FACULTY OF SCIENCE

SYLLABI

FOR

M.Sc. (TWO YEAR COURSE)

IN

PHYSICS

1st & 2nd YEAR (Semester System)

EXAMINATIONS 2012-2013
OUTLINES OF SYLLABI AND COURSES OF READING FOR M.Sc. (TYC) IN PHYSICS (1st to 4th SEMESTER) FOR THE EXAMINATION 2012-13

M.Sc 1st Semester

PHY 6001  MATHEMATICAL PHYSICS I  15+60 = 75
PHY 6002  CLASSICAL MECHANICS   15+60=75
PHY 6003  QUANTUM MECHANICS I   15+60=75
PHY 6004  CLASSICAL ELECTRODYNAMICS I  15+60=75
PHY 6005  ELECTRONICS I         15+60=75
PHY 6051  PHYSICS LAB I          125

M.Sc 2nd Semester

PHY 6011  MATHEMATICAL PHYSICS II  15+60 = 75
PHY 6012  QUANTUM MECHANICS II    15+60=75
PHY 6013  PARTICLE PHYSICS I      15+60=75
PHY 6014  NUCLEAR PHYSICS I       15+60=75
PHY 6015  ELECTRONICS II          15+60=75
PHY 6052  PHYSICS LAB II          125
M.Sc 3rd Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Teaching hours per week</th>
<th>Marks</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PHYS 7001</td>
<td>Classical Electrodynamics II</td>
<td>4</td>
<td>15+60 = 75</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 7002</td>
<td>Statistical Mechanics</td>
<td>4</td>
<td>15+60 = 75</td>
<td>3</td>
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<tr>
<td>PHYS 7003</td>
<td>Nuclear Physics II</td>
<td>4</td>
<td>15+60 = 75</td>
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<tr>
<td>PHYS 7004</td>
<td>Condensed Matter Physics I</td>
<td>4</td>
<td>15+60 = 75</td>
<td>3</td>
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<tr>
<td>PHYS 7021</td>
<td>Physics Laboratory III</td>
<td>9</td>
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<tr>
<td>PHYS 7022</td>
<td>Computational Physics I</td>
<td>6</td>
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M.Sc 4th Semester

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<tr>
<td>PHYS 7051</td>
<td>Particle Physics II</td>
<td>4</td>
<td>20+80 = 100</td>
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<tr>
<td>PHYS 7052</td>
<td>Condensed Matter Physics II</td>
<td>4</td>
<td>20+80 = 100</td>
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<tr>
<td>PHYS 7071</td>
<td>Physics Laboratory IV*</td>
<td>9</td>
<td>125</td>
<td>5</td>
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<tr>
<td>PHYS 7072</td>
<td>Project *</td>
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<tr>
<td>PHYS 7073</td>
<td>Computational Physics II</td>
<td>6</td>
<td>75</td>
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Special Paper (one of the following)**

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<tr>
<th>Course Code</th>
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<th>Teaching hours per week</th>
<th>Marks</th>
<th>Credits</th>
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<tr>
<td>PHYS 7053</td>
<td>Experimental Techniques in Nuclear Physics and Particle Physics</td>
<td>4</td>
<td>20+80 = 100</td>
<td>4</td>
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<tr>
<td>PHYS 7054</td>
<td>Fibre Optics and Non-linear Optics</td>
<td>4</td>
<td>20+80 = 100</td>
<td>4</td>
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<tr>
<td>PHYS 7055</td>
<td>Nonlinear Dynamics</td>
<td>4</td>
<td>20+80 = 100</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 7056</td>
<td>Particle Accelerator Physics</td>
<td>4</td>
<td>20+80 = 100</td>
<td>4</td>
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* Some students will be allotted project on the basis of their option and percentage of marks in M.Sc. I examination, while all other students will do Physics Laboratory IV.

** The special papers will be offered depending upon the availability of teachers, and the students will be allotted one of the courses being taught, on the basis of their option and percentage of marks in M.Sc. I examination.

- All Theory Papers will be of 3 hours.
- All Practical Exams. will be of 3 hours.
M.SC.- 1ST SEMESTER

PHY6001  MATHEMATICAL PHYSICS I

Max. Marks: 15+60=75

Objectives: The aim and objective of the course on Mathematical Physics I is to equip the M.Sc student with the mathematical techniques for understanding theoretical treatment in different courses e.g. to evaluate various definite integrals, to solve various differential equations including

Laplace equation, Schrodinger equation, equations used in electronic circuits, electrical circuits, nuclear decays etc. Concepts of Complex analysis, Dirac Delta function, beta, gamma functions, Special functions: Bessel, Legendre, Hermite, Lagurre functions

For developing a strong background if he chooses to pursue research in Physics as a career.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I


(6.1-6.5, 7.1-7.3 of Book1)

UNIT II

II Delta and Gamma Functions: Dirac delta function. Delta sequences for one dimensional function, properties of delta function, gamma function, factorial notation and applications. Beta function.

(8.7, 10.1, 10.4 of Book 1)

UNIT III


(8.1, 8.3-8.6 of Book 1)
UNIT IV


TUTORIALS: Relevant problems given at the end of each section in the text books.

Books


PHY6002 CLASSICAL MECHANICS

Max. Marks: 15+60=75

Objectives: The aim and objective of the course on Classical Mechanics is to train the students of M.Sc class in the Lagrangian and Hamiltonian formalism, conservation theorems, rigid body motion, Hamilton’s equations, Canonical Transformations to an extent that they can use these in the modern branches like Quantum Mechanics, Quantum field theory, Condensed matter Physics, Astrophysics etc.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.
2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I


(1.1-1.6 of BOOK 1)


(2.1-2.6 of Book 1)

UNIT II

III Rigid Body Motion: Independent co-ordinates of rigid body, orthogonal transformation. Eulerian Angles and Euler’s theorems. Infinitesimal rotation. Rate of change of vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation. Euler equations of motion. Torque free motion of rigid body, motion of a symmetrical top.

(4.1, 4.2, 4.4, 4.6, 4.8, 4.9, 4.10, 5.1, 5.3, 5.7 of Book 1)

UNIT III


(6.1-6.4 of Book 1)


(8.1-8.3, 8.5, 8.6 of Book 1)

UNIT IV


(9.1, 9.2, 9.4-9.6, 10.1, 10.4, of Book 1)
TUTORIALS: Relevant problems given at the end of each section in the textbook.

Books

PHY6003 QUANTUM MECHANICS I

Max. Marks: 15+60=75

Objectives: The aim and objective of the course on Quantum Mechanics I is to introduce the students of M.Sc to the formal structure of the subject and to equip them with techniques of linear vector space and matrix mechanics, Stationary state approximate methods, angular momentum, perturbation theory, Variational method with the application to ground states of harmonic oscillator, hydrogen atom etc., Fermi’s Golden rule so that they can use these in various branches of Physics as per requirement.

Note:
1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.


(Ch,1, 2.3, 2.7, 3.9 of Book 1 and 3.16 of Book 2)


(3.8, 3.10, 3.11, 3.12 of Book 1 and 8.1-8.3, 8.5, 8.6, 8.9, of Book 2, Book 5)
III Stationary State Approximate Methods: Non-Degenerate and degenerate perturbation theory and its application to anharmonic oscillator, Variational method with application to the ground states of harmonic oscillator, hydrogen atom, helium and other simple cases.

(5.1-5.4, 5.6-58, of Book 2 and Ch 4 of Book 1)

IV Time Dependent Perturbation: General expression for the probability of transition form one state to another, constant and harmonic perturbations, Fermi’s golden rule and its application to radiative transition in atoms. Selection rules for emission and absorption of light.

(Ch 6 of Book 1 and 9.5-9.8, 9.12-9.15 of Book 2)

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:


PHY6004 CLASSICAL ELECTRODYNAMICS I

Max. Marks: 15+60=75

Objectives: The Classical Electrodynamics course covers Electrostatics and Magnetostatics, Multipole expansion, concepts of dielectrics: Molecular polarizability, Clausius Mossetti equation, boundary value problems: Green’s theorem, Method of images, Maxwell equations and their applications to propagation of electromagnetic waves in dielectrics, metals and plasma media, EM waves in bounded media: Fresnel amplitude relations, polarization, Total internal reflection, wave guides, radiation from localized time varying sources.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.
2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

I   **Electrostatics in Vacuum**: Coulomb’s Law, Gauss Law, Scalar potential. Laplace and poisson’s equations. Electrostatic potentials, energy and energy density of the electromagnetic field.
(1.1-1.4 and 1.6 of Book 1 and 1.1-1.7 of Book 2)

II  **Magnetostatics**: the differential equations of magnetostatics, Vector potential. Magnetic field of a localized current distribution.
(3.1-3.5 of Book 1, 5.1 – 5.7 of Book 2)

(1.5, 1.7 of Book 1: 4.1-4.2 of Book 2)

UNIT II

(2.1-2.5 of Book 1: 4.3, 4.5-4.7 of Book 2)

(4.1-4.3 of Book 1: 1.8-1.10, 2.1-2.7, 3.12, 5.9-5.12 of Book 2)

UNIT III

(5.1-5.5 of Book 1: 6.1-6.5, 6.8-6.9 of Book 2)

UNIT IV

VII  **Electromagnetic Waves**: Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, poynting’s theorem for a complex vector field, waves in conducting media, skin depth, EM waves in rare field plasma and their propagation in ionosphere. Reflection and Refraction of EM waves at plane interface, Fresnel’s amplitude relations. Reflection and transmission coefficients. Polarization by reflection. Brewster’s angle,
Total internal reflection, Wave guides, TE and TM waves, Rectangular wave guides. Energy flow and attenuation in wave guides, Cavity resonators.

(6.1-6.8, 7.1-7.3 of Book 1 ; 7.1-7.5, 7.7, 8.1-8.8 of book 2)

VIII Radiation from Localized Time Varying Sources: Solutions of the inhomogeneous wave equation in the absence of boundaries. Fields and Radiation of a localized oscillating source. Electric dipole and electric quadrupole fields, centre fed linear antenna.

(8.1-8.6 of Book 1: 9.1-9.4 of Book 2)

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books


PHY6005 ELECTRONICS I

Max. Marks: 15+60=75

Objectives: The Electronics I course covers linear wave shaping which throws light on high pass and low pass RC circuits and response to various wave forms, Clamping and clipping circuits, diode clippers, transistor clippers, clamping circuit theorem, operation of transistor as a switch, Multivibrators: Astable, Monostable and Bistable modes and their applications, Counting circuits, operational amplifier, communication systems, IC fabrication : basic ideas of integrated circuits, various steps of fabrication of Monolithic integrated circuits.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40\% of the total marks.

UNIT I

Linear Wave shaping: High pass RC circuits: response to STEP PLUSE, SQUARE WAVE, RAMP, EXPONENTIAL, WAVE FORMS, applications as a Differentiator, Low Pass RC Circuit, response to STEP PULSE SQUARE WAVE, RAMP, EXPONENTIAL, wave forms, applications as an integrator.
**Clamping and clipping circuits:** Diode Clippers, Transistor Clippers, Operation of Clamping circuits, Clamping Circuit theorem, Practical Clamping Circuit Theorem. Operation of Transistor as a switch.

**UNIT II**

**Multivibrators:** Basic concepts of operation Astable, Monostable and Bistable multivibrator, quantitative discussion of Quasi stable state and Symmetrical and A symmetrical triggering, quantitative discussion of time periods, Applications of multi-vibrators (brief)

**Counting Circuits:** Use of Binaries as a Counter, Forward and Reverse counting, Counting to a base other than power of 2.

**UNIT III**


**UNIT IV**

**Communication systems:** Generation and detection of amplitude modulated, Single- side band, Double-side band suppressed carrier and Frequency modulated wave.

**IC Fabrication:** Standard gate assemblies, Fabrication of integrated Circuits and Devices: Basic ideas of integrated circuits, Epitaxial growth, Diffusion, Masking, Etching, Fabrication of Monolithic Integrated circuits.

**TUTORIALS:** Relevant problems given in the books listed below:

**1st Semester**

**PHY6051 PHYSICS LABORATORY I**

**Max. Marks :125**

**Objectives:** The aim and objective of the courses on Physics Laboratory I and Physics Laboratory II is to expose the students of M.Sc. to the experimental techniques in general Physics, electronics, nuclear Physics and condensed matter Physics so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.

**Note:** Students are expected to perform at least 10 experiments in one semester.
**Duration of the examination will be 4 hours.**

1. To study the dependence of energy transfer on the mass ration of colliding bodies using air track.
2. To study the dependence of frequency of normal modes and their difference in a couples oscillator on the coupling mass.
3. To verify the law of conservation of linear momentum in collision using air track apparatus.
4. To obtain the potential energy curve due to magnet-magnet interactions using air track apparatus.
5. To study oscillations in a rectangular potential well using air track apparatus.
6. To determine Planck’s constant using photocell.
7. To find wavelength of given laser light using diffraction grating and carry out related studies.
8. To study the characteristics of given astable multivibrator.
9. To study the distributed capacity of given inductance coil.
10. To study the characteristics of Colpitts oscillator.
11. To study the characteristics of Hartley oscillator.
12. To study the characteristics of phototransistor.
13. To study the characteristics of given voltage doubler and tripler.
14. To verify the statement: Power dissipation in the side bandsin amplitude modulation is directly proportional to the square of the modulation.
15. To study the characteristics of a superheterodyne receiver.
16. To study use of operational amplifier for different mathematical operations.
17. Frequency response of operational amplifier.
18. To study SR and JK flip flop circuits using logic gates.
19. To find conductivity of given semiconductor crystal using four probe method.
20. To study the seven segment display (IC) trainer.
21. To study the various aspects of frequency modulation.
22. To determine the Hall coefficient for given semiconductor and study its field dependence.
23. To determine the velocity of ultrasonic waves in given liquid, using interferometer.
24. To study non-radiative transitions in LED.
25. To determine the dead time of given G. M Counter.
26. Electron Spin Resonance spectrum of DPPH and calculation of g factor.
27. To study the statistical fluctuations of background counts in a G. M. Counter.
28. To determine the absorption coefficient of Pb and Fe for gamma rays using G. M. Counter.
29. To determine the energy of a pure beta-emitter using G.M. Counter and Al absorbers.
30. Design different Clipper and Clamper circuits: positive, negative & bias (using through breadboard)
31. Design of Wein bridge oscillator using IC 741 (using through breadboard)
M.Sc.- 2nd SEMESTER

PHY6011 MATHEMATICAL PHYSICS II

Max. Marks: 15+60=75

Objectives: The aim and objective of the course on Mathematical Physics II is to equip the M.Sc student with the mathematical techniques for understanding theoretical treatment in different courses. The knowledge of Fourier analysis, Laplace transforms, tensor analysis, integral equations help to solve plenty of problems in higher Physics. Numerical analysis helps to solve problems of computational physics and develop a strong background if he chooses to pursue research in Physics as a career.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

I. Group Theory: Basic definitions, Multiplication table, conjugate elements and classes.


   (1.1-1.7, 3.1-3.3, 3.5, 3.6, 4.1,4.3,(excluding 4.3.2 and 4.3.3), 4.5 (excluding its subsections) and based on chapters 5-8 of Book 2)

UNIT II


(14.1-14.5, 15.1-15.6, 15.8-15.10, 15.12 of Book 1)
UNIT III

III Integral Equations: Definitions and classifications, Neumann series, Separable kernels, Hilbert-Schmidt theory. Green’s function in one dimension.

(16.1, 16.3, 16.4, 9.5 of Book 1)


(2.6-2.10 of Book 1)

UNIT IV


TUTORIALS: Relevant problems given at the end of each section in the text books.

Books

Objectives: The aim and objective of the course on Quantum Mechanics II is to introduce the students of M.Sc to the formal structure of the subject and to equip them with scattering theory, Born approximation, Relativistic quantum mechanics: Klein Gordon equation, Dirac equation, fine structure of hydrogen atom, Lambshift, Field Quantization, Relativistic Quantum Field Theory, the concept of Feynman diagrams helps to study various phenomena like Compton scattering etc. so that they can use these in various branches of Physics as per requirement.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

Scattering Theory: Scattering Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green’s function in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Electron scattering by an atom, Optical theorem, Scattering of identical particles. (CH 5 of Book 1 and 6.1, 6.2, 6.4-6.6, 6.8-6.13, 6.19 of Book 2)

UNIT II

Relativistic Quantum Mechanics: Klein-Gordon equation, Dirac equation and its plane wave solution, significance of negative energy solutions, spin angular momentum of the Dirac particle, non-relativistic limit of Dirac equation. Electron in electromagnetic fields, spin magnetic moment. spin–orbit interaction, Dirac equation for a particle in a central field. fine structure of hydrogen atom, Lambshift. (Chs 7, 8 of Book 1, Ch10 of Book 2. Ch. 10 of Book 3 (Except Foldy Wouthuysen Transformation and 10.2B))

UNIT III

Field Quantization: Resume of Lagrangian and Hamiltonian formalism of a classical field. Second quantization: Concepts and illustrations with Schroedinger field. Quantization of a real scalar field and its application to one meson exchange potential. (Ch. 9 of Book 1 and 11.2, 11.3 of Book 3)

UNIT IV

Relativistic Quantum Field Theory; Quantization of a complex scalar field. Dirac field and e.m. field. Commutation relations. Covariant perturbation theory. Introduction to Feynman Diagrams. (Ch II-12 of Book 1: 11.4, 11.5 of Book 3: 1.5, 2.1-2.3, 3.13, 4, 4.1-4.5, 5.1, 5.2, 6.1-6.3, 7.1 of Book 4)

TUTORIALS: Relevant problems given at the end of each section in the text books.
Books:

1. Quantum Mechanics: M.P. Khanna (Har Anand, New Delhi)(2009)

PHY6013 PARTICLE PHYSICS I

Max. Marks: 15+60=75

Objectives: The aim and objective of particle Physics is to familiarize with the concepts of Fermions, bosons and other particles and their interactions with fields in particle physics, Yukawa picture, Invariance principles and conservation laws: parity, Charge conjugation, CPT theorem, Hadron- Hadron Interactions: Strangeness, G-Parity, Relativistic Kinematics and Phase Space: Dalitz plots, Static Quark Model of Hadrons: Baryon decuplet, Baryon octet, spin, colour, quark- anti quark combination, Weak Interaction: Classification, Fermi theory, cabobbo theory, CP violation In K-decay and its experimental determinations and develop a strong background if the student pursue research in particle physics.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

I Introduction: Fermions and Bosons, particles and antiparticles, quarks and leptons, interactions and fields in particles physics, classical and quantum pictures. Yukawa Picture, types of interactions- electromagnetic, weak, strong and gravitational, Natural unit.
(Book 1-4)

UNIT II

II Invariance Principles and Conservation Laws: Invariance in classical mechanics and in quantum mechanics, parity, pion parity, Charge conjugation, Positronium decay, Time reversal invariance, CPT theorem.
(Book 1-4)
III Hadron-Hadron Interactions: Cross section and decay rates, Pion spin, Isospin, Two nucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastics cross section, Particle Production at high energy.
(Book 1-4)

UNIT III

(Book 1-4)

V Static Quark Model of Hadrons: The Baryon decuplet, baryon octet, meson octet, quark spin and color, quark- antiquark combination.
(Book 1-4)

UNIT IV

(Book 1-4)

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:


PHY6014 NUCLEAR PHYSICS I

Max. Marks: 15+60=75

Objectives: The aim and objective of the course on Nuclear Physics is to familiarize the students of M.Sc class to the basic aspects of Nuclear Physics like wave mechanical properties of nuclei, electric and magnetic moments, nuclear shapes, nuclear forces, basic properties of neutrons, detection, Nuclear reactions, types of reactions, conservation laws so that they are equipped with the techniques used in studying these things.

Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.
2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT-I

I  (a) Nuclear size and Shape

Scattering and electromagnetic methods for determining the nuclear radius. Electric and magnetic moments and nuclear shapes.
(Books 1,2)

(b) Radio Active Decays

Kinematics of alpha-decay: Alpha particle energy, barrier penetration of alpha decay, Alpha spectroscopy; Branching ration, Centrifugal barrier affects, Nuclear structure effects, (example of alpha emission in $^{238}_{92}$U$^{146}$).
(Chapter -04 of Book 03)

(Chapter -05 of Book 03)

Multipolarity of gamma transitions, Angular momentum and parity selection rules, Internal Conversion process, Transition rates, Angular distribution and polarization measurements.
(Chapter -10 of Book 04)

UNIT-II

II  Nuclear Forces

Evidence for saturation of nuclear density and binding energy (Review), types of nuclear potentials, Ground and exited states of deuteron, dipole and quadrupole moment of deuteron, neutron-proton (n-p) scattering at low energies, Partial wave analysis, Scattering length, spin dependence of n-p scattering, Singlet state in n-p system, Significance of sign of the scattering length, Effective range Theory in n-p scattering. Coherent and incoherent scattering tensor forces and deuteron problem, p-p scattering at low energy, analysis of n-p and p-p scattering.
(Chapter 3 (Sub unit 3.1 to 3.14) of Book- 01)

UNIT-III

III  (a) Neutron Physics

Basic properties of neutrons, Neutron production and detection. Slowing down power and moderating ratio, thermal neutron density flux. Maxwellian distribution and the diffusion of thermal neutrons, measurements of different cross section, Scattering, absorption and activation cross sections.
(Chapter 18 of Book -02)
(b) Nuclear Fission

Review of the Semi-empirical mass formula, Fission Cross Section, Spontaneous fission, Mass and energy distribution of fragments, Liquid drop model of Nuclear fission, Barrier penetration, statistical model of fission.

(Chapter 5 (Part I and Part II) of Book-01)

UNIT-IV

IV Nuclear Reactions: Nuclear Reactions and Cross sections, Type of reactions and Conversation laws. Q-values and its significance. Laboratory and Centre of mass coordinates and their relationship, Isospin, Resonance: Breit-Wigner Dispersion Formula for \( l=0 \), Breit – Wigner Dispersion formula for all values of \( I \), The compound Nucleus, Continuum Theory of cross section \( \sigma_c \). Statistical theory of Nuclear Reactions, Evaporation probability and Cross Sections for Specific Reactions.

(Chapter -06 of Book-1 and Chapter-11 of Book 4)

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:

5. Nuclear Physics, Principle and Applications, John Willey Sons, Ltd. (2001), Indian edition is available from Wiley India (P) Ltd. (This is a basic level book and Problems given at the end of the relevant chapters may be given to students as a tutorial).

PHY6015 ELECTRONICS-II

Max. Marks: 15+60=75

Objectives: The Electronics II covers the logic systems: concepts of dc positive, negative systems, logic gates in DL, RTL, DTL and TTL logic families, number systems, Karnaugh map representation of logic functions, Multiplexers and Flip Flops, Registers, Analog to digital converters, digital to analog converters, Semiconductor memory devices: Organizations, operations, classification and characteristics of memories, digital display, Seven segment display, charged couple device memory and applications, Fundamentals, types and various concepts of Microprocessors
Note:

1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

Unit I:

**Logic Systems:** Basic concepts of dc positive, negative and dynamic logic systems, Logic gates (AND, OR, NOT, NOR, NAND and EX-OR gates) in DL, RTL, DTL and TTL logic families.

Number systems, Binary arithmetic, Boolean algebra, De-Morgan laws.

Karnaugh map representation of logic functions and simplification of logic functions (up to three variables).

Unit II:

Multiplexers, demultiplexers, adders, subtractors, comparators, Latch, FLIP FLOPS (SR, JK, T, D, MASTER SLAVE)

Registers, shift registers (serial and parallel operations), Asynchronous counters (up, down, up-down, decade) and synchronous counter (up, down, up-down, decade).

Analog-to-digital converters, digital-to-analog converters

Unit III

**Semiconductor memory devices:** organizations, operations, Classification and characteristics of memories, read only memory (ROM organization, PROM, EEPROM), RAM (Bipolar RAM, MOS RAM), Memory Storage Cell (both Bipolar and MOS RAM),

Digital display, Seven Segment Display, Charged Couple Device Memory, Applications

Unit IV

Fundamentals of Microprocessors, ideal microprocessor, data bus, address bus, control bus, ALU, Registers, program counters, flags, timing and control sections, microprocessor based system, basic operations, Programming Languages (introduction and basic instructions)

Books:

2nd Semester

PHY6052 PHYSICS LABORATORY II Max. Marks 125

Objectives: The aim and objective of the courses on Physics Laboratory I and Physics Laboratory II is to expose the students of M.Sc. to the experimental techniques in general Physics, electronics, nuclear Physics and condensed matter Physics so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.

Note: Students are expected to perform at least 10 experiments in one semester.

The Duration of the examination will be 4 hours

1. To study the dependence of energy transfer on the mass ration of colliding bodies, using air track.
2. To study the dependence of frequency of normal modes and their difference in a couples oscillator on the coupling mass.
3. To verify the law of conservation of linear momentum in collision using air track.
4. To obtain the potential energy curve due to magnet-magnet interactions using air track.
5. To study oscillations in a rectangular potential well, using air track.
6. To determine Planck’s constant using photocell.
7. To find wavelength of given laser light using diffraction grating and carry out related studies.
8. To study the characteristics of given astable multivibrator.
9. To study the distributed capacity of given inductance coil.
10. To study the characteristics of Colpitts oscillator.
11. To study the characteristics of Hartley oscillator.
12. To study the characteristics of phototransistor.
13. To study the characteristics of given voltage doubler and tripler.
14. To verify the statement: Power dissipation in the side bands is directly proportional to the square of the modulation.
15. To study the characteristics of a superheterodyne receiver.
16. To study use of operational amplifier for different mathematical operations.
17. Frequency response of operational amplifier.
18. To study SR and JK flip flop circuits using logic gates.
19. To find conductivity of given semiconductor crystal using four probe method.
20. To study the seven segment display (IC)trainer.
21. To study the various aspects of frequency modulation.
22. To determine the Hall coefficient for given semi-conductor and study its field dependence.
23. To determine the velocity of ultrasonic in given liquid. Using interferometer.
24. To study non-radiative transition in LED.
25. To determine the dead time of given G. M Counter.
26. Electron Spin Resonance spectrum of DPPH.
27. To study the statistical fluctuations of background counts in a G. M. Counter.
28. To determine the absorption coefficient of Pb and Fe for gamma rays using G. M. Counter.
29. To determine the energy of a pure beta-emitter using G.M. Counter and Al absorbers.
30. Design different Clipper and Clamper circuits: positive, negative & bias. (using breadboard)
31. Design of Wein Bridge Oscillator using IC 741. (using breadboard)
OBJECTIVES:
The course of classical electrodynamics includes the postulates of special theory of relativity, Lorentz transformations, motion of particle in various aspects of electric and magnetic fields like constant and varying fields including non-relativistic and relativistic motions of charge particle and magnetic mirroring. The Covariant Formulation of Electrodynamics in Vacuum gives information of Four vectors in Electrodynamics, covariant continuity equation, wave equation, covariance of Maxwell equations. Electromagnetic field tensor, Energy momentum tensor of the EM fields and the conservation laws. Lagrangian and Hamiltonian of a charged particle in an EM field. The aim of the course is to take a glimpse of radiation from accelerated charges, Thomson scattering, Rayleigh scattering, absorption of radiation by bound electron.

Note:
1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

UNIT II
II) Charged Particle Dynamics : Non-relativistic motion in uniform constant fields: Constant uniform electric field, Constant uniform magnetic field, Crossed uniform and constant electric and magnetic fields. Non-relativistic motion of a charged particle in a slowly varying magnetic field : Time varying magnetic field, Space varying magnetic field, Gradient Drift, Curvature Drift. Adiabatic magnetic field invariance of flux through an orbit, magnetic mirroring, Relativistic motion of a charged particle: Constant magnetic field, Constant electric field Electromagnetic Field of a plane wave. (10.1-10.4 of Book 1).
UNIT III

(11.1-11.4, 11.6-11.7 of Book 1; 12.1, 12.3-12.6 of Book 2).

UNIT IV

(12.1-12.6, 13.1 and 13.2 of Book 1; 14.1-14.5 of Book 2).


TUTORIALS: Relevant problems given in each chapter in the text and reference books.

Books

PHY7002 STATISTICAL MECHANICS

Max. Marks: 15+60=75
Total teaching hours: 60

Objectives:
The aim of the course is to familiarize the students with the techniques of ensemble theory and relate the statistics and thermodynamics, Gibbs paradox, micro canonical ensemble theory and its application to ideal gas of monatomic particles, equipartition and virial theorems, physical significance of various statistical quantities, energy fluctuations, a system of harmonic oscillators as canonical ensemble, statistics of paramagnetism, thermodynamics of magnetic systems and negative temperatures, significance of statistical quantities, Ising model and Heisenberg models, Fluctuations so that he/she can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents.
Note:
1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

I The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution. (1.1-1.6 of Book 1).

II Elements of Ensemble Theory: Phase space and Liouville's Theorem, The micro canonical ensemble theory and its application to ideal gas of monatomic particles, equipartition and virial theorems, canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism. (2.1-2.4, 3.1-3.9 of Book 1)

UNIT II


IV Elements of Quantum Statistics: Quantum states and phase space, quantum statistics of various ensembles. An ideal gas in quantum mechanical ensembles, statistics of occupation numbers. (2.5, 6.1-6.3 of Book 1)

UNIT III

V Ideal Fermi Systems: Thermodynamic behaviour of an ideal fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism (8.1, 8.2A, 8.3 (omit sub sections A and B), 8.4 of Book 1).

VI Ideal Bose Systems: Basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, Discussion of gas of photons (the radiation fields) and phonons(The Debye field), Liquid helium and superfluidity. (7.1, 7.2, 7.3, 7.5 of Book 2).

UNIT IV

VII) Elements of Phase Transitions: Introduction, a dynamical model of phase transitions, Ising and Heisenberg models. (11.3 of Book 1)
VIII) **Fluctuations:** Thermodynamic Fluctuations, random walk and Brownian motion, introduction to non equilibrium processes, diffusion equation
(14.1-14.3 of Book 1)

**TUTORIALS:** Relevant problems given in the end of each chapter in the text book.

**Books**


**PHY 7003 NUCLEAR PHYSICS II**

**Max.Marks:** 15+60=75

**Total teaching hours:** 60

**Aim & Objectives:**
The aim and objectives of the course on Nuclear Physics-II is to expose the students of M.Sc. class to the relatively advanced topics in nuclear models and nuclear reactions so that they understand the details of the underlying aspects and it can prepare them to use all these techniques if they decide to become a nuclear physicists in their career.

**Note:** 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

**UNIT I**

**Nuclear Shell Model:**

Coupling of angular momentum, C.G. Coefficients and Racah Coefficients,


(Book 1 and Book-02)
UNIT II

**Collective Model of Nucleus I:** Rotation - D Matrices, Collective modes of motion, Nuclear Vibrations, Iso-scalar Vibrations, Sum rules in the vibrational motion, Giant resonance (brief overview), Parameterization of nuclear surface, Rotation of deformed nuclei, Derivation of the collective hamiltonian and its application, $\beta$ and $\gamma$ vibrations, Rotational Energy Spectra and the nuclear wave functions for even-even and odd-$A$ nuclei, Electromagnetic and quadrupole properties, Coupling of particle to even-even core, (Book-01, Book-02 and Book-05)

UNIT III

**Collective Model of Nucleus II:**
Nilsson model, Cranking model, Kinematics and dynamic moment of inertia, Routhians and alignment plots, Rotational motion at very high spins, Backbending behavior, signature splitting and signature inversion in nuclei, Pairing Interaction, Deformation energy surface at very high spin, Super and Hyper-deformation. (Book-05 and Book-06)

UNIT IV

**Nuclear Reactions:** Optical model (Book-06), Basics of Heavy-ion induced reaction (Calculations of Q values, excitation energy, Angular momentum population, Lab to C.M. conversion in a nuclear reaction) (Book-06), Elastic and Inelastic Scattering (Book-06), Heavy-ion induced fusion reaction, sub-barrier fusion, Super heavy elements (Review) (Book-07), Nucleon transfer reaction (Brief review and experimental aspects) (Book-06), A brief discussions on various phenomena at Low, Intermediate and high energy domain (Book-06). (Book 01, Book 06 and Book-07)

**TUTORIALS:** Relevant problems given at the end of each section in the text books.

**Books:**

Objectives:
The aim and objective of the course on Condensed Matter Physics I is to make the students of M.Sc class familiar to the topics like elastic constants, lattice vibrations, dielectric properties, energy band theory and transport theory so that they are prepared with the techniques used in investigating these aspects of the matter in condensed phase.

Note: 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding units of the syllabus. Unit V in the paper will have one compulsory question consisting of 5 to 8 short answer type questions covering the whole syllabus. Each question will have a weightage of 12 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I
Elastic constants: Resume of binding in solids; Stress components, stiffness constant, elastic constants, elastic waves in crystals.

Lattice Dynamics and Thermal Properties:
Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamic properties of crystal, anharmonic effects, thermal expansion. (Books 3, 4 and 6).

UNIT-II
Energy Band Theory:
Review of electrons in a periodic potential; Nearly free electron model; tight binding method; Impurity levels in doped semiconductors, Band theory of pure and doped semiconductors. (Books 1-3 and 5).

UNIT-III
Transport Theory:
Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation, calculation of relaxation time in metals; thermal conductivity of metals and insulators; thermoelectric effects; Hall effect and magnetoresistance; Transport in semiconductors. (Books 3-5).

UNIT-IV
Dielectric Properties of Materials:
Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity. (Books 1-4).
TUTORIALS: Relevant problems given in the books listed below:

Books:

PHY 7021 PHYSICS LABORATORY III Max. Marks: 125
Teaching hours: 9 hrs per week

Objective: The aim and objective of the courses on Physics Laboratory III and Physics Laboratory IV is to train the students of M.Sc. class to advanced experimental techniques in general physics, electronics, nuclear physics, particle physics and condensed matter physics so that they can investigate various relevant aspects and are confident to handle sophisticated equipment and analyze the data.

Note: Students are expected to perform at least 10 experiments distributed over all the sections in one semester. Duration of the examination will be 4 hours.

1. To study uncertainty principle using Laser.
2. To study the characteristics of IC555
3. To study the characteristics of FET
4. To study the characteristics of MOSFET
5. To Study (i) refraction through a prism (ii) double slit interference (iii) Fabry-Perot interferometer using Gunn diode microwave generator
6. Use of microwaves to study (i) Michelson interferometer (ii) Brewster’s angle for polarization (iii) Bragg’s diffraction from crystal model.
7. To Study the Half and Full Adder, Half and Full Subtractor.
8. To study time regulation of gamma – ray coincidence set-up
9. To study anisotropy of gamma-ray for $^{60}$Co using coincidence set-up
10. To study energy resolution and calibration of a gamma-ray spectrometer using multi-channel analyzer.
11. To study time resolution and calibration of a coincidence set-up using a multi-channel analyzer.
12. To study calibration of a beta-ray spectrometer.
13. To study scattering of photons from different elements.
14. To study p(bar)-p interaction and find the cross section of a reaction using a bubble chamber.
15. To study n(bar)-p interaction and find the cross section of a reaction using a bubble chamber
16. To study k^+ -d interaction and find its multiplicity and moments using a bubble chamber
17. To determine crystal structure of different material using x-ray diffraction.
18. To measure dielectric constant of Barium titanate as function of temperature and frequency and hence study its transition.
19. To measure heat capacity of solid at high and low temperatures.
20. To determine the Curie temperature of a given ferroelectric material
21. To study the energy resolution of Cs$^{137}$.
22. To identify the unknown gamma source using energy calibration.
23. To study use of operational amplifier for different mathematical operation.
24. To determine Planck’s constant using photocell.
25. To study RC circuit as integrator and differentiator.
26. To determine the intensity response of a photoresistor.
27. Analog to digital convertor
28. Digital to analog convertor
29. To study quantized excitation energy in argon using Franck-Hertz experiment.
30. To measure reverse saturation current in pn junction diode at various temperatures and to find the approximate value of energy gap.
31. To trace B-H curves for different materials using CRO and find the magnetic parameters from these. Also calculate the energy loss per cycle.
32. To study magnetic properties using B-H curve of a given material.

PHYS 7022 COMPUMATIONAL PHYSICS I

Max. Marks: 75
Teaching hours: 6 hrs per week

2. Computer hardware, software, programming languages, Fortran 77, classification of data, variables, dimension and data statement, input/output, format, branching, IF statements, DO statements, subprograms, operations with files.

3. List of Numerical Problems:
1. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.
2. Choose a set of 10 values and find the least squared fitted curve.
3. Generation of waves on superposition like stationary waves and beats.
4. Fourier analysis of square waves.
5. To find the roots of quadratic equations.
7. Find first order derivative at given x for a set of 10 values with the help of Lagrange interpolation.
8. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.
10. To find determinant of a matrix - its eigenvalues and eigenvectors.

Books
M.Sc.- 4th SEMESTER

PHY 7051                                                  PARTICLE PHYSICS II

Max. Marks: 20+80=100
Total teaching hours : 60

Objectives:
The aim and objective of the course on Particle Physics II is to expose the students of M.Sc. class to the relatively advanced topics like internal symmetries and quark model, details of different types of fundamental interactions and unification schemes so that they understand these aspects properly and are well equipped to pursue a career in high energy physics.

Note : 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding unit of the syllabus. Unit V in the paper will have one compulsory question consisting of short answer type questions covering the whole syllabus. The compulsory question will not have any choice. Each question will have a weightage of 16 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40 % of the total marks.

UNIT I

UNIT II
II Quark Model : Introduction to constituent quark model, Quantum number of quarks & valence quark contents of hadrons, simple applications to hadron phenomenology e.g. unitary spin & spin hadron wave function of baryons and mesons.


UNIT III

V Strong Interactions : Introduction to gauge field theories, including Non-Abelian gauge field (motivation, construction and consequences of Yang-Mills theory). Elements of QCD.
UNIT IV
VI Unification Schemes: Spontaneous symmetry breaking, Introduction to Glashow-Weinberg-Salam model, Standard model-introduction and lagrangian, Higgs Production and detection, Gravitational Interaction and Planck scale, Brief introduction to GUTS.

TUTORIALS: Relevant problems given at the end of each chapter in the books listed below.

Books

PHY 7052 CONDENSED MATTER PHYSICS II
Max. Marks: 20+80=100
Total teaching hours: 60

Objectives:
The aim and objective of the course on Condensed Matter Physics II is to expose the M.Sc. students with relatively advanced topics like optical properties, magnetism, superconductivity, magnetic resonance techniques and disordered solids so that they are confident to use the relevant techniques in their later career.

Note: 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding unit of the syllabus. Unit V in the paper will have one compulsory question consisting of short answer type questions covering the whole syllabus. The compulsory question will not have any choice. Each question will have a weightage of 16 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I
(Books 4-7)
UNIT II
Magnetism: Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian and resume of the results; Ferro-, ferri- and antiferro-magnetism; spin waves; specific heat - Bloch law.
(Books 5-7).

Magnetic Resonance Techniques: Principles of ESR and NMR
(Book 4)

UNIT III
Superconductivity: Experimental Survey, Basic phenomenology, Type I and Type II superconductors; BCS pairing mechanism; High Tc superconductors.
(Books 4-7).

UNIT IV
Defects and Disorder: Elementary ideas of point defects and dislocations; Brief introduction to nanostructures.
(Book 4).

TUTORIALS: Relevant problems given at the end of each chapter in the books listed below.

Books:
**Objective:** The aim and objective of the courses on Physics Laboratory III and Physics Laboratory IV is to train the students of M.Sc. class to advanced experimental techniques in general physics, electronics, nuclear physics, particle physics and condensed matter physics so that they can investigate various relevant aspects and are confident to handle sophisticated equipment and analyze the data.

**Note:** Students are expected to perform at least 10 experiment distributed over all the section in one semester. Duration of the examination will be 4 hours.

1. To study uncertainty principle using Laser.
2. To study the characteristics of IC555
3. To study the characteristics of FET
4. To study the characteristics of MOSFET
5. To Study (i) refraction through a prism (ii) double slit interference (iii) Fabry-Perot interferometer using Gunn diode microwave generator
6. Use of microwaves to study (i) Michelson interferometer (ii)Brewster’s angle for polarization (iii) Bragg’s diffraction from crystal model.
7. To Study the Half and Full Adder, Half and Full Subractor.
8. To study time regulation of gamma – ray coincidence set-up
9. To study anisotropy of gamma-ray for using coincidence set-up
10. To study energy resolution and calibration of a gamma-ray spectrometer using multi-channel analyzer.
11. To study time resolution and calibration of a coincidence set-up using a multi-channel analyzer.
12. To study calibration of a beta-ray spectrometer.
13. To study scattering of photons from different elements.
14. To study p-p interaction and find the cross section of a reaction using a bubble chamber.
15. To study n(bar)-p interaction and find the cross section of a reaction using a bubble chamber
16. To study k⁺-d interaction and find its multiplicity and moments using a bubble chamber
17. To determine crystal structure of different material using x-ray diffraction.
18. To measure dielectric constant of Barium titanate as function of temperature and frequency and hence study its transition.
19. To measure heat capacity of solid at high and low temperatures.
20. To determine the Curie temperature of a given ferroelectric material
21. To study the energy resolution of Cs$^{137}$.
22. To identify the unknown gamma source using energy calibration.
23. To study use of operational amplifier for different mathematical operation.
24. To study use of operational amplifier for different mathematical operations.
25. To determine Planck’s constant using photocell.
26. To study RC circuit as integrator and differentiator.
27. To determine the intensity response of a photoresistor.
28. Analog to digital convertorp.
29. Digital to analog converter
30. To study quantized excitation energy in argon using Franck-Hertz experiment.
31. To measure reverse saturation current in pn junction diode at various temperatures and to find the approximate value of energy gap.
32. To trace B-H curves for different materials using CRO and find the magnetic parameters from these. Also calculate the energy loss per cycle.
33. To study magnetic properties using B-H curve of a given material.

PHY 7072 PROJECT

Max. Marks: 125

The aim of project work in M.Sc. 4th semesters is to expose some of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data etc. Project work can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report of about 30 pages about the work done in the project will be submitted by a date to be announced by the committee. Assessment of the work done under the project will be carried out by a committee formed by the college consisting of three members (one external & two internal including supervisor), on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva voce/seminar, etc. as per guidelines prepared by the committee.

This load (equivalent to 3 hours per week) will be counted towards the normal teaching load of the teacher.

PHYS 7073 Computational Physics II Max. Marks: 75
Teaching hours: 6 hrs per week

List of Physics Problems.
Note: Do at least 10 problems.

1. Study the charging and discharging of a capacitor in RC circuit with a DC source using Euler method. Graphically demonstrate the variation of charge with time for two values of time step size.

Modify the program to include AC source instead of D.C. Source.

2. Study the growth and decay of current in RL circuit containing (a) DC source and (b) AC source using Runge Kutta method. Draw graphs between current and time in each case. Perform power analysis in the circuit for two values of time step size for the case.
3. Write a program to study graphically the EM oscillations in a LCR Circuit (use Runge-Kutta method). Show the variations of (a) charge vs time, (b) current vs time.

4. Study graphically the motion of a falling spherical body under various effects of the medium (viscous drag, buoyancy and air drag) using Euler method.

5. Study graphically the path of a projectile with and without air drag, using FN method. Find the horizontal range and maximum height in either case. Write your comments on the findings.

6. Motion of artificial satellite.

7. Study of motion of a one-dimensional harmonic-oscillator without and with damping effect (use Euler method). Draw graphs showing the relations (a) velocity vs time (b) acceleration vs time (c) position vs time.

8. Obtain the energy eigen values of a quantum oscillator using Runge-Kutta method.

9. Study the motion of a charged particle in (a) uniform electric field (b) in uniform magnetic field (c) in combined electric and magnetic fields (cyclotron). Draw graphs in each case.

10. Monte-Carlo technique to simulate phenomenon of Nuclear radioactivity. Modify your program to a case when daughter nucleus is also unstable.

11. Study the motion of two coupled harmonic oscillators. Compare the numerical results with analytic results.

Books
PHYS7053 Experimental techniques in Nuclear, Particle and Condensed Matter Physics

Max. Marks: 20+80 = 100
Total Teaching Hours : 60

Aim & Objective: The aim and objective of the course on Experimental Techniques in Nuclear, Particle and Condensed Matter Physics is to expose the students of M.Sc. class to theoretical aspects of different equipment and methods used in the fields of Nuclear, Particle and Condensed Matter Physics.

Note: 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding unit of the syllabus. Unit V in the paper will have one compulsory question consisting of short answer type questions covering the whole syllabus. The compulsory question will not have any choice. Each question will have a weightage of 16 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40 % of the total marks.

Unit I

Detection of radiations:

Data interpretation and analysis, precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and nonlinear curve fitting, chi-square test, statistical model statistical treatment of experimental data, Common probability distributions.

Interaction of (gamma-rays, neutrons, electrons and heavy charged particles) with matter, Relativistic particle interaction, General properties of radiation detectors, modes of detector operations, pulse height spectra, energy resolution, detection efficiency, dead time, Proportional counters, Gas multiplication factor, space charge effects, energy resolution,

(Book 01 and Book 02)

Unit II

Organic and inorganic scintillations and their characteristics, Photomultiplier tubes, pulse shape analysis. Properties of scintillation gamma-ray spectrometers, liquid scintillators, Cerenkov Counter.

Semiconductor detector, Ge(Li) and Si (Li) detectors. Charge production and collection process detector configurations, Semiconductor detector in X-ray, gamma-ray Spectroscopy, Semiconductor detector in particle identification and charged particle Spectroscopy (Telescope arrangement, time of flight), Detection of fast and slow neutrons- nuclear reactions for neutron detection.

Electron spectrometer, Nuclear life time measurements (DSAM and RDM Techniques).

(Book 01 and Book 02)
Unit III

Brief account of Particle Accelerators. Colliding beam and available energy in the center of mass, beam stability, accelerator magnet configurations, particle beams for fixed target experiments, Particle separators, Secondary beams, Beam transport system. Back ground radiation and detector shielding, Electromagnetic and Hadron calorimeters.
(Book 03)

UNIT IV


(Book 04 and Book 05)

Books:

2. Techniques for Nuclear and Particle Physics experiments: W.R. Leo (Springer).

PHYS7054 Fibre Optics and Non-Linear Optics

Max. Marks: 20+80=100
Total teaching hours : 60

Objective: The aim and objective of the course on Fibre Optics and Nonlinear Optics is to expose the M.Sc. students to the basics of the challenging research field of optical fibers and their use in nonlinear optics.

Note: 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding unit of the syllabus. Unit V in the paper will have one compulsory question consisting of short answer type questions covering the whole syllabus. The compulsory question will not have any choice. Each question will have a weightage of 16 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.
2. The question paper is expected to contain problems with a weightage of 30 to 40 % of the total marks.
UNIT I
I Optical fibre and its properties: Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types.
(Ch. 3 of book 1)

UNIT II
II Fibre fabrication and cable design: Fibre fabrication, mass production of fibre, comparison of the processes, fibre drawing process, coatings, cable design requirements, typical cable design, testing.
(Ch. 4 of book 1)

UNIT III
III Optics of anisotropic media: Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/polarizer combinations.
(Ch. 18 of book 2)

UNIT IV
IV Electro-optic and acousto-optic effects and modulation of light beams: Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electrooptic modulation, electro-optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of LM for a longitudinal acoustic wave in isotropic medium, calculation of LM for a shear wave in lithium niobate, Raman-Nath diffraction, Raman-Nath acousto-optic modulator.
(Ch. 19 of book 2, Ch. 16, 17 & 19 of book 3)

TUTORIALS: Relevant problems pertaining to the topics covered in the course.

Books
1. The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall) 1993.
Note: 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding unit of the syllabus. Unit V in the paper will have one compulsory question consisting of short answer type questions covering the whole syllabus. The compulsory question will not have any choice. Each question will have a weightage of 16 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I
I Phenomenology of Chaos: Linear and nonlinear systems, A nonlinear electrical system, Biological population growth model, Lorenz model; determinism, unpredictability and divergence of trajectories, Feigenbaum numbers and size scaling, self similarity, models and universality of chaos.

UNIT II
II Dynamics in State Space: State space, autonomous and non autonomous systems, dissipative systems, one dimensional state space, Linearization near fixed points, two dimensional state space, dissipation and divergence theorem. Limit cycles and their stability, Bifurcation theory, Heuristics, Routes to chaos. Three-dimensional dynamical systems, fixed points and limit cycles in three dimensions, Lyapunov exponents and chaos. Three dimensional iterated maps, U-sequence.

UNIT III

UNIT IV

V Quantum Chaos: Quantum Mechanical analogies of chaotic behaviour. Distribution of energy eigenvalue spacing, chaos and semi-classical approach to quantum mechanics.

TUTORIALS: Relevant problems pertaining to the topics covered in the course.

Books
PHYS 7056  Particle Accelerator Physics

Max. Marks: 20+80=100
Total teaching hours : 60

Note : 1. The question paper for the final examination will consist of five units. Unit I-IV will have TWO questions each from the corresponding unit of the syllabus. Unit V in the paper will have one compulsory question consisting of short answer type questions covering the whole syllabus. The compulsory question will not have any choice. Each question will have a weightage of 16 marks. The candidates will attempt five questions in all, selecting one each from the units I to IV and the compulsory question from unit V.

2. The question paper is expected to contain problems with a weightage of 30 to 40 % of the total marks.

UNIT I
I Charged Particle Dynamics : Particle motion in electric and magnetic fields, Beam transport system, Beam pulsing and bunching techniques, microbeams, Particle and ion sources, secondary beams, Measurement of beam parameters.

UNIT II

UNIT III
III Electrostatic and Heavy Ion Accelerators : Van de Graaff voltage generator, Cockcroft-Walton voltage generator, insulating column, voltage measurement, Acceleration of heavy ions, Tandem electrostatic accelerator, Production of heavy negative ions, Pelletron and Tandetron, Cluster beams, Superconducting Heavy Ion Linear Accelerators.

UNIT IV
IV Synchrotron Radiation Sources : Electromagnetic radiation from relativistic electron beams, Electron synchrotron, dipole magnet, multipole wiggler, noncoherent and coherent, Undulator, Characteristics of synchrotron radiation.

V Radioactive ion beams : Production of Radioactive ion beams, Polarized beams, Proton synchrotron, Colliding accelerators.

TUTORIALS : Relevant problems given in the books listed below:

Books :


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