Kepler's Problem, Inverse Square Law of Force, Classification of Orbit's, Rutherford Scattering

Unit 4 **06 hrs**

Canonical Transformations

Equation of Canonical Transformation, Example of Harmonic Oscillator, Poisson Brackets Properties of Poisson Brackets, Angular Momentum Poisson Bracket Relation. Virial Theorem

Unit 5 **08 hrs**

Hamilton – Jacobi Theory

Hamilton – Jacobi Theory, Hamilton – Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator Example, Hamilton's Characteristic and Principle Functions.

Moving Coordinate System, Coordinate System with Relative Translational Motions, Rotating Coordinate Systems, Coriolis Force, Motion on the Earth

Reference Books

1. Mathematical Physics – Rajput
2. Mathematics for Physics – M.L. Boas
3. Mathematical Methods for Physics – G. Arfkan
4. Classical Mechanics – H. Goldstein
5. Classical Mechanics – N.C. Rana and P.S. Joag

6. Introduction to Classical Mechanics – R.G. Takwale & Puranik
7. Classical Mechanics of Particles and Rigid Bodies – Kiran C. Gupta
8. Classical Mechanics – Y.R. Waghmare
9. Classical Mechanics – Bhatia
10. Classical Mechanics – Leech

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-I

Core Paper: CT-2: Solid State Electronic Devices and Circuits

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Solid State Electronic Devices and Circuits (CT-2)
Course (Paper) Unique Code: 1603010202010200
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	1	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: A student shall be able to explain the physics of various optoelectronic devices
CO2: A student shall be able to explain characteristics and applications of various solid state Electronic devices
CO3: A student shall be able to design combinational logic circuit and implement by using suitable hardware

Semester-1

Course Content

Unit 1 **08 hrs**

Junction Field Effect Transistors, Comparison with BJT, basic Construction, polarity conventions, Characteristics, JFET parameters, JFET-biasing methods, Common source amplifier, Source-follower, MOSFETS, DE-MOSFETS: Construction and Characteristics, E-MOSFETS: Construction and Characteristics, Complementary MOS (CMOS)

Unit 2 **08 hrs**

Optoelectronic Devices

Photometry and radiometry units, Classification of optoelectronic devices,, Radiative and non-radiative transitions, Light dependent resistors, , Photo-diode, PIN Photodiode, Photo-transistor, Light emitting diodes, Physics of LED, materials for LED, Liquid Crystal Displays

Unit 3 **10 hrs**

Solid State Devices for Special Applications

Zener diode, voltage regulation, Silicon Controlled Rectifier, TRIAC, DIAC, Uni-Junction transistor, UJT-relaxation oscillator, Programmable UJT (PUT), Thermistors, Solar-cells, Semiconductor Laser, population inversion at junction, optical gain and threshold current for lasing

Unit 4 **08 hrs**

Integrated Logic Families

Digital IC terminology, The TTL logic family, Loading and fan-out, other TTL series, The ECL logic family, MOS digital ICs, CMOS series characteristics

Unit 5 **06 hrs**

Combinational logic Circuits Designing Using SSI

Review of Boolean algebra, Axioms and theorems, Canonical and standard Boolean functions, Designing of combinational logic circuits using gates, Various implementations, Design examples

References Books

1. Electronic Circuits: Discrete and Integrated, Donald Schilling & Charles Belove, MaGraw Hill International
2. Electronic devices and circuit theory, Robert Boylestad & Louis Nahselsky, PHI
3. Solid State Devices and integrated circuits, W.D. Cooper Weisbecker, Reston Pub (USA)
4. Solid state Devices & applications, Frederick Driscoll & Robert Coughlin, Prantice Hall
5. Digital Systems: Principles and Applications, Ronald J. Tocci, PHI

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-I

Core Paper: CT-3: Quantum Mechanics – I (CT-3)

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Quantum Mechanics – I (CT-3)
Course (Paper) Unique Code: 1603010302010300
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	1	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question Paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: Ability developed to solve one dimensional and three dimensional harmonic oscillator differential equations by power series method. Apply this to understand hydrogen spectrum.
CO2: Ability to derive angular momentum operators and spherical harmonics with polar diagrams
CO3: Ability to derive the time independent and time dependent perturbation equations and apply to explain different phenomenon
CO4: Ability to apply approximation methods to understand various phenomenon, estimate ground state energy, etc.

Semester-1

Course Content

Unit 1 **08 hrs**

One – dimensional harmonic oscillator by Schrodinger equation – power series solution, Plotting of Harmonic oscillator wave functions – classical correspondence – operator methods. Bra and Ket notations, Matrix representation of an operator, The Unitary transformation

Unit 2 **08 hrs**

Angular momentum commutation relation, coordinate transformation, Angular momentum operators and its eigen value problems in position representation, Spherical harmonics

Unit 3 **08 hrs**

Solution of Schrodinger equation in three dimension separable variable method, Applications to (I) Square well (II) Attractive coulomb potential (III) Hydrogen Atom

Unit 4 **08 hrs**

Time independent perturbation theory: Stationary perturbation, Degenerate and no degenerate case, Application such as stark effect. Time dependent perturbation, General formulation and the first order theory, Periodic perturbation and Fermi Golden Rule, Interaction of electromagnetic field with atom

Unit 5 **08 hrs**

Approximation methods: Variational method and its application. WKB approximation – solution of one – dimensional Schrodinger equation, Conditions at turning points. Application of WKB approximation

References Books

1. Quantum Mechanics – Schiff (McGraw Hill)
2. A text book of Quantum Mechanics – Mathews and Venkatesan
3. Quantum Mechanics – Amit Gowsami
4. Fundamental of Quantum Mechanics – Vaghmare
5. Modern Quantum Mechanics – J. J. Sakurai
6. Quantum Mechanics – J. P. E. Peebles
7. Quantum Mechanics – K. K. Chopra, G. C. Agarwal

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-I

Core Paper: CT-4: Electrodynamics and Plasma Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Electrodynamics and Plasma Physics (CT-4)
Course (Paper) Unique Code: 1603010402010400
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	1	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: Electrodynamics and plasma physics belong to basic research disciplines that have many different areas of applications; students will be well acquainted with fundamental and applied aspects

CO2: A student shall be equipped with strong foundations of electrodynamics and plasma physics which will help to understand theories of communication electronics, dielectrics, radio wave propagation and various properties of plasma

Semester-1

Course Content

Unit 1 **08 hrs**

Maxwell's Equations

Vector algebra, Introduction to electrodynamics, Electrodynamics before Maxwell, Ampere's law, Maxwell equations in matter and boundary conditions

Unit 2 **10 hrs**

Electromagnetic Waves, Potentials and Fields

The wave equation for E and B, propagation in linear media, reflection and transmission at normal and oblique incidence, electromagnetic waves in conductors, scalar and vector potentials, Gauge transformations, Retarded potentials, Lienard - Wiechert potentials, the field of a moving point charge

Unit 3 **08 hrs**

Definition of Plasma, Plasma parameters, criteria for plasma, Applications of Plasma Motion of Charged particle in Uniform B and E fields, non uniform B and E fields, time varying E field, adiabatic invariants

Unit 4 **07 hrs**

Dielectric constant of Plasma, Fluid equation of Plasma, convective derivative, fluid drifts perpendicular to B, plasma instabilities

Unit 5 **07 hrs**

Concept of phase and group velocities, plasma oscillations, expression for ω_p, Experimental consequences – Whistler modes, Faraday rotation, Hydro magnetic waves and Magneto sonic or Alfven waves

References Books

1. Introduction to Plasma Physics & controlled fusion (IInd edition): Vol. 1: Plasma Physics By F.F. Chen
2. Introduction to electrodynamics, D.J. Griffith (PHI, New Delhi)
3. Plasma Physics by Bittencourt
4. Plasma Physics by Chakraborty

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Semester-2

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-5: Quantum Mechanics – II and Statistical Mechanics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Quantum Mechanics-II and Statistical Mechanics (CT-5)
Course (Paper) Unique Code: 1603010502020500
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: Understanding the concepts of various ensembles in classical and quantum statistics and applicability
CO2: Super fluid nature of liquid helium and understanding of various phenomena
CO3: Ability to use Ising model to explain magnetism, lattice gas, and binary alloys
CO4: Ability to apply Born approximation to different scattering problems, i.e., square well potential and Yakawa Potentials, etc.
CO5: Ability to understand scattering by Born approximation, Eikonel approximation, Partial Wave analysis and solve problems.

Semester-2

Course Content

Unit 1 **08 hrs**

Classical Statistical Mechanics

The postulate of classical statistical mechanics, Derivation of thermodynamics, Classical ideal gas, Gibbs Paradox

Canonical Ensembles and Grand Canonical Ensembles

Canonical Ensemble, Energy fluctuations in canonical ensemble, Grand canonical ensemble, Density fluctuations in grand canonical ensemble

Unit 2 **08 hrs**

Quantum Statistical Mechanics

Postulate of Quantum Statistical mechanics, Density matrix, Macro – Canonical ensemble, canonical ensemble, The ideal gases, Micro – canonical ensemble

Unit 3 **08 hrs**

Super Fluids

Liquid Helium, Why helium does not solidify? Tisza's two – fluid model

The Ising Model

Definition of the Ising model, Lattice gas, Binary alloys

Unit 4 **08 hrs**

Scattering Theory

Kinematics of the scattering process, Differential and total cross – sections, Wave mechanical picture of scattering, The scattering amplitude, Green's functions, Formal expression for the scattering amplitude, Born approximation, The screened Coulomb potential, Validity of Born approximation, Born series, The eikonel approximation

Unit 5 **08 hrs**

Partial Wave Analysis

Definition of partial waves, Asymptotic behavior of partial waves: phase shifts (a) partial waves (b) asymptotic form of radial function (c) phase shifts, The scattering amplitude in terms of phase shifts, The differential and total cross – sections, Optical theorem, Phase shifts: Relation to the potential, Expression for the phase shift

References Books

1. Statistical Mechanics – K. Huang (Wiley)
2. Quantum Mechanics – Mathews and Vankatesan

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-6: Atomic and Molecular Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Atomic and Molecular Physics (CT-6)
Course (Paper) Unique Code: 1603010602020600
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: To understand the basic mechanism taking place inside the atom and molecule.
CO2: To understand the spectrum of Hydrogen like species, molecular structure and Spectroscopy.
CO3: To distribute electrons in elements and to analyze/interpret rotational and vibrational spectra.

Semester-2

Course Content

ATOMIC PHYSICS

Unit 1 **08 hrs**

Electronic Spectroscopy Of Atoms

The Structure of Atoms

The shape of Atomic Orbitals; Atomic Quantum Numbers – The Energies of Atomic Orbitals; Hydrogen Atom Spectrum

Electronic Angular Momentum

Orbital Angular Momentum – Electron Spin Angular Momentum – Total Electronic Angular Momentum – The Fine Structure of the Hydrogen Atom Spectrum

Many-Electron Atoms

The Building-Up Principle – The Spectrum of Lithium and Other Hydrogen-like Species

The Angular Momentum of Many-Electron Atoms

Summation of Orbital Contributions – Summation of Spin Contributions – Total Angular Momentum – Term Symbols

Unit 2 **08 hrs**

The Vector Atom Model

Quantum Numbers Associated with the Vector Atom Model – Coupling Schemes: The L-S Coupling, The j-j Coupling – Important Principles: Pauli's Exclusion Principle, The Selection Rules, The Intensity Rules, The Interval Rule, The Lande Splitting Factor "g" – Magnetic Moment Due to Orbital Motion; The Bohr Magneton – Magnetic Moment Due to Electron Spin – Zeeman Effect – Paschen-Back Effect – Stark Effect

MOLECULAR PHYSICS

Unit 3 **08 hrs**

Rotation of Molecules

Classification of Molecules, Interaction of Radiation with Rotating Molecule, Rotational Spectra of Rigid Diatomic Molecules, Isotope Effect in Rotational Spectra, Intensity of Rotational Lines, Non-rigid Rotator, Linear Polyatomic Molecules

Unit 4 **08 hrs**

Symmetric Top Molecules, Asymmetric Top Molecules, Stark Effect, Microwave Spectrometer, *Infrared Spectroscopy*: Vibrational Energy of a Diatomic Molecule; The Morse Curve and the Energy Levels of a Diatomic Molecule, Infrared Spectra (Preliminaries)

Unit 5 **08 hrs**

Vibrating Diatomic Molecule, Diatomic Vibrating Rotator, Normal Vibrations of CO_2 and H_2O Molecules, Interpretation of Vibrational Spectra, I-R Spectrophotometer-Instrumentation

References Books

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell (Tata MacGraw-

Hill, New Delhi)
2. Atomic Physics by J. B. Rajam (S. Chand & Company, New Delhi)
3. Molecular Structure and Spectroscopy by G. Aruldhas (Prentice - Hall of India, New Delhi)
4. Elements of Spectroscopy by Gupta-Kumar-Sharma (Pragati Prakashan, Meerut)
5. Introduction to Atomic Spectra by H. E. White (Tata McGraw Hill, New Delhi)
6. Spectroscopy Vol. 1, 2 & 3 by Straughan B. P. and Walker M. A. (Chapman and Hall, London)
7. Spectra of Atoms and Molecules by Peter Bernath (Oxford Uni. Press, USA)
8. Atomic Spectroscopy by K. P. Rajappan Nair (MJP Publishers, Chennai)
9. Atom, Laser and Spectroscopy by S. N. Thakur – D. K. Rai (PHI Learning Private Ltd., Delhi)
10. Introduction to Atomic and Molecular Spectroscopy by Vimal Kumar Jain (Narosa Publishing House, New Delhi)
11. Atomic & Nuclear Physics by C. R. Basu (New Central Book Agency Pvt. Ltd., Culcutta)
12. Atoms, Molecules and Lasers by K. P. Rajappan Nair (Narosa Publishing House, Delhi)
13. Introduction to Molecular Spectroscopy by G. M. Barrow (McGraw-Hill, New York)

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Semester-2

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-7: Space Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Space Physics (CT-7)
Course (Paper) Unique Code: 1603010702020700
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: Students will get basic knowledge of atmospheric science and also learn the techniques of observations

CO2: Some introduction to remote sensing will make them realize the importance and applications of it

Semester-2

Course Content

Unit 1 **10 hrs**

Basic Concepts of Earth's Atmosphere

Atmospheric nomenclature, Hydrostatic equation scale height, Geopotential height, Exosphere and gaseous escape, Chemical concepts of atmosphere, Thermodynamic considerations, elementary chemical kinetics composition and chemistry of middle atmosphere and thermosphere. Thermal balance in the atmosphere, models of neutral atmosphere (CIRA, US Standard atmosphere)

Unit 2 **12 hrs**

Solar Radiation and its Effects on the Atmosphere

Solar radiation at the top of the atmosphere, Attenuation of solar radiation in the atmosphere, radiative transfer, thermal effect of radiation, photochemical effects of radiation, Airglow

Structure and Variability of Earth's Ionosphere

Introduction to ionosphere, photochemical processes, Chapman's theory of photo ionization, production of ionospheric layers, loss mechanisms and chemistry of ionospheric regions, morphology of the ionosphere

Unit 3 **08 hrs**

Ionosphere Propagation and Measurement Techniques

Effect of Ionosphere on radiowave propagation, Refraction, Dispersion and polarization, Magnetoionic theory, critical frequency and virtual height, Oblique propagation and maximum usable frequency, Ground based techniques: ionosondes, radars, scintillation and TEC, ionospheric absorption, rocket and satellite borne techniques: Langmuir probe, electric field probe mass spectrometer

Unit 4 **06 hrs**

Elements of Solar Physics

Structure and composition of the Sun, sun as a source of radiation, sunspots an solar cycles, solar flares, coronal mass ejection

Magnetosphere of Earth

Solar wind and its characteristics, Interplanetary magnetic field and sector structure, Formation of geomagnetic cavity, magnetopause, magnetosheath and bow shock, polar cusp and magnetotail, Plasmasphere and Van Allen radiation belts

Unit 5 **04 hrs**

Concepts and Foundations of Remote Sensing

Energy sources and Radiation principles, Energy interactions in the atmosphere, energy interactions with earth surface features, Data acquisition and Interpretations, Reference data, The Global Positioning System An ideal remote sensing system, Characteristics of real remote sensing system, Practical applications of remote sensing, Land and Geographic Information System

References Books:

1. Physics of the Space Environment T.I. Gombosi, (CUP)
2. The Solar-Terrestrial Environment: JK. Hargreaves (CUP)
3. Remote Sensing and Image Interpretation: T.M. Lillesand and R.L. Kiefer, (John Wiley & Sons, 4th Edition)

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Semester-2

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-8: Solid State Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Solid State Physics (CT-8)
Course (Paper) Unique Code: 1603010802020800
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: Knowledge and understanding of solid state materials for their basic properties and possible technological applications

CO2: The use of fundamental properties and other well developed mechanisms / theories of solid state materials for their better applications in various technological fields

CO3: Development of transferable knowledge and explanation capabilities in master degree physics students for their better career point of views in research and academic fields

Semester-2

Course Content

Unit 1 **08 hrs**

Physics of Crystalline Solids

Crystalline State, Basic Definitions, Bravais and Non-Bravais Lattices, Elements of Symmetry, Crystal Planes and Miller Indices, Examples of Simple Crystal Structures, Principals of X-Ray, Neutron and Electron Diffraction in Crystalline Solids, Bragg's Law, Concept of Reciprocal Lattice, Experimental Techniques of X-Ray Diffraction

Defects in Solids

Types of Defects - Point Defects, Line Defects, Plane Defects, Grain Boundaries, Stacking Faults, Diffusion in Solids

Unit 2 **08 hrs**

Band Theory of Solids

Electron in Periodic Potential, Bloch Theorem, Kronig-Penney Model, Effective Mass, Tight Binding Approximation, Brillouin Zones, Cellular and Pseudo Potential Methods, Fermi Surfaces, De Hass Van Alfon Effect, Cyclotron Resonance, Classification of Solids, Limit of Band Theory – Metal Insulator Transition

Unit 3 **08 hrs**

Superconductivity

Definition, Types of Superconductors, Properties, Meissner Effect, Isotope Effect, BCS Theory – Qualitative Approach, Outcomes of BCS Theory, Josephson Effects, SQUID, Applications of Superconductivity

Unit 4 **08 hrs**

Diamagnetism and Paramagnetism

Classical Theory, Paramagnetism – Origin of Paramagnetic Moment, Langevin's Theory, Quantum Theory, Paramagnetism in Rare Earth and Iron Group Ions, Paramagnetism of Conduction Electrons

Unit 5 **08 hrs**

Ferromagnetism, Antiferromagnetism and Ferrimagnetism

Weiss Theory, Temperature Dependence of Saturation Magnetization (M_S), Heisenberg's Exchange Model, Slater's Criterion, Concept of Magnons, Ferromagnetic Domains, Origin of Domains, Antiferromagnetism and Ferrimagnetism, Ferrites

References Books:

1. Introduction to Solid State Physics - C. Kittel (Wiley Eastern)
2. Elementary Solid State Physics - M. Ali Omar (Addison Wesley)
3. Elements of solid state physics - J. P. Srivastava (Prentice Hall India)
4. Solid State Physics - M.A. Wahab (Nerosa Publishers)
5. Solid State Physics - Dan Wei (Cengage Learning)

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Core Paper: CT-9: Nuclear and Particle Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Nuclear and Particle Physics (CT-9)
Course (Paper) Unique Code: 1603010902030900
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:
CO1: Understand the basic nuclear properties and phenomena
CO2: Understand the nuclear transformations
CO3: Understand the nuclear reactions mechanism
CO4: Understand about the elementary particles and their quantum numbers

Semester-3

Course Content

Unit 1 **08 hrs**

Basic nuclear properties – Nuclear mass, charge and size – Intrinsic angular momentum of a nucleus – Dynamic properties of nuclei – nomenclature – Nuclear binding energy – Average binding energy per nucleon and saturation of nuclear forces-separation energy systematic – Abundance systematic of stable nuclides

Unit 2 **09 hrs**

Liquid drop model- Semi empirical mass formula – mass parabola – liquid drop model of fission – experimental evidences for shell effects – shell model – spin orbit coupling model– magic numbers – angular momenta and parities of nuclear ground states

Unit 3 **10 hrs**

Beta decay – introduction – modes of beta decay- conditions for spontaneous emission of beta decay- neutrino hypothesis – decay constant for beta decay- Fermi's theory of beta decay – shape of beta spectrum – life time and classification of beta decay – Allowed and forbidden transitions – selection rules – parity non conservation in beta decay - electron capture decay – detection and properties of neutrino

Unit 4 **07 hrs**

Gamma decay – energetics of gamma decay – interaction of gamma rays with matter – internal conversion

Nuclear reactions – introduction – conservation laws – non relativistic Q – equation – types of nuclear reactions - cross sections

Unit 5 **06 hrs**

Elementary particles – interaction of charge particles with matter - leptons – hadrons – elementary particle quantum numbers – isospin - symmetry and conservation laws – Quarks – charm, bottom and top quarks – fundamental interactions

References Books:

1. Elements of Nuclear Physics, L.E. Mayerhof, Tata Mc Graw Hill, 1959
2. Concepts of modern physics, Arthur Beiser, Mc Graw Hill Inter. 1987
3. Nuclear structure, A.Bohr and B.R. Mottelson, Vol.1 (1969) & Vol.2, Benjamin Reading A.(1975)
4. Introductory Nuclear Physics, Kenneth S. Kiane, Wiley, New York, 1988
5. Atomic and Nuclear Physics, Vol.2 ,Ghoshal
6. Introduction to High Energy Physics, P.H. Perkins, Addison-Wesley, London, 1982
7. Nuclear Physics Vol. 1 & 2, Shirokov Yudin,Mir Publishers, Moscow, 1982
8. Introduction to Elementary Particles, D. Griffiths,Har4per and Row, New York, 1987
9. Introduction to Nuclear Physics, H.A. Enge, Addision-Wesley, 1975
10. Nucleon – Nucleon Interaction, G.E. Brown and A.D. Jackson, North – Holland, Amsterdam 1976
11. Nuclear Interaction, S. de Benedetti, Hohn Wiley &Sons, New York, 1964
12. Theory of Nuclear Structure, M.K. Pal, Affiliated East West Madras, 1982
13. Introductory Nuclear Physics, Y.R. Waghmare, Oxford – IBH, Bombay, 1981

14. Elementary Particles, J.M. Longo, Mc Graw Hill, New York, 1971
15. Atomic Nucleus, R.D. Evans, Mc Graw Hill, New York, 1955
16. Nuclear Physics, I. Kaplan, 2nd Ed., Narosa, Madras, 1989
17. Concepts of Nuclear Physics, B.L.Cohen, TMGH, Bombay, 1971
18. Nuclear Physics, R.R. Roy and B.P. Nigam, Wiley-Eastern Ltd. 1983

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Semester-3

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Core Paper: CT-10: Physics and Chemistry of Nanomaterials

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Physics and Chemistry of Nanomaterials (CT-10)
Course (Paper) Unique Code: 1603011002031000
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: A student will have clear basic concepts of nano-structured materials
CO2: It is expected to train the students for synthesis of various nano-materials, various characterization methods and applications
CO3: A student will be able to appreciate the importance of nano-materials in regard to numerous applications

Semester-3

Course Content

Unit 1 **06 hrs**

Nanomaterials and Nanotechnology

Introduction, Scientific Revolutions, Basic Science, Nanotechnology, Materials at Nanoscale, Quantum Confinement, Size Effects, Size and Shape Matter

Unit 2 **10 hrs**

Carbon in the Nanoworld

Introduction, Graphite, Diamond, Fullerenes, Graphene, Carbon Nanotubes – Structure, Types, Properties, Growth and Applications

Prime Materials in Nanotechnology

Introduction, Natural and Man–Made, Semiconductors – ZnO and TiO_2, Ceramics, Polymers, Composites, Metals – Silver, Gold, Iron and Copper, Biomaterials

Unit 3 **06 hrs**

Nanofabrication

Introduction, Synthesis Categories, Top–Down Fabrication Methods – Arc Discharge, Laser Ablation, Ball Milling and Inert Gas Condensation, Bottom–Up Fabrication Methods – Homogeneous Nucleation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol – Gel, Hydrothermal and Microwave, Challenges in Fabrications

Unit 4 **10 hrs**

Nanomaterial Characterization Techniques

Structural Characterizations

X-Ray Diffraction (XRD), Small Angle X-ray Scattering (SAXS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM)

Chemical Characterizations

Optical Spectroscopy, Electron Spectroscopy, Photoelectron Spectroscopy (PS), Vibrational Spectroscopy, Ionic Spectroscopy: RBS, SIM, FIB Dynamic Light Scattering (DLS)

Physical Properties (Overview)

Mechanical, Optical, Electrical Conductivity, Magnetic

Unit 5 **08 hrs**

Applications of Nanomaterials

Molecular and Nano Electronics

Molecular Motors, Molecular Devices, Single Molecular Devices

Nanotribology

Nanotribometer, Surface Force Apparatus, Quartz Crystal Microbalance, Superlubricity, Hard Disk Capacity, Micro-Electromechanical Systems (MEMS)

Nanosensors

Nanoscale Organization, Quantum Size Effects, Electrochemical Sensors, Nano-Bio-Sensors, Future

Nanomedicines
Developments, Various Nanosystems in use, Diagnostic and Therapeutic Applications

References Books:

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press (Distributed by World Scientific Publishers, Singapore)
2. Nanotechnology: The Science of Small by M.A. Shah and K.A. Shah, WILEY (2013)
3. Nano - The Essentials: Understanding Nanoscience and Nanotechnology by T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi
4. Nanophysics and Nanotechnology by Edward C-Wolf, Wiley – VCH
5. Introduction to Nanotechnology by Charles P. Poole Jr. and Frank J. Owens, Wiley Interscience
6. Introduction to nano-science & nano-technology by K.K.Chattopadhyay and A.N. Banerjee, PHI
7. Nanoscience and Nanotechnology: Fundamental to Frontiers by M.S. Ramachandra Rao & Shubra Singh, Wiley India Pvt. Ltd. (2013)
8. Nanotechnology by S. Shanmugam, MJP Publishers

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Semester-3

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Elective Paper: ET-1: Synthesis of Materials

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Synthesis of Materials (ET-1)
Course (Paper) Unique Code: 1603011102031101
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The students will be able to carry out laboratory experiments under guidance for synthesis of bulk and nano-materials by ceramic and wet-chemical methods
CO2: The students will be able to implement any of the techniques for crystal growth under expert supervision
CO3: The students will be well acquainted with the various techniques of thin film deposition.

Semester-3

Course Content

Unit 1 **08 hrs**

Physical Methods

Solid State Reaction (Ceramic) Method

General Principles, Experimental Procedure: Reagents, Mixing, Container Material, Heat Treatment, Analysis, Kinetics of Solid State Reaction, Disadvantages

Microwave Synthesis

Background & General Principle, Preparation of $YBa_2Cu_3O_{7-\delta}$ Superconductor through Microwave Synthesis, Importance

Unit 2 **08 hrs**

Chemical Routes

Sol-gel Method

Principle, Lithium Niobate ($LiNbO_3$), Doped Tin Dioxide

Co-precipitation Method

Co-precipitation as a precursor to Solid State Reaction, Advantages & Disadvantages, Synthesis of CMR Manganites

Unit 3 **08 hrs**

Thin Film Synthesis

Vacuum Evaporation, Sputtering, Spin Coating, Pulsed Laser Deposition (PLD)

Unit 4 **10 hrs**

Growth of Single Crystals

Introduction to Methods of Growth of Crystals, Czochralski Method, Bridgman and Stockbarger Methods, Zone Melting and Zone Refining Methods, Impurity Leveling Factor, Verneuil Method, Molten Flux Method

Unit 5 **06 hrs**

Vapor Phase Transport Methods and Thin Film Growth

Hydrothermal Methods, Vapor Methods, Fundamental of Epitaxial Growth of Thin Layers

References Books:

1. Solid State Chemistry and its Applications
   Anthony R. West (John Wiley & Sons, Singapore)
2. Solid State Chemistry – An Introduction
   Lesley E. Smart and Elaine Moore (Viva Books Private Limited)
3. Solid State Chemistry
   R.C. Ropp (Elsevier)
4. Reactions and Characterization of Solids
   Sandra E. Dann (The Royal Society of Chemistry)
5. Magnetic Ceramics
   Raul Valenzuela (Cambridge Uni. Press)
6. New Directions in Solid State Chemistry
   C. N. R. Rao and J. Gopalakrishnan (Cambridge Uni. Press)
7. Hand Book of Thin Film Technology

K. L. Chopra (MacGrow Hill)
8. Thin Film Fundamentals
Goswami A. (New Age International)
9. Hand Book of Thin-Film Deposition Processes and Techniques
Krishna Seshan (Noyes Publications)
10. Crystal Growth – A Tutorial Approach
Eds. W. Bradsley, D.T.J. Hurle & J. B. Mullin (North Holland)
11. Crystal Growth Processes & Methods
P. Santhana Raghavan, P. Ramasamy (KRU Publications)

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Semester-3

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Elective Paper: ET-2: Physics of Ionosphere-Magnetosphere System

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Physics of Ionosphere-Magnetosphere System (ET-2)
Course (Paper) Unique Code: 1603011202031202
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The Students will understand the dynamics of the different parts of the atmosphere. They will get the idea about how to monitor and interpret the atmospheric changes

CO2: The students will also get exposure to the instrumental techniques for ionospheric studies, observations and data analysis, this will give them thorough idea about the various atmospheric phenomena.

Semester-3

Course Content

Unit 1 **10 hrs**

Ionospheric Plasma motions due to applied forces, generation of Electric field, collision frequencies, charged particle motion, response to neutral air wind and electric field, Electrical conductivities

Unit 2 **08 hrs**

Ionospheric conductivity, Ionospheric electric currents, Sq current system, EEJ Peculiarities of low latitude ionosphere, ionospheric storms, irregularities (ESF, scintillation and EEJ irregularities), EIA

Unit 3 **08 hrs**

Aurora and Airglow: Night glow, Dayglow, Twilight glow, Aurora, Photometer for airglow measurement, applications of Airglow measurement for ionospheric dynamics and composition

Unit 4 **10 hrs**

Magnetosphere: Circulation in the magnetosphere, magentospheric electric fields, particles in the magnetosphere, plasmasphere and its dynamics, magnetospheric current system, magneto pause current tail current ring current and Birlkeland current

Unit 5 **04 hrs**

Magentospheric substorms, substorm triggering and influence of IMF, substorm currents, Whistlers, micro pulsations

References Books:

1. The solar terrestrial environment – J K Hargreaves, CUP
2. Space Plasma Physics – A C Das, Narosa Publications
3. Introduction to Ionosphere and Magnetosphere: J.A. Ratcliffe (CUP)
4. Introduction Space Physics: M.J. Kievelson (CUP)

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Semester-3

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Elective Paper: ET-3: Space Technology

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Space Technology (ET-3)
Course (Paper) Unique Code: 1603011302031303
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: Students will understand the basic laws of Physics governing the satellites in its orbits.

CO2: How the power is generated in space? Powers storage devices and deep space requirements will be very interesting for them. Students will also learn about the ground and space based observation techniques.

Semester-3

Course Content

Unit 1 **12 hrs**

Orbital dynamics, Control and Guidance

Spherical coordinate system, Kepler's laws, sub satellite point, orbital parameters, sun-synchronous and geo-synchronous orbits, low earth orbits, attitude sensors, sun sensors, star sensors, earth sensors, magnetic aspect sensors, accuracies, spin stabilization and gyros, control of flight path, closed loop guidance, altitude control system

Unit 2 **06 hrs**

Power Generation and Storage

Space craft power system, special power sources, solar cells and panels, nuclear power, thermoelectric power generation, fuel cells, primary and secondary batteries, controlled harcware

Unit 3 **08 hrs**

Rocketry

Principles of Rocketry, sounding rockets, launchers, rocket fuels, combustion and thrust generation, solid and liquid propellent motors, electric propeulsion, multistage rockets

Unit 4 **10 hrs**

Ground based Experimental Techniques

Ionospheric sounding, Partial reflection, Scintillation and TEC measurements, airglow photometer, Volume scattering, Coherence and Incoherent scatter, Incoherent scatter radar, MST radar, LIDAR

Unit 5 **04 hrs**

Space borne Experimental Techniques

Langmuir probe and derivatives, Impedance and resonance probe, Mass spectrometers

References Books:

1. The Solar-Terrestrial environment, J.K. Hargreaves, CUP, 1992
2. Spacecraft system engineering – P Fortescue et al , Wiley

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Semester-3

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Elective Paper: ET-4: Analog and Digital Systems

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Analog and Digital Systems (ET-4)
Course (Paper) Unique Code: 1603011402031404
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The students will be able to explain the functioning of various operational amplifier based circuits including filters
CO2: The students will be able to design and implement various digital combinational and sequential circuits including ADC/DAC.

Semester-3

Course Content

Unit 1 **08 hrs**

The Basic Operational Amplifier

Block diagram representation of typical op-amp, Schematic symbol IC packages, Op-amp data sheet and op-amp electrical parameters, ideal op-amp, equivalent circuit of op-amp, ideal voltage transfer curve, open loop configurations, Op-amp with negative feedback: Feedback configurations, voltage series feedback amplifier (non-inverting amplifier with feedback), voltage shunt feedback amplifier (inverting amplifier with feedback)

Unit 2 **08 hrs**

Op-amp Circuits

Summing, Scaling and averaging amplifiers, subtractor, Integrator, differentiator, Active filters, first order low pass and high pass butterworth filters, Band-pass, Band reject and all pass filters, Phase shift and Wien bridge oscillators, Voltage controlled oscillator, Comparator, zero crossing detection, Voltage limiters

Unit 3 **08 hrs**

Combinational Logic Circuits

Implementation with gates, design procedure, designing binary adder and subtractor, BCD to Excess – 3 code converter

Implementation with MSI & LSI

Parallel binary adder, carry propagation delay and look ahead carry generator, 4-bit magnitude comparator, decoders, BCD to seven segment decoder, multiplexers

Unit 4 **08 hrs**

Sequential logic circuits

Flip-flops, Buffer registers, shift registers, bi-directional shift register, Ring counters, binary counters, Ripple counters, Synchronous counters, Counters with MOD number less than 2N, presettable counter, decade counter

Unit 5 **08 hrs**

A/D and D/A Converters

Digital to analog conversion, R-2R ladder network, Analog to digital conversion, open-loop methods, flash converter, time window converter, tracking A/D converter, successive approximation converter

References Books:

1. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, PHI
2. Digital Electronics : Christopher Strangio ,PHI
3. Fundamentals of Digital Circuits : Anadkumar, PHI
4. Digital Logic and Computer Design : M. Morris Mano, PHI
5. Digital Systems : Principles and Applications : Ronald Tocci, PHI

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Elective Paper: ET-5: Nuclear Radiation Detectors & Accelerators

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Nuclear Radiation Detectors & Accelerators (ET-5)
Course (Paper) Unique Code: 1603011502031505
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The students will be able to explain the functioning of various types of radiation detectors including high energy particle detectors
CO2: The students will acquire in-depth knowledge in the area of nuclear particle accelerators

Semester-3

Course Content

Unit 1 **09 hrs**

Ionizing Radiations

Ionization and transport phenomena in gas – Avalanche multiplication

Detector Properties

Detection – Energy measurement – Position measurement Time measurement

Gas Counters

Ionization chambers – Proportional counters – Multiwire proportional counters – Geiger – Muller counters

Unit 2 **07 hrs**

Solid State Detectors

Semiconductor detector – Surface barrier detectors

Scintillation Counters

Organic and inorganic scintillation – Theory, characteristics and detection efficiency

Unit 3 **08 hrs**

High Energy Particle Detectors

General principles – Nuclear emulsions – Cloud chambers – Bubble chambers – Cerenkov counter - Neutron Detectors & Spectroscopy

Unit 4 **08 hrs**

Historical Developments

Different types of accelerators –Layout and compoents of accelerators – Accelerator applications

Linear Accelerators

Historical milestones, Fundamental properties of accelerating structures Particle acceleration by EM waves

Unit 5 **08 hrs**

Principle and Design Details of Accelerators

Basic principle and design details of accelerator viz electrostatic, electrodynamic resonant with special emphasis on microtron, pelletron and cyclotron – Synchrotron radiation sources – Spectrum of the emitted radiation and the applications

References Books:

1. Nuclear Radiation Detectors S.S. Kapoor and V.S. Ramamurthy, Wiley – Eastern, New Delhi 1986
2. Radiation Detection, W.H. Tait, Butterworths, London, 1980
3. Nuclear Radiation Detection, W.J. Price, Mc Graw Hill, New York, 1964
4. Accelerator Physics, S.Y. Lee, World Scientific, Singapore, 1999
5. Principles of Cyclic Particle Accelerators, J.J. Livingood, D. Van Nostrand Co. 1961
6. Particle Accelerators, J.P. Blewett, McGraw Hill Book Co.

7. The Microtron, S.P. Kapitza and V.N. Melekhin, Harwood Academic Publishers
8. Particle Accelerators and Their Uses, W. Scharf, Harwood Academic Publishers
9. Theory of Resonance Linear Accelerators, I.M. Kapchinskyu, Harwood Academic Publishers
10. Linear Acccelerators, P. Lapostole and A. Septier, North Holland

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-III

Elective Paper: ET-6: Neutron Physics and Nuclear Reactor Theory

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Neutron Physics and Nuclear Reactor Theory (ET-6)
Course (Paper) Unique Code: 1603011602031606
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	3	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The students will be able to the interaction of neutrons with matter, moderation of neutrons and neutron diffusion
CO2: The students shall acquire fundamental knowledge of reactor physics and also be aware about the radiation hazards

Semester-3

Course Content

Unit 1 **06 hrs**

Neutrons and its Interaction with Matter

Nuclear cross section – Microscopic cross section – Macroscopic cross section – Cross section for mixtures

Unit 2 **10 hrs**

Slowing Down of Neutrons

Neutron moderation by elastic scattering – Collision kinematics – Differential elastic scattering cross section – Isotropic scattering – Average energy loss per collision and average cosine of scattering angle – Double differential scattering cross section – Description of the dynamics of elastic collision in terms of lethargy – Average lethargy gain – Slowing down power and moderation ratio – Average logarithmic energy decrement

Unit 3 **08 hrs**

Diffusion of Neutrons

Transport theory – Diffusion theory approximation – Calculation of neutron leakage – The diffusion equation – Solution of the diffusion equation – Boundary conditions – The linear extrapolation distance – Diffusion of mono-energic neutrons from a point source – The diffusion length

Unit 4 **10 hrs**

The Fission Chain Reaction and Nuclear Reactors

Self sustained chain reaction and reactor criticality – Critical Size and critical mass of a reactor – The multiplication factor – Approximate kinetics of chain reaction – Neutron life cycle and four factor formula – An infinite system – finite system – Nuclear reactors – Classification – General features – Efficiency – thermal reactors

Fuel Depletion and Poisoning Effects

Fuel depletion and its consequences – Fission product poisoning – Xenon poisoning – Samarium poisoning

Unit 5 **06 hrs**

Radiation Protection and Environmental Effects

Radiation hazards – Different types of radiation – External and internal radiation sources – Radiation Units – The Roentgen and the Rad – The Rem

Biological Effect of Radiation

Somatic effects of radiation – Genetic effects of radiation

References Books

1. Physics of nuclear reactors, S Garg, F. Ahmed, L.S. Kothari, Tata-McGraw Hill
2. Nuclear reactor engineering, S.Glasstone and A. Sesonske, CBS publisher & distributors
3. Introduction to nuclear reactor theory, J.R. Lamarash, Addison Wesely

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Core Paper: CT-11: Numerical Analysis and Computer Programming

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Numerical Analysis and Computer Programming (CT-11)
Course (Paper) Unique Code: 1603011702041700
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The students will be able to explain various methods of numerical analysis taught in units: 1 – 3

CO2: The students will learn the capabilities of FORTRAN language. The students will be able to write computer programme in FORTRAN language for solving numerical problems and curve fitting

Semester-4

Course Content

Unit 1 **10 hrs**

Methods of solving of linear and non-linear algebraic equations, transcendental equations, Convergence of Solutions, Solution of simultaneous linear equations, Gaussian elimination

Finite differences, interpolation with equally spaced and unevenly spaced points, Curve fitting, Polynomial, Least squares and Cubic Spline fitting

Unit 2 **10 hrs**

Numerical differential and integration, error estimates. Numerical solutions of ordinary differential equations – Euler and Runge-Kutta methods

Harmonic Analysis and FFT techniques

Unit 3 **02 hrs**

Elementary information about digital computers, Introduction to compilers and Operating systems

Unit 4 **14 hrs**

Programming introduction to FORTRAN, Flow Charts, Data type and structures, Constants and variables, mathematical Expressions in programming, , built in functions, Input and output statements, Logical control statements(with examples), functions and subroutines , operation with files, formatted input and output

Unit 5 **04 hrs**

Programme of straight line fitting, Programme for numerical integration techniques, Harmonic analysis

References Books

1. Numerical Recipes – (CUP)
2. Computer Programming In FORTRAN 77– Rajaraman , PHI
3. Programming & Computing with FORTRAN 77/90 – P.S. Grover
4. Computer based Numerical analysis – Shanthakumar – Khanna Pub

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Core Paper: CT-12: Experimental Techniques with Interdisciplinary Applications

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Experimental Techniques with Interdisciplinary Applications (CT-12)
Course (Paper) Unique Code: 1603011802041800
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

- Students will be able to explain principle, characteristics and applications of different types of radiation detectors
- Students will be able to explain the instrumentation of X-ray generation and X-ray spectroscopy and applications
- Students will be able to explain different types of Spectroscopic characterizations and their applications

Semester-4

Course Content

Unit 1 **09 hrs**

Radiation sources, Radiation interactions, Radiation detectors – gas filled detectors – scintillation detectors – semiconductor detectors

Unit 2 **09 hrs**

Introduction to production of X-ray & X-ray spectra, Instrumentation, X-ray generation, collimators, filters, detectors, X-ray absorption methods, X-ray fluorescence methods, XF – Spectrometer (XFS), Electron spectroscopy for chemical analysis (ESCA)

Unit 3 **07 hrs**

Nuclear Magnetic Resonance (NMR) spectroscopy, basic principles, nuclear magnetic energy levels, magnetic resonance, NMR Spectrometer

Electron Spin Resonance spectroscopy, ESR spectrometer, ESR spectra, Hyperfine interactions

Unit 4 **07 hrs**

Mass spectroscopy – principle, spectrometer, and its operation, resolution, Mass spectrum, applications

Infrared Spectroscopy, correlation of IR spectra with molecular structure, Instrumentation

Unit 5 **08 hrs**

Mossbauer Spectroscopy – Mossbauer effect, spectrometer, 57 Fe Mossbauer spectroscopy, nuclear hyperfine interactions

Neutron diffraction, neutron diffractometer (position sensitive diffractometer)

References Books

1. Instrumentation Methods of analysis: VIIth Edition, Willard Meritt, Dean, Settle, CBS publishers & distributors
2. Mossbauer Spectroscopy : Leopold May, Plenum Press, N.Y.
3. Neutron Diffraction: G.C. Becon
4. X-Ray diffraction: B.D. Culity, Edison Weisley
5. Radiation Detection & Measurement: Glenn F. Knoll, McGraw Hill

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Semester-4

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Elective Paper: ET-7: Materials Characterization

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Materials Characterization (ET-7)
Course (Paper) Unique Code: 1603011902041901
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: After taking up the course on materials characterizations, the students shall be able to explain the principle, instrumentation and application of each technique learnt.
CO2: The students will also wisely select the required characterization technique for study of specific material property

Semester-4

Course Content

Unit 1 **09 hrs**

X-ray Diffraction

X-rays and their Generation, Diffraction: Diffraction of Light by an Optical Grating, Crystals and the Diffraction of X-rays, d-spacing & Unit Cell Formulae, Overview of Powder Diffractometer

Effect of Crystal Size on the Powder Pattern; Particle Size Measurement, Effect of Stress on a Powder Pattern, Refinement of Unit Cell Parameters and Indexing of Powder Patterns, A Powder Pattern as a Crystal's 'Fingerprint', Structure Determination from Powder Patterns, Powder Patterns Calculated from Crystal Structure Data, Influence of Crystal Symmetry and Multiplicities on Powder Patterns

Unit 2 **08 hrs**

Imaging Techniques (Microscopy)

Scanning Electron Microscopy (SEM)

Physical Basis and Primary Modes of Operation, Instrumentation, Sample Requirements, FESEM, Advantages over conventional SEM, Applications

Transmission Electron Microscopy (TEM)

Basic Principle, Resolution, Sensitivity, TEM Operation, Image Mode, Specimen Preparation

Scanning Tunneling Microscopy (STM) and Scanning Force Microscopy (SFM)

Introduction, Instrumentation, Topography, Profilometry, Sample Requirements

Unit 3 **08 hrs**

Resistivity

Two point-four point probes, Derivation of four point probe expression, Correction factors, Measurement errors and precautions factors:- sample size, Carrier injection, probe spacing, current, temperature, surface preparation, high sheet resistance material, Van der Pauw method – measurement of arbitrary shape samples

Dielectric Study

Dielectric materials, types of polarizability, dielectric behavior with frequency, introduction to Cole- Cole plot, Ferro-electricity, P-E loop

Unit 4 **09 hrs**

UV-Vis

Introduction, principle of UV-vis spectroscopy, Beer-Lambert's law, molar absorbility, absorbing species, containing π, σ and η electrons, charge transfer absorption, Instrumentation of UV-vis spectroscopy: Radiation Sources, Wavelength Selectors, Monochromators, Sample Handling, Detectors, Signal Processing and Output Devices, Types of UV-Visible Spectrometers: Single Beam Spectrometers, Double Beam Spectrometers, Photodiode Array Spectrometer, applications

FT-IR

What is FT-IR, Why IR spectroscopy, Principle of IR spectroscopy, Theory of infrared absorption, vibrational modes, infrared ranges, Typical Instrumentation, use of FT-IR,

typical spectral analysis

Unit 5 **06 hrs**

Magnetometry

Basic principle, Vibrating sample magnetometer, SQUID magnetometer

Thermogravimetry

Principle, Apparatus, application, Differential thermal analysis and Differential Scanning Calorimetry, Principles, Apparatus and Applications

References Books

1. Solid State Chemistry and its Applications
   Anthony R. West, John Wiley & Sons, Singapore
2. Characterization of Materials by P.K. Mitra, PHI (2014)
3. Encyclopedia of Materials Characterization
   C. R. Brundle, C. A. Evans, S. Wilson, Butter Worth-Heinemann, Boston
4. Elements of X-ray Crystallography
   L. V. Azaroff, McGraw-Hill Book Company
5. Characterization of Materials
   E. N. Kaufmann, Wiley- Interscience
6. Principles of Instrumental Analysis
   D. A. Skoog and P. M. West
7. Spectroscopy
   B. K. Sharma, Goel Publication
8. Semiconductor Material and Device Characterization
   D. K. Schroder, IEEE, Wiley Interscience
9. Nano: The Essentials Understanding: Nano Science and Nano-technology by T. Pradeep, Tata McGraw Hill
10. Nanotechnology by S. Shanmugam, MJP Publishers
11. Infrared Spectroscopy by Barbara Stuart, Wiley Publication

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Elective Paper: ET-8: Functional Materials

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Functional Materials (ET-8)
Course (Paper) Unique Code: 1603012002042002
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: After taking up this elective course, the students will be able to appreciate the necessity of acquiring knowledge of various functional materials in order to select a material for intended specific application

CO2: The students will be motivated for research in the area of functional materials as they will have the required prerequisite knowledge.

Semester-4

Course Content

Unit 1 **04 hrs**

Fundamental Concepts

Crystallographic Structure, Chemical Structure, Bonding, Concept of Mixed Valances, Material Properties and Functional Characteristics

Unit 2 **10 hrs**

Magnetic Oxide Functional Materials: CMR Manganites

Structure and Chemistry of Mixed Valent Manganites, Concept of Magnetoresistance, Types of Magnetoresistance (MR), Physical Properties and Affecting Parameters, Role of Mn – O Lattice, Zener Double Exchange Mechanism, Jahn – Teller Effect, Phase Diagram of Mixed Valent Manganites, Applications of Manganites

Unit 3 **08 hrs**

Multiferroics (MFs)

Introduction, Types of Ordering, Magnetoelectric Effect, Problem with Multiferroics, Structural – Physical – Chemical Behavior, Types of Multiferroics, Multiferroicity in $BiFeO_3$

Unit 4 **10 hrs**

High Temperature Superconductor (HTSC)

Discovery, Families of HTSC, General Features, Synthesis of YBCO (123) Superconductor and Crystallographic Structure – Property Correlations, Role of Copper and Oxygen, Application of HTSC

Unit 5 **08 hrs**

Ferrites

Fundamentals, Crystal Structures, Synthesis Methods, Properties and Applications, Hard and Soft Ferrites, Ferrites Compositions for Specific Applications

Diluted Magnetic Semiconductor (DMS)

Introduction to Spintronics, Properties and Applications of Spintronics, Origin of Ferromagnetism in DMS: Model Considering Defects, Mean Field Theory and Bound Magnetic Polaron

References Books

1. Functional and Smart Materials by Zhong Lin Wang and Z.C. Kang, Plenum Press, 1998 Plenum Publishing Corp
2. Colossal Magnetoresistance by C.N.R. Rao & B. Raveau World Scientific, Singapore, 1998
3. Superconductivity Today by T.V. Ramakrishnan and C.N.R. Rao University press Hyderabad

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Elective Paper: ET-9: Elective Theory Paper: Remote sensing and Applications

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Elective Theory Paper: Remote sensing and Applications (ET-9)
Course (Paper) Unique Code: 1603012102042103
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: Students will have thorough idea about the various types of camera and sensors used in remote sensing.

CO2: They will also be able to understand the defects and its solutions in the space borne images.

CO3: Students will be able to interpret the remote sensing images for different aspects.

Semester-4

Course Content

Unit 1 **10 hrs**

Elements of Photographic Systems

Early history of Aerial photography, Basic negative to positive photographic sequence, Film exposure, Film density and characteristic curves, structure & Spectral sensitivity of black and white, color and color infrared films, film resolution, Aerial cameras, filters, electronic imaging, multiband imaging

Unit 2 **08 hrs**

Principles of Photogrammetry

Basic geometric characteristics of aerial photograph Photographic scale, Area measurement, Relief displacement of vertical features, image parallax, measurement of object height and ground coordinate, Mapping with aerial photographs

Unit 3 **06 hrs**

Visual Image Interpretation

Fundamentals of visual image interpretation, Basic visual image interpretation equipment, Land use/land cover mapping, Geologic and soil mapping, Forestry mapping, water resources and wetland mapping

Unit 4 **06 hrs**

Multispectral and Thermal Scanning

Across tack and along track scanning, Operating principles of multi spectral scanners, Across track thermal scanning, thermal radiation principles, interpreting thermal scanner imagery, Radiometric calibration of thermal scanners. Temperature mapping with thermal scanner data

Unit 5 **10 hrs**

Digital Image Processing

Introduction, Image rectification and restoration, Image enhancement, contrast manipulation, spatial feature manipulation, image classification, different classification schemes, Classification accuracy assessment, Image transmission and compression

Earth Resources Satellites

Early history of space imaging Landsat 1-4 system, Landsat image interpretation, SPOT satellite program, IRS system, data and applications

References Books

1. Remote sensing and image interpretation. T.M. Lillesand and R.W. Kiefer (4^{th} ed.) John Wiley and Sons, 2002
2. Fundamentals of Remote Sensing – George Joseph Univ. Press

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Elective Paper: ET-10: Pulse & Microwave Electronics Syllabus

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Pulse & Microwave Electronics Syllabus (ET-10)
Course (Paper) Unique Code: 1603012202042204
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: After taking up the course on pulse and microwave electronics, the students will be able to design the required pulse circuits and explain operation of microwave tubes, microwave solid state devices, types of antenna and RADAR

Semester-4

Course Content

Unit 1 **08 hrs**

Characteristic of Pulse waveforms, rise time, fall time, duty cycle concept, tilt, R-C circuits, constant rate charging, relationship between rise time and upper cutoff frequency, relationship between fall time and tilt, integrating and differentiating circuits. Clipping and clamping circuits using diodes

Unit 2 **06 hrs**

Schmitt trigger and Ramp generator **:** Circuit operation, designing for a given upper trigger point (UTP) and lower trigger point (LTP), speed-up capacitor, input and output characteristics, RC ramp generators, constant current ramp generators

Unit 3 **08 hrs**

Transistorised Multivibrators

Astable and Monostable multivibrators, Bistable multivibrator with set-reset triggering The timer IC-555, functional block diagram, Astable & Monostable multivibrator using IC-555

Unit 4 **10 hrs**

Fundamentals of microwave technology, limitations of vacuum tubes. Klystrons, Two cavity Klystron, Multi-cavity and Reflex Klystrons, Traveling wave tube, Magnetron

Solid-State Microwave Devices

Microwave transistors, Tunnel diodes, Gunn Effect diodes

Unit 5 **08 hrs**

Antennas

Terms and definition, Antenna gain, resistance, beamwidth and polarization, resonant & non resonant antenna, effect of ground on antennas, antenna height, directional high frequency antennas, dipole arrays, Yagi-Uda antenna, Parabolic reflector

Radar

Basic principle, Radar Range equation, Factor influencing maximum range, display methods, moving target indication

References Books

1. Solid State Pulse Circuits, David A Bell, PHI
2. Electronic Communication Systems : George Kennedy TMH
3. Microwave Devices & Circuits, III Edition, Samuel Y. Liao, PHI
4. Electronic communications systems, Wayne Tomasi, Pearson Education

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Elective Paper: ET-11: Electronic Communication

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Electronic Communication (ET-11)
Course (Paper) Unique Code: 1603012302042305
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The students taking up this elective course on electronic communication shall be able to understand the intricacies involved in the wire-less electronic communication like using ionosphere/troposphere, LOS, satellite communication and digital modulation.

CO2: The students will be able to explain theoretical aspects of electronic communication with some medium like transmission line, waveguide and fiber optic cables.

Semester-4

Course Content

Unit 1 **06 hrs**

Radio wave propagation, propagation in free space, transmission – path, loss, ground-wave propagation, space-wave propagation: radio horizon, sky wave propagation: ionosphere, plasma and critical frequency, secant law and MUF Vertical height, Service range, skip distance

Unit 2 **10 hrs**

Digital communication, Shannon limit for information capacity, digital amplitude modulation, frequency shift keying, FSK transmitter and receiver, Phase shift keying, BPSK, QPSK, Quardrature Amplitude modulation (8-QAM), bandwidth efficiency, Pulse code modulation (PCM)

Unit 3 **08 hrs**

Satellite communication, Orbital and geostationary satellites orbital patterns, look angles, satellite construction, radiation patterns, satellite system link models, transponder, satellite system parameters

Unit 4 **10 hrs**

Transmission lines and waveguides : Equivalent circuit, primary constants, transmission line equations, infinite line, characteristic impedance, secondary constants, open and short circuited line, line with any termination

Waveguides

Rectangular waveguides, Modes, Properties of TE_{10} mode, generating TE_{10} mode from two TEM waves, fields patterns

Unit 5 **06 hrs**

Optical fiber communication, fiber optic communication link, fiber type, cable construction, propagation of light through optical fiber configurations, signle mode and multi mode slip index fiber, graded-index fiber, Acceptance angle and cone, numerical aperture, losses in optical fiber, Light sources and detectors

References Books

1. Electronic Communication Systems, Wyne Tomasi, Pearson Education Asia, II Ed. (2001)
2. Electronic Communication System : George Kennedy TMH
3. Electronic Communications, Dennis Roddy & John Coolen, PHI
4. Modern Electronic Communication, Gray M. Miller & Jeffrey S. Beasley, PHI

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV

Elective Paper: ET-12: Nuclear Reactions, Nuclear Energy and Nuclear Models

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Nuclear Reactions, Nuclear Energy and Nuclear Models (ET-12)
Course (Paper) Unique Code: 1603012402042406
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	4	Elective	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Course outcome:

CO1: The fundamental concepts of the nuclear reactions, nuclear fission , nuclear fusion nuclear shell model will be strengthened.
CO2: The students shall be well equipped for taking up further research tasks in the area of nuclear physics.

Semester-4

Course Content

Unit 1 **08 hrs**

Nuclear reaction characteristics – Reaction energetics Non-relativistic and relativistic Q–equation – Energy correlation analysis – Energy levels in nuclei – Theories of nuclear reactions – Compound nucleus model – Breit – Wigner formula – Resonance scattering and resonance cross sections

Unit 2 **10 hrs**

Mechanism of Nuclear Fission, Fission Cross sections, Fission reactors, Fission Rate & reactor Power, Fission neutrons and gamma rays, prompt neutrons, delayed neutrons, fission gamma rays, Fission products, Amounts and activities of fission products, Fission–product activity after shutdown, Heat generation after shutdown

Unit 3 **07 hrs**

Nuclear Fusion – Thermonuclear reactions – Energy production in stars, Fundamental interactions & elementary particles, Strong, Weak & Electromagnetic interactions

Unit 4 **08 hrs**

Nuclear shell model – Single particle potential – spin orbit potential – analysis of shell model predictions – single particle shell model – total spins J for various configurations (J) – Nuclear isomerism – magnetic moment – configuration mixing – Individual (independent) particle model – Russell Saunders coupling (L-S) coupling – jj coupling scheme – transformation between the L-S and the jj coupling schemes and beta decay

Unit 5 **07 hrs**

Unified (Collective) Model

Introduction – The vibrational modes of a spherical nucleus – Collective modes of deformed even-even nucleus – Symmetries of the collective wave function for well deformed eve-even nuclei – Collective spectral of even-even nuclei

References Books

1. Structure of the Nucleus, M.A. Preston and R.K. Bhaduri, Addison Wesley
2. Nuclear Physics : Theory and Experiments, R. Roy and B.P. Nigam, Wiley Eastern
3. Physics of Nuclei and Particles, P. Marmier and E. Sheldon, Vol.1, Academic Press Physics of the Nucleus, M.A. Preston Addision Wesley
4. Nuclear and Particle Physics, W.S.C. Williams, Clarendon Press
5. Fundamentals of Radiochemistry, D.D. Sood, A.V.R. Reddy, N. Ramamoorthy, Indian association of nuclear chemists & allied scientists

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