Syllabus

MASTER OF SCIENCE

SEMESTER – I to IV

PHYSICS

Choice Based Credit System (CBCS)

M.Sc. PHYSICS
(CBCS)
Semester-I to IV

DEPARTMENT OF PHYSICS
SAURASHTRA UNIVERSITY
RAJKOT

Effective from June 2016
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, Biosciences, 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

<table>
<thead>
<tr>
<th>Semester I</th>
<th>Course</th>
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<td>(includes experimental work, data analysis, library work and viva-voce preparation)</td>
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<td>AND PROJECTS</td>
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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
Semester-1

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: 160301010201010
External Examination Time Duration: 2½ hours

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<th>Semester</th>
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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)

Semester-1

Course Content

Unit 1 07 hrs
Ordinary Differential Equations
Introduction, Solution of Second Order Differential with Variable Coefficients (1)
Homogeneous Equations (2) Inhomogeneous Equations
Series Integration Method of the Solution of Linear Differential Equations (Frobenius’ Method)
Unit 2

Laplace and Fourier Transforms

11 hrs

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

The Equation of Motion and First Integrals

08 hrs

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

Canonical Transformations

06 hrs


Unit 5

Hamilton – Jacobi Theory

08 hrs


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
7. Classical Mechanics of Particles and Rigid Bodies – Kiran C. Gupta
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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

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<tr>
<th>All FIVE questions are of equal weightage: 14 marks</th>
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<td>Q.4 Answer the following : Any two out of three questions (7 marks each)</td>
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<td>Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)</td>
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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  
**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  
**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  
**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  
**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

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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

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<th>Semester</th>
<th>Course Group</th>
<th>Credit</th>
<th>Internal Marks</th>
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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)

Semester-1

Course Content

Unit 1 08 hrs
Unit 2
Angular momentum commutation relation, coordinate transformation, Angular momentum operators and its eigen value problems in position representation, Spherical harmonics

Unit 3
Solution of Schrodinger equation in three dimension separable variable method, Applications to (I) Square well (II) Attractive coulomb potential (III) Hydrogen Atom

Unit 4
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
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)
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

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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

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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
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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)

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  
**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 $\omega_p$, Experimental consequences – Whistler modes, Faraday rotation, Hydro magnetic waves and Magneto sonic or Alfven waves

**References Books**  
2. Introduction to electrodynamics, D.J. Griffith (PHI, New Delhi)  
3. Plasma Physics by Bittencourt  
4. Plasma Physics by Chakraborty

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Faculty of Science, M.Sc. Physics Syllabus (2016)

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
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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

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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)

Semester-2

Course Content

Unit 1

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

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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

Maximum Marks: 70 and Time: 2½ hours

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Q.3 Answer the following: a, b, c/a, b, 5, 5, 4 OR 7 marks each (all compulsory)
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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
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

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 CO2 and H2O 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)
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)
7. Spectra of Atoms and Molecules by Peter Bernath (Oxford Uni. Press, USA)
10. Introduction to Atomic and Molecular Spectroscopy by Vimal Kumar Jain (Narosa Publishing House, New Delhi)

== X == X ==
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

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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 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, Magnetooionic theory, critical frequency and virtual height, Oblique propagation and maximum usable frequency, Ground based techniques: ionosondes, radars, scintillation and TEC, ionspheric 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)

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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: 16030108020800
External Examination Time Duration: 2½ hours

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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

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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 Content

Unit 1 08 hrs
Physics of Crystalline Solids
Defects in Solids
Types of Defects - Point Defects, Line Defects, Plane Defects, Grain Boundaries, Stacking Faults, Diffusion in Solids
Unit 2

Band Theory of Solids

Unit 3

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

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

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)
5. Solid State Physics - Dan Wei (Cengage Learning)

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Semester-3

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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

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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 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  
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  

Unit 4  
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  

References Books:
1. Elements of Nuclear Physics, L.E. Mayerhof, Tata Mc Graw Hill, 1959
5. Atomic and Nuclear Physics, Vol.2, Ghoshal
9. Introduction to Nuclear Physics, H.A. Enge, Addision-Wesley, 1975
17. Concepts of Nuclear Physics, B.L.Cohen, TMGH, Bombay, 1971
Faculty of Science, M.Sc. Physics Syllabus

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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

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Q.5 Answer the following: Any TWO out of FOUR questions (7 marks each)

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  
**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 TiO₂, Ceramics, Polymers, Composites, Metals – Silver, Gold, Iron and Copper, Biomaterials  

Unit 3  
**Nanofabrication**  

Unit 4  
**Nanomaterial Characterization Techniques**  
**Structural Characterizations**  
**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  
**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)  
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
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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

Maximum Marks: 70 and Time: 2½ hours

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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 Content

Unit 1 08 hrs
Physical Methods
Solid State Reaction (Ceramic) Method
Microwave Synthesis
Background & General Principle, Preparation of YBa$_2$Cu$_3$O$_{7-δ}$ 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
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. Bradshley, 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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

Maximum Marks: 70 and Time: 2½ hours

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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 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: Nightglow, 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, magnetospheric electric fields, particles in the magnetosphere, plasmasphere and its dynamics, magnetospheric current system, magneto pause current tail current ring current and Birkeland current

Unit 5  
04 hrs  
Magnetospheric substorms, substorm triggering and influence of IMF, substorm currents, Whistlers, micro pulsations

References Books:
1. The solar terrestrial environment – J K Hargreaves, CUP
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

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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

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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 Content

Unit 1
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  
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  
hardware

Unit 3  
Rocketry  
Principles of Rocketry, sounding rockets, launchers, rocket fuels, combustion and thrust  
generation, solid and liquid propellent motors, electric propeulsion, multistage rockets

Unit 4  
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  
Space borne Experimental Techniques  
Langmuir probe and derivatives, Impedance and resonance probe, Mass spectrometers

References Books:  
2. Spacecraft system engineering – P Fortescue et al , Wiley

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Faculty of Science, M.Sc. Physics Syllabus (2016)
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
4. Digital Logic and Computer Design : M. Morris Mano, 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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

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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

Solid State Detectors
Semiconductor detector – Surface barrier detectors

Scintillation Counters
Organic and inorganic scintillation – Theory, characteristics and detection efficiency

Unit 3

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

Unit 4

Historical Developments
Different types of accelerators – Layout and components of accelerators – Accelerator applications

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

Unit 5

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:
8. Particle Accelerators and Their Uses, W. Scharf, Harwood Academic Publishers
10. Linear Acccelerators, P. Lapostole and A. Septier, North Holland

== X == X ==
Semester-3

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

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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)
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    OR
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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 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  
**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  
**Diffusion of Neutrons**

Unit 4  
**The Fission Chain Reaction and Nuclear Reactors**

**Fuel Depletion and Poisoning Effects**
Fuel depletion and its consequences – Fission product poisoning – Xenon poisoning – Samarium poisoning

Unit 5  
**Radiation Protection and Environmental Effects**

**Biological Effect of Radiation**
Somatic effects of radiation – Genetic effects of radiation

**References Books**
2. Nuclear reactor engineering, S.Glasstone and A. Sesonske, CBS publisher & distributors
3. Introduction to nuclear reactor theory, J.R. Lamarash, Addison Wesely
Semester-4

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

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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 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  
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  

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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

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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
4. X-Ray diffraction: B.D. Culity, Edison Weisley

== X == X ==
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

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Course Content

Unit 1  
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  
**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  
**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  
**UV-Vis**
Introduction, principle of UV-vis spectroscopy, Beer-Lambert’s law, molar absorbility, absorbing species, containing $\pi$, $\sigma$ and $\eta$ 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  
**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
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
10. Nanotechnology by S. Shanmugam, MJP Publishers
11. Infrared Spectroscopy by Barbara Stuart, Wiley Publication
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: 16030120024002
External Examination Time Duration: 2½ hours

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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

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Course Content

Unit 1 04 hrs

Fundamental Concepts
Crystallographic Structure, Chemical Structure, Bonding, Concept of Mixed Valances, Material Properties and Functional Characteristics
Unit 2  
**Magnetic Oxide Functional Materials: CMR Manganites**  
10 hrs  
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  
**Multiferroics (MFs)**  
08 hrs  
Introduction, Types of Ordering, Magnetoelectric Effect, Problem with Multiferroics, Structural – Physical – Chemical Behavior, Types of Multiferroics, Multiferroicity in BiFeO$_3$

Unit 4  
**High Temperature Superconductor (HTSC)**  
10 hrs  
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  
**Ferrites**  
08 hrs  
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**  
FACULTY OF SCIENCE
M. Sc. (Physics) Semester-IV


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

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Q.5 Answer the following: Any TWO out of FOUR questions (7 marks each)

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  
**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  
**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  
**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  
**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**

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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

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Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination

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Q.5  Answer the following : Any TWO out of FOUR questions (7 marks each)

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
4. Electronic communications systems, Wayne Tomasi, Pearson Education
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: 160301230204205
External Examination Time Duration: 2½ hours

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Total Contact hours: 48 (Including tutorials)

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Maximum Marks: 70 and Time: 2½ hours
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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)

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, Quadrature 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, single 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  
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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Semester-4

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

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Total Contact hours: 48 (Including tutorials)

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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 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

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
4. Nuclear and Particle Physics, W.S.C. Williams, Clarendon Press
### List of Theory papers of M.Sc. Physics programme with their examination-unique codes

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<tr>
<th>Sr. No.</th>
<th>Name of Paper</th>
<th>Unique code</th>
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<td>Mathematical Physics &amp; Classical Mechanics</td>
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