POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-Two year programme)

Course No. **P2PHTC101**	Credits: **4 (4-0-0)**
Title: **Mathematical Physics**	Maximum Marks: **100**
Minor Tests (I & II): **40**	Major Test: **60**
Duration of Examination: **3 hours**	

Syllabus for the examination to be held in Dec 2025, Dec 2026, Dec 2027.

Objectives: The main objectives of this course are to introduce students to learn mathematical tools and techniques and to apply these techniques to solve problems in physical sciences.
Course outcomes: This course provides the ability to apply various mathematical methods for solving problems in physics.

Unit-I: Complex Integration:
Recapitulation of complex variables. Cauchy's integral theorem, Cauchy's integral formula, Morera's theorem, Liouville's theorem, Taylor and Laurent series, Singularities of an analytic function, Residues and methods of evaluating residues, Cauchy's Residue theorem, Evaluation of definite integrals by use of residue theorem. Contour integration, Evaluation of infinite integrals by Jordan's Lemma. Simple problems on the above topics.

Unit-II: Linear Algebra and Tensor Analysis:

Linear Algebra: Recapitulation of matrices, Special matrices, Similar matrices, Hermitian, anti-hermitian, orthogonal and unitary matrices, linear transformations, orthogonal, unitary and similarity transformations, Matrices in Classical and Quantum mechanics: the rotation, Pauli spin and Dirac matrices, Determination of eigen values and eigen vectors of matrices and their properties, Diagonalization of matrices.
Tensor Analysis: Introduction, Space of N-dimensions, coordinate transformation, summation convention, contravariant and covariant vectors, Contravariant, covariant and mixed tensors, Kronecker delta, The fully antisymmetric tensor, Tensors of higher rank, scalars or invariants, symmetric and skew-symmetric tensors, fundamental operations with tensors (Addition, Subtraction, Outer multiplication, Contraction, Inner multiplication). Quotient law, metric tensor, Conjugate or reciprocal tensor, Associate tensors, Covariant differentiation of vectors and tensors, Simple problems on the above topics

Unit-III: Special functions and Differential Equations:

Beta and Gamma functions, their properties and inter relationships. Power series solution of ordinary differential equations, Singular points: regular and irregular singular points; Frobenius method, Wronskian method. Bessel's differential equation and its solutions, Bessel's functions of first and second kind, Spherical Bessel and Neumann functions, Recurrence formulae, Orthogonality of Bessel functions, Laguerre's differential equation and polynomials, Rodrigues' formula, Recurrence relations, Generating Function, Orthogonal properties.

Unit IV: Integral Transforms:

Finite fourier transforms, Fourier integrals, Fourier integral theorem, Complex form of fourier integrals, Parseval's identity for Fourier integrals, Fourier and inverse Fourier transforms, Fourier sine and cosine transforms, Properties of Fourier transforms, Convolution theorem, Parseval's theorem, Fourier transform of Dirac Delta and Gaussian functions, Fourier transform of derivatives, Fourier transform of functions of two or three variables, Simple problems and applications of Fourier transforms.

Unit V: Laplace Transforms:

Laplace transform, Conditions for L.T., Properties of L.T., First and Second shifting theorems, L.T. of derivatives, L.T. of integrals, L.T. of periodic functions, Initial and final value theorems, Convolution Theorem, Relationship between Fourier and Laplace transforms, Inverse L.T. of derivatives, Inverse L.T. of Integrals, Inverse L.T. by Partial fraction's method, Inverse L.T by Convolution, Solution of Differential equations by Laplace transforms, Simple problems on the above topics.

Text and Reference Books:

1. Mathematical Methods for Physicists by G.B. Arfken and H.J. Weber
2. Matrices and Tensors for Physicists by A.W. Joshi
3. Schaum's Outlines Complex variables by Murray. R. Spiegel
4. Schaum's Outline of Theory and problems of Laplace Transforms by Murray. R.Spiegel
5. Schaum's Outline of Theory and problems of Fourier Analysis by Murray. R. Spiegel
6. Schaum's Outline of Theory and problems of Tensor Analysis by Murray. R. Spiegel
7. Advanced Engineering Mathematics by E. Kreyszig
8. Special functions, by E.D. Rainvile
9. Special functions, by W.W. Bell
10. Mathematical Methods for Physics and Engineering, by K.F. Riley, M.P. Hobson and S.J. Bence
11. Mathematical Methods in the Physical Sciences by Mary L. Boas
12. Mathematical Physics by B.D. Gupta
13. Mathematical Physics by H.K. Dass
14. Mathematical Physics by B.S. Rajput
15. Mathematical Physics by Satya Prakash

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10

TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-Two year programme)

Course No. **P2PHTC102**
Title: **Classical Mechanics**
Minor Tests (I & II): **40**
Duration of Examination: **3 hours**

Credits: **4 (4-0-0)**
Maximum Marks: **100**
Major Test: **60**

Syllabus for the examination to be held in Dec 2025, Dec 2026, Dec 2027.

Objectives: The objective of this course is to apprise and equip the students with the knowledge of Lagrangian, Hamiltonian Principles, Equations, canonical transformations so that students may apply these equations and principles in modern physics research.

Course Outcomes: This course gives strong theoretical foundation for advanced physics lies in Hamiltonian mechanics for Statistical and Quantum Mechanics Physics.

UNIT-I: Constrained Motion and Lagrangian formulation

Revision of Constraints and their types, D Alembert's principle, Lagrange's equations, kinetic energy function and theorem on total energy, Lagrangian formulation for conservative theorems and in an electromagnetic field, Gauge transformations, Applications of Lagrange's equations. (10)

UNIT-II: Non-inertial frames of References, Central force

Rotating frames of reference, inertial forces in rotating frames, Larmour precision, electromagnetic analogy of inertial effects of coriolis force, two body central force problem, stability of orbits, condition for closure, integrable power laws, orbits of artificial satellites, virial theorem and problems. (10)

UNIT-III: Variational principle and Hamilton's formulation

Variational principle, Euler's equation, Applications of variational principle, shortest distance problem, branchistrochrone, Geodesics of a sphere, Hamilton function and Hamilton's equation of motion, configuration space, phase space, state space, Lagrangian and Hamiltonian of relativistic particles, Applications of variational principle and Hamilton equations. (10)

UNIT-IV: Canonical transformation and Brackets

Legendre Transformation, Generating functions, condition for canonical transformation and problems, Definitions, identities, Poisson theorem, Relationship between angular momentum and Poisson brackets, Lagrange brackets, Relationship between Poisson and Lagrange Brackets, problems. (10)

UNIT-V: Hamilton- Jacobi Method

Hamilton-Jacobi equation, Hamilton's characteristic function, Hamilton- Jacobi equation for Hamilton's characteristic function (conservative system), Separation of variables in Hamilton Jacobi equation, Action and angle variables, Problem of Harmonic oscillator using action angle variables, Hamilton Jacobi equation-Geometrical optics and Wave Mechanics, problems (10)

Text & Reference Books:

1. Classical Mechanics by H. Goldstein
2. Classical Mechanics of particles and system by Marion and Thomtron
3. Classical Mechanics by P.V. Panat
4. Classical Mechanics by N.C. Rana and P.S. Joag
5. Classical Mechanics by J.C. Upadhyaya
6. Classical Mechanics by Satya Prakash
7. Introduction to classical Mechanics by R.G. Takawale and P.S. Puranik

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60	21 to 40%	1 hour	10 + 10

days)			
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-Two year programme)

Course No. **P2PHTC103** Credits: **4 (4-0-0)**
Title: **Electronics-I** Maximum Marks: **100**
Minor Tests (I & II): **40** Major Test: **60**
Duration of Examination: **3 hours**

Syllabus for the examination to be held in Dec 2025, Dec 2026, Dec 2027.

Objectives: This course consists of two parts: Semiconductor Physics (Unit I, II and III) and Digital Electronics (Unit IV and V). The objectives are –

1. To understand the basic fundamentals of semiconductor device physics
2. To understand the properties of semiconductors with application to the PN junction device and BJT's.
3. To familiarize students with Combinational and Sequential logic circuits
4. How digital logic gates are built using transistors design and build of digital logic systems

Course Outcomes: Upon successful completion of this course, students will be able to understand the fundamental principles of semiconductor physics. They will gain the ability to analyze the characteristics and applications of PN junctions and bipolar junction transistors (BJTs), and apply this knowledge to evaluate semiconductor materials for device applications. Additionally, students will be able to design and analyze combinational and sequential digital logic circuits, understand the implementation of logic gates using transistors, and develop basic digital electronic systems with a strong foundation in both theoretical concepts and practical design.

UNIT I

Semiconducting Materials, Carrier Concentration & transport

Elemental and compound semiconductors, the valence bond model of the semiconductors, the energy band model, the energy-Momentum diagram of intrinsic semiconductors, Fermi level and energy distribution of carriers inside intrinsic and doped semiconductors, Intrinsic carrier concentration, carrier drift in electric field: mobility, Resistivity and Conductivity, Hall effect.
Carrier diffusion phenomenon: Einstein's relationship, Generation and recombination processes: direct and indirect recombination, Auger recombination, continuity equation.

UNIT II

pn Junction

Concept and Theory of pn Junctions: thermal equilibrium condition, depletion region (abrupt and linearly graded junctions). Depletion capacitance, Capacitance-Voltage characteristics; Current-Voltage characteristics: Ideal characteristics, junction breakdown: tunneling effect (Zener Diode) and avalanche multiplication; semiconductor heterojunctions. Concepts of Absorption and Emission: Spontaneous and Stimulated Emission Basic concepts of Transferred electron effect, Gunn Diode, Tunnel diode, IMPATT Diode, Light Emitting Diodes and semiconductor LASERs, Photodiodes, Solar cell Structure and Parameters

UNIT III

BJT's

Bipolar junction Transistors: Principle of Operation, Transistor action: operation in active mode, current gain. Modes of operation of BJT, Current Voltage characteristics of common base and common emitter configuration, frequency response and switching in BJT.
Field Effect Transistor (FET and MOSFET): Structure, Operations and Characteristics

UNIT IV

Introduction to Digital Electronics

Combinational Logic: Introduction to Logic families, Characteristics of Digital ICs, Transistor as switch, binary number system, Decimal number system, Octal number system, hexadecimal number system, conversion from one number system to another, Logic Gates: TTL, ECL, MOS (Basic Circuits).

Review of Boolean Laws & Theorems, Standard forms of Boolean expressions (SOP & POS form) and their implementation; simplification of SOP & POS Boolean expressions using K-maps (4-variables).

UNIT V

Sequential circuits

Clock waveform and its characteristics, One bit memories; RS, JK, JK-master slave, D and T Flip Flops (Unclocked, Clocked and Edge triggered).

Registers and its types (Buffer Registers and Shift Registers)
Counters: Modulus Counters, Asynchronous 2-bit, Up/Down and decade counter, design of synchronous counter (Mod-8), (Mod 10),

Text and Reference Books:

1. Semiconductor Devices: Physics & Technology; S.M.Sze, John Wiley & Sons.
2. Introduction to semiconductor materials and devices, M.S. Tyagi.
3. Solid State Electronics Devices: Ben. G. Streetman; Prentice-Hall of India Ltd.
4. Modern Semiconductor devices for Integrated circuits by Chenming Calvin Hu, Pearson Publications
5. Digital Electronics, A Anand Kumar
6. Digital Electronics by G.K. Kharate (Oxford Higher Education)
7. Digital Electronics An Introduction to Theory and Practice by William H. Gothmann

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-Two year programme)

Course No. **P2PHTC104**
Title: **Scientific Programming & Editing**
Minor Tests (I & II): **40**
Duration of Examination: **3 hours**

Credits: **4 (4-0-0)**
Maximum Marks: **100**
Major Test: **60**

Syllabus for the examination to be held in Dec 2025, Dec 2026, Dec 2027.

Objectives: This course is designed to equip students with foundational and practical skills in scientific computing and technical communication. Students will develop structured programming techniques to model and solve physics-based problems, master the use of scientific computing libraries for analyzing real-world data, and apply key numerical methods to simulate simple physical phenomena. Additionally, the course emphasizes the acquisition of professional documentation skills using LaTeX, preparing students for academic research, publishing, and effective technical communication.

Course Outcomes: After completing this course content, student will be able to-

- Develop structured programming skills to model and solve physics problems.
- Master the use of scientific computing libraries for real-world data analysis.
- Apply numerical methods to simulate simple physical phenomena.
- Acquire professional skills in scientific documentation using LaTeX.
- Prepare for academic research, publishing, and technical communication.

Unit 1: Programming Foundations - I

Introduction to Scientific Computing: Overview of computing in physics, Real-world examples: weather simulation, quantum mechanics, fluid flow.
Basic Programming Concepts: Variables, constants, and data types (integer, float, string, boolean), Operators, expressions, and precedence.
Control Structures: Decision making: if, else, elif. Looping: for loops, while loops, nested loops.

Unit 2: Programming Foundations - II

Functions and Modular Programming: Defining and calling functions, Passing arguments, returning values, Scope of variables. Data Structures: Lists, tuples, dictionaries, sets: operations and use-cases in physics, Arrays (NumPy introduction). File Handling and Basic Input/Output: Reading and writing text files, Structured data: CSV, JSON basics.
Error Handling and Debugging: Types of errors (syntax, runtime, logic), Try-except blocks, assertions. Debugging techniques. Version Control Basics: Introduction to Git: repositories, commits, branches, Using GitHub for collaborative coding.

Unit 3: Scientific Libraries

NumPy for Scientific Computations: Creating arrays, array operations. Indexing, slicing, and broadcasting. Linear algebra operations (dot product, matrix inversion). **SciPy for Numerical Analysis:** Using `scipy.optimize`, `scipy.integrate`, `scipy.interpolate`. Solving mathematical problems with SciPy modules.
Data Visualization**:** Plotting basics: line plots, scatter plots, histograms (Matplotlib). Styling plots: titles, labels, legends, annotations.

Unit 4: Scientific Tools, Optimization & Simulation

Basics of Optimization: Introduction to optimization problems. Gradient descent algorithm for finding minima. Applications: fitting a curve to data points. Simulation Techniques: Concept of Monte Carlo simulation. Random number generation. Simulating random walks and diffusion processes.
Modeling Physical Systems: Setting up and solving models: damped oscillator, population growth.

Unit 5: Scientific Editing and Documentation with LaTeX

Introduction to LaTeX: Installation and overview of editors. LaTeX Document Basics: Document classes (article, report, book), Sections, subsections, paragraphs**.** Mathematical Typesetting: Inline and displayed equations. Align environment, multline, equation numbering. Example: Write Schrödinger equation and Maxwell's equations in LaTeX.
Tables and Figures: Creating tables (tabular environment). Inserting and positioning images. Cross-referencing figures and tables. Bibliography Management: BibTeX and citation management. Styles and formatting references, Creating presentations using Beamer.

<u>Text and Reference Books:</u>

1. Hans Petter Langtangen, *A Primer on Scientific Programming with Python*, Springer.
2. Mark Lurtz, Learning Python, O'REILLY.
3. Leslie Lamport, *LaTeX: A Document Preparation System*, Addison-Wesley.

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each.

Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-Two year programme)

Course No. **P2PHTC105**
Credits: **4 (4-0-0)**
Title: **Lab Work (Practicals)**
Maximum Marks: **100**
Internal Exam: **50**
External Exam: **50**
Duration of Examination: **3 hours**

Syllabus for the examination to be held in Dec 2025, Dec 2026, Dec 2027.

Objectives: The objective of this course is to get basic training on the experiments of various topics.

Course Outcomes: This course gives strong experimental concepts from the experiments.

List of practicals

1. Measurement of resistivity by using 4-probe technique
2. Determining the magnetic field as a function of the resonance frequency using ESR
3. Determination of charge carrier density using Hall Effect
4. Measuring width of a narrow slit, diameter of a thin wire and counting number of slits in diffraction grating
5. To determine the energy loss in the transformer core, using B-H Curve unit.
6. To measure the wavelengths of spectral lines of a Mercury (Hg) source using diffraction grating and a spectrometer
7. To study monostable multivibrator using transistor
8. To study the characteristics of FET
9. To study the V-I characteristics of PN Junction Diode
10. Measurements with a cathode ray oscilloscope
11. To study the hybrid parameters of a transistor
12. To study the solid state power supply
13. Measurement of the wavelength of He-Ne Laser and Na lamp using circular fringes
14. To determine Cauchy’s Constants using a prism and spectrometer.
15. To study the V-I characteristics of U.J.T
16. To study a set of experiments using optoelectronics devices

17. To study the operation and working principle of JK, D and T Flip Flop
18. To study the decoder for conversion of BCD to seven segment display.
19. To study logic gates and verify DeMorgan's law
20. To study RC coupled amplifier and plot a graph between gain and frequency
21. To study astable multivibrator using 555 timer.
22. To determine Planck constant using the stopping potential of different filters
23. To design inverting and non-inverting op-amp and to study gain of each and observe the waveforms on CRO
24. To design and study the various electronic circuits (half wave rectifier, full wave rectifier, clipper, clamper etc) using Expeyes-17 and to study their input output wave forms.
25. Design and observe input output waveforms of various logic gates using Expeyes-17
26. Determination of the electronic charge by Milikan's oil drop experiment electronic charge by Milikan's oil drop experiment.
27. Simple programs using control structures
28. Fitting a curve to data points.
29. Plotting and analyzing a real-world dataset (for example blackbody radiation curve).
30. Writing mini scientific article fully in LaTeX with equations, tables and fgures.
31. Create a Latex presentation using Beamer template

Scheme of Examination:

External Practical examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance of the students.

Practical / Research (thesis/project/patent)	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	4 hours	50% (50 Marks)
External Examination	100%	4 hours	50% (50 Marks)
Total			100 Marks

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-Two year programme)

Course No. **P2PHTC201**
Title: **Quantum Mechanics**
Minor Tests (I & II): **40**
Duration of Examination: **3 hours**

Credits: **4 (4-0-0)**
Maximum Marks: **100**
Major Test: **60**

Syllabus for the examination to be held in May 2026, May 2027, May 2028.

Objectives: It is an essential core course for the students of M. Sc. Physics in 2nd semester. The course covers the detailed contents about the Perturbation Theory, approximation methods and Scattering Theory.

Course Outcomes: The students will be able to solve simple problems by using perturbation theory and apply them to various quantum systems. They shall also be able to solve barrier problem by using WKB method, understand the idea of Born approximation and the method of partial waves.

Unit-I: Stationary state perturbation Theory

Time-independent perturbation Theory (Rayleigh-Schrodinger), non-degenerate perturbation theory up to second order, Application to perturbed (anharmonic) harmonic oscillator and ground state of Helium atom , Time-independent degenerate perturbation theory up to first order, Application of degenerate perturbation theory to Stark effect and Zeeman effect.

Unit-II: Time- dependent Phenomena

Time dependent perturbation theory, formulation**,** calculation of first order transition amplitude, transition probability, transitions into a continuous spectrum and the derivation of Fermi's Golden rule. Absorption and emission of radiation, Einstein's co-efficients of emission and absorption. Adiabatic and sudden approximations, expression for transition probabilities. Transition rates for absorption and emission of radiation, Transition rates with the dipole approximation.

Unit-III: Approximation methods

The variational (Rayleigh-Ritz) principle and its application to the ground state of Helium atom. The WKB (Wentzel, Kramers, Brillouin) approximation, classical turning points, connection formulae, application of WKB method to bound state problem and tunnelling through a potential barrier and calculation of transmission probability for the rectangular barrier, alpha decay derivation and Geiger Nuttal Law.

Unit-IV: Scattering theory-I

Differential and total scattering cross-sections, scattering amplitude, relation between differential scattering cross-section and scattering amplitude, Laboratory and Centre of mass reference frames, relation of scattering angles and cross-sections in Laboratory and Centre of mass systems, Partial wave analysis, formalism, expression for scattering amplitude and total scattering cross-section in terms of phase shifts, scattering by a perfectly rigid sphere and by square well potential, deduction of optical theorem from scattering cross-section.

Unit-V: Scattering theory-II

Free particle Green's function, Green's function method for scattering, derivation of scattering amplitude and Born approximation, validity of Born approximation, application of Born approximation to square well, Yukawa and screened coulomb potential, Many particle systems, the two particle system, Identical particles, the exchange operator, the Pauli principle, Slater determinant, Scattering of identical particles.

Text and Reference books:

1. Quantum Mechanics: concepts and applications by N. Zettili.
2. Modern Quantum Mechanics by J.J. Sakurai and J. Napolitano.
3. Applied quantum mechanics by A.F.J. Levi
4. Quantum Mechanics by L.I. Schiff (McGraw-Hill).
5. Quantum Physics by S. Gasiorowicz (Wiley India).
6. Quantum Mechanics by Franz Schwabl (Narosa Publishing House).
7. A text book of Quantum Mechanics by P.M. Mathews and K. Venkatesan.
8. Quantum Mechanics by B. Craseman and J D Powell (Addison Wesley).
9. Quantum Mechanics: Theory and applications by Ajoy Ghatak and S. Lokanathan.
10. Quantum Mechanics by G. Aruldhas (PHI Learning Private limited)
11. Advanced quantum mechanics by Satya Prakash (KNRN publications).

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-Two year programme)

Course No. **P2PHTC202**	Credits: **4 (4-0-0)**
Title: **Electrodynamics and Plasma Physics**	Maximum Marks: **100**
Minor Tests (I & II): **40**	Major Test: **60**
Duration of Examination: **3 hours**	

Syllabus for the examination to be held in May 2026, May 2027, May 2028.

Objectives: Classical Electrodynamics and Plasma Physics is a course that covers electrostatics and magneto-statics as well the basics of plasma physics.

Course Outcomes: This course gives strong theoretical foundation for students to understand the subject of plasma physics in detail.

UNIT-I: Electromagnetic waves, Application and Electric Multipole moment

Revisiting Maxwell's equations, waves in different conducting mediums, Polarisation of Electromagnetic waves, rectangular wave guide, circular wave guides, resonant cavities, scattering and scattering parameters, polarisation of scattering light, coherence and incoherence of scattered light, Electric dipole and multipole moments of a system of charges, Multipole expansion of the scalar potential of an arbitrary charge distribution. (10)

UNIT-II: Electrodynamics of a moving charge and radiating systems

Retarded potentials, Lienard-Wiechert potentials, Fields due to an arbitrarily moving point charge, special case of a charge moving with constant velocity, Radiations from an oscillating dipole, Power radiating by a point charges (Larmor Formula), Lienard's generalisation of Larmor formula, Energy loss in Bremsstrahlung and Linear Accelerators, Radiation reaction (Abraham-Lorentz formula). (10)

UNIT-III: Relativistic Electrodynamics

A review of charges and fields as observed in different frames. Covariant formulation of Electrodynamics-Electromagnetic field tensor, Transformation of fields, Field due to point charge in uniform motion, Lagrangian formulation of the motion of charged particle in an electromagnetic field, Numerical problems. (10)

UNIT-IV: Plasma Physics

Kinetic Pressure in a partially ionised gas, Mean free path and collision cross-section, Mobility of charged particles, Effect of Magnetic field on the mobility of ions and electrons, Diffusion of electrons and ions, Ambipolar diffusion, Diffusion in Magnetic field, Thermal conductivity, Effect of magnetic field, Electron and ion temperature, Dielectric constant of Plasma, Quasi-neutrality of Plasma, Debye shielding distance, optical properties of Plasma, Magnetic susceptibility of Plasma. (10)

UNIT-V: Motion of charged particles in Electric and Magnetic field

Particle description of Plasma, Motion of charged particle in an electrostatic field, Motion of charged particle in uniform magnetic field, Motion of Charged particle in electric and magnetic fields, Motion in a torroidal magnetic field, Motion of an electron in a time varying electric field, Motion in a crossed radio frequency and magnetic field, Magnetohydrodynamics, Decay of charge in conductors, Decay of current in conductors, Introduction to production of plasma (Tokamak). (10)

Text & Reference Books:

1. Introduction to Electrodynamics by D.J. Griffiths
2. Classical Electrodynamics by J.D. Jackson
3. Electromagnetic by B.B. Laud
4. Plasma Physics by S.N. Sen
5. Principles of optics by M. Born and E. Wolf
6. Electromagnetic waves and radiating systems by Jordan and Balmain
7. Classical Electrodynamics by S. P. Puri

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-Two year programme)

Course No. **P2PHTC203**
Title: **Electronics-II**
Minor Tests (I & II): **40**
Duration of Examination: **3 hours**

Credits: **4 (4-0-0)**
Maximum Marks: **100**
Major Test: **60**

Syllabus for the examination to be held in May 2026, May 2027, May 2028.

Objectives: This course provides a comprehensive understanding of four key areas in Electronics: the principles and applications of Operational Amplifiers in analog circuit design using negative feedback for stability; the use of specialized analog and digital ICs in designing timers, oscillators, and waveform generators; the fundamentals of Radio Waves, including electromagnetic wave propagation, antenna functions, and the working of TV transmitters, receivers, and Superheterodyne receivers; and an introduction to Microprocessors, focusing on hardware and software integration, fault identification, and basic assembly language programming to prepare students for roles in equipment maintenance and product development.

Course Outcomes: Upon completion of this course, students will be able to analyze and design analog circuits using operational amplifiers, apply specialized ICs to develop timers, oscillators, and signal generators, understand the principles of radio wave propagation, antenna functions, and the operation of TV transmitters and receivers, including Superheterodyne systems, and gain foundational knowledge in microprocessor architecture, fault identification in microprocessor-based systems, and basic assembly language programming to support both troubleshooting and development tasks.

UNIT I
Operational Amplifier-I

Differential Amplifiers: Circuits Configurations, dual input, balanced output differential amplifier (using BJTs), Output of Differential amplifier using CMRR.
Introduction to Op-Amps: Block diagram of a typical Op-Amp, Circuit symbol and terminals, equivalent circuit and transfer characteristics, Ideal Op-Amp characteristics, Open loop configurations of Op-Amps, DC analysis of inverting and non-inverting, Applications of open loop Op-Amp, constant current bias.
Practical Op-Amp: input-offset Voltage, input bias current, input offset current, total output offset voltage, CMRR, frequency response.

UNIT II
Operational Amplifier-II

Op-amp with negative feedback: Voltage series feedback – effect of feedback, bandwidth and output offset voltage, voltage follower.
DC and AC amplifier, summing, scaling and averaging amplifiers, instrumentation amplifier: integrator and differentiator, logarithmic and antilogarithmic amplifier, sample and hold amplifiers, Schmitt trigger, clipper and clamper, active filters.

UNIT III
Analog and Digital Circuits
Oscillators: Principle, types, frequency stability, response. The phase shift oscillator and LC tunable oscillator. , 555 timer, Multivibrators: Monostable and astable MV, square and triangular wave generators.
Voltage Regulators: Zener diode as voltage regulator, Dual Polarity regulated power supplies using 78 XX and 79 XX series regulators (Basic ideas only).
Digital to analog converters (ladder and weighed resistor types), Analog to digital converters (Counter type, successive approximation and dual slope converters), Applications of DACs and ADCs.

UNIT IV
Memory Devices and Microprocessors
Concepts of Memories Devices: CCD (Principle of operation and applications), concept of MOS diode for CCDs, Block level description of microcomputers, Memories and their types, Memory chips.
Architecture of 8085, PIN layout and description of Signals, types of instructions, addressing modes, and instruction set. Instruction execution and timing diagrams: Opcode Fetch machine cycle, Memory Read Machine cycle, I/O Read, I/O write cycle, demultiplexing the address bus Simple Arthimatic and Logic Operations, Simple Programs.

UNIT V
Microcontrollers and Data Interpretation

Introduction to microcontrollers: Architecture of 8051, PIN layout and Simple Programming
Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding.

Text and Reference Books

1. Op-Amp & Linear Integrated Circuits by R.A. Gayakwad
2. Operational Amplifiers and Linear ICs bi David A. Bell, Oxford University Press
3. Electronic Communication system by George Kennedy
4. Electronic devices & circuits theory By R.L. Boylestad, Louis Nashelsky, Pearson education
5. R.R.Gulati, Monochrome & Colour Television

6. R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with 8085, Penram India (1999).
7. Microprocessors and Microcontrollers, N. Senthil Kumar, M. Sarvanan and S. Jeevananthan, Oxford University Press

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-two year programme)

Course No. **P2PHTC204**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**
Title: **Radiation and Medical Physics**
Maximum Marks : **100**
Minor Tests (I & II): **40**
Major Test : **60**

Syllabus for the examinations to be held in May 2026, May 2027, May 2028.

Course Objectives:

This course aims to provide students with comprehensive knowledge and understanding of the physical principles and applications of radiation in medical science. The primary objectives include:

- To introduce the fundamentals of radiation and the various mechanisms of interaction between radiation and matter.
- To explore the sources of radiation and the methods of radiation beam production in X-ray machines and particle accelerators.
- To understand the concept of radiation dose and techniques for measuring radiation using detectors.
- To study the biological effects of radiation exposure and the principles of radiation protection for safety.
- To examine the use of radiation in medical diagnostics, therapy, and modern medical imaging technologies.

Expected course outcomes: This course provides a foundation in the fundamental principles of radiation physics and its applications in medical contexts. The primary aim is to enable students to achieve the following learning outcomes:

- Understand the concepts of radiations, including its interaction with matter, energy deposition calculation and radioactive decay laws.
- Calculate radiation dose and describe the principles of radiation detection of different kinds of detectors and dosimetry.
- Concept of production and characteristics of X-rays, production of radiation beams for treatments from modern accelerators such as LINACs and cyclotrons.
- Analyze radiation effects at the cellular and tissue level, DNA damage mechanisms, survival curves.
- Discuss the principles and practices of radiation protection, including the concept of dose limits.

Understand the basic principles of radiotherapy and the working mechanisms of medical imaging devices such as CT, PET, SPECT.

UNIT-I: Introduction of Radiation and Interaction of Electromagnetic Radiation with Matter (10 lectures)

Classification of radiation, radioactivity, general properties and production of radioactive materials, radioactive decay, half-life, mean-life, transient and secular equilibrium,

Mass-energy conservation, Interaction of electromagnetic radiation with matter– Thomson scattering, Rayleigh scattering, Compton scattering (Klein-Nishina differential cross section), photoelectric absorption, pair production, annihilation radiation, photonuclear reaction; Attenuation – linear attenuation, mass attenuation coefficients, half value layer; Absorption– mass-energy absorption coefficients.

UNIT-II: Interaction of Particle Radiation with Matter (10 lectures)

Concept of cross-section, mean free path of collisions, classical theory of inelastic collisions of heavy charged particles with atomic electrons, Bethe-Block formalism for energy loss dE/dx, mass scaling law, dE/dx for mixtures, mass collision stopping power, Bragg peak, energy straggling, particle range, Cerenkov radiation, Interaction of light charged particles (electrons and positrons) with matter– collision loss, Bremsstrahlung, electron range and transmission curve, absorption of beta-electrons, positron interaction, energy loss in thick and thin absorbers, CSDA range (continuous slowing down approximation)

Interaction of neutrons with matter– thermal and fast neutrons interaction, neutron interaction cross-section, neutron beam in medicine

UNIT-III: Radiation for Treatments (10 lectures)

Sources of radioactive elements– natural sources, artificial radionuclides; Machines for Producing radiation– X-ray production and spectra, factors affecting X-ray emission, teletherapy, Van-de Graaff generator, linear accelerator, synchrotron, betatron, cyclotron, microtron

UNIT-IV: Radiation Dosimetry and Monitoring Instruments (10 lectures)

Radiation measurements– photon fluence and energy fluence, energy transfer, kerma, cema, absorbed dose, exposure, exposure-dose relationship, stopping power, relationship between various dosimetric units, Brag-Gray cavity theory; Radiation dosimeters– property of dosimeters, film dosimetry, ionization chamber dosimetry, luminescence dosimetry, semiconductor dosimetry
Radiation Detectors– types of detectors and basic principles, gas-filled detectors, scintillator detectors, semiconductor detectors

UNIT-V: Radiation Biology, Protection and Imaging (10 lectures)

Biologic effect of radiation; Molecular and cellular response to radiation–DNA damage (direct effect), cell damage by radicals (indirect effect), cell cycle and cell survival surve theory, interaction of radiation with tissue, cell recovery process, dose rate and Fractionation,
Radiation protection– effect of radiation exposure, sources of radiation exposure, methods of reducing occupational exposure, dose limits, shielding, use of dosimeters.
Concept of radiotherapy; Radioimaging– radiography, Computed Tomography (CT), Single-Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET)

Text and Reference Books:

1. **William R. Leo,** *Techniques for Nuclear and Particle Physics Experiments,* Springer-Verlag, Berlin.
2. **G. F. Knoll,** *Radiation Detection and Measurement,* Wiley, New York.
3. **E. B. Podgorsak,** *Radiation Physics for Medical Physicists,* Springer, USA.
4. **Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone,** *The Essential Physics of Medical Imaging,* Lippincott Williams & Wilkins.
5. **E. B. Podgorsak,** *Radiation Oncology Physics: A Handbook for Teachers and Students,* International Atomic Energy Agency (IAEA), Viena.
6. **D. R. Dance, S. Christofides, A. D. A. Maidment, I. D. McLean, K. H. Ng,** *Diagnostic Radiology Physics: A Handbook for Teachers and Students,* International Atomic Energy Agency (IAEA), Viena.
7. **Todo Pawlicki, Daniel J. Scanderbeg, George Starkschall,** *Hendee's Radiation Therapy Physics,* Wiley-Blackwell.

8. **Herman Cember, Thomas E. Johnson,** *Introduction to Health Physics*, McGraw-Hill Medical.
9. **Hall, E. J., Giaccia, A. J.,** *Radiobiology for the Radiologist (8th Edition)*, Wolters Kluwer, 2018.
10. **W. J. Meredith and J. B. Massey,** *Fundamental Physics of Radiology* John Wright (Butterworth-Heinemann).

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-Two year programme)

Course No. **P2PHTC205** Credits: **4 (4-0-0)**
Title: **Lab Work (Practicals)** Maximum Marks: **100**
Internal Exam: **50** External Exam: **50**
Duration of Examination: **3 hours**

Syllabus for the examination to be held in May 2026, May 2027, May 2028.

Objectives: The objective of this course is to get basic training on the experiments of various topics.

Course Outcomes: This course gives strong experimental concepts from the experiments.

List of practicals

1. Measurement of resistivity by using 4-probe technique
2. Determining the magnetic field as a function of the resonance frequency using ESR
3. Determination of charge carrier density using Hall Effect
4. Measuring width of a narrow slit, diameter of a thin wire and counting number of slits in diffraction grating
5. To determine the energy loss in the transformer core, using B-H Curve unit.
6. To measure the wavelengths of spectral lines of a Mercury (Hg) source using diffraction grating and a spectrometer
7. To study monostable multivibrator using transistor
8. To study the characteristics of FET
9. To study the V-I characteristics of PN Junction Diode
10. Measurements with a cathode ray oscilloscope
11. To study the hybrid parameters of a transistor
12. To study the solid state power supply
13. Measurement of the wavelength of He-Ne Laser and Na lamp using circular fringes
14. To determine Cauchy's Constants using a prism and spectrometer.
15. To study the V-I characteristics of U.J.T
16. To study a set of experiments using optoelectronics devices
17. To study the operation and working principle of JK, D and T Flip Flop
18. To study the decoder for conversion of BCD to seven segment display.
19. To study logic gates and verify DeMorgan's law
20. To study RC coupled amplifier and plot a graph between gain and frequency
21. To study astable multivibrator using 555 timer.
22. To determine Planck constant using the stopping potential of different filters
23. To design inverting and non-inverting op-amp and to study gain of each and observe the waveforms on CRO
24. To design and study the various electronic circuits (half wave rectifier, full wave rectifier, clipper, clamper etc) using Expeyes-17 and to study their input output wave forms.
25. Design and observe input output waveforms of various logic gates using Expeyes-17

26. Determination of the electronic charge by Milikan’s oil drop experiment electronic charge by Milikan’s oil drop experiment.
27. Simple programs using control structures
28. Fitting a curve to data points.
29. Plotting and analyzing a real-world dataset (for example blackbody radiation curve).
30. Writing mini scientific article fully in LaTeX with equations, tables and fgures.
31. Create a Latex presentation using Beamer template
32. Simple Programming using 8085 microprocessor
33. Simple Programming using 8051 microcontroller

Scheme of Examination:

External Practical examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance of the students.

Practical / Research (thesis/project/patent)	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	4 hours	50% (50 Marks)
External Examination	100%	4 hours	50% (50 Marks)
Total			100 Marks

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-Two year programme)

Course No. **P2PHVC251** — Credits: **04 (0-0-4)**
Title: **Vocational Course on Radiation and Medical Physics** — Maximum Marks:
Internal Exam: — External Exam:
Duration of Examination:

Syllabus for the examination to be held in May 2026, May 2027, May 2028.

Objectives: This vocational course is designed to provide learners with practical skills and hands-on knowledge essential for proficiency in Radiation and Medical Physics. Participants will gain a thorough understanding of industry-relevant tools, techniques, and safety standards. The course focuses on developing job-ready competencies through real-world applications and practice-oriented tasks. Learners will also enhance their problem-solving abilities and learn to work effectively both independently and as part of a team.

Course Outcomes: By the end of the course, students will be prepared to perform key functions confidently in their chosen vocational field and will be equipped with resources to support ongoing professional growth.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-Two year programme)

Course No. **P2PHVC252**
Title: **Scientific Programming & Editing**
Internal Exam:
Duration of Examination:
Credits:
Maximum Marks:
External Exam:

Syllabus for the examination to be held in May 2026, May 2027, May 2028.

Objectives: This vocational course is designed to provide learners with practical skills and hands-on knowledge essential for proficiency in Scientific Programming & Editing. Participants will gain a thorough understanding of industry-relevant tools, techniques, and safety standards. The course focuses on developing job-ready competencies through real-world applications and practice-oriented tasks. Learners will also enhance their problem-solving abilities and learn to work effectively both independently and as part of a team.

Course Outcomes: By the end of the course, students will be prepared to perform key functions confidently in their chosen vocational field and will be equipped with resources to support ongoing professional growth.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTC101 / P2PHTC301**
Credits: **4 (4-0-0)**
Maximum Marks : **100**
Major Test : **60**
Duration of Examination: **3 hours**
Title: **Condensed Matter Physics**
Minor Tests (I & II): **40**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The objective of this course is to apprise and equip the students with the deeper insights into the field of Crystallography and magnetic properties of materials. The course prepares students for further study in advanced crystallography techniques. By studying magnetic properties of materials, students can better understand their behavior for use in various technologies.

Course Outcomes: By the end of the course, students will have a strong foundation in crystallographic principles, including the structure, symmetry, and properties of crystals. Students will be able to explain the basic principles of magnetism, including the different types of magnetic materials.

UNIT-I: Basic Crystallography

Introduction, anisotropy, the significance of order, crystal symmetry, coupling of symmetry elements, combination of symmetry elements, lattice directions and planes, indexing of planes, directions and positions of atoms, atom sizes and coordination, crystal shape, twinned crystals, quasi-crystals. (10)

UNIT-II: Point Groups and Space Groups

Derivation of 14 Bravais lattices, non- translational symmetry elements, derivation of 32 point groups, translational symmetry elements, space groups, derivation of space groups (triclinic, monoclinic and orthorhombic systems). (10)

UNIT-III: Diffraction

Interaction of electromagnetic radiation with matter, diffraction and information, X-ray diffraction, the mathematics of diffraction, diffraction and Fourier transforms, The significance of the Fourier transform, Fourier transforms and phase, Fourier transforms and the wave equation, Fourier transforms and information, The inverse transform. (10)

UNIT-IV: X-ray Diffraction by a three dimensional lattice

The diffraction pattern of a crystal, Bragg's law, The Laue equations, Equivalence of Bragg and Laue equations, Bragg's law in Ewald construction, Reciprocal Space, X-ray diffraction in direct and reciprocal space, Diffraction by liquids and amorphous bodies, Electron diffraction, Neutron diffraction, Electron, Neutron and X-ray diffraction : comparison and perspectives. (10)

UNIT-V: Magnetic Properties of materials

Classification of magnetic materials, Atomic theory of magnetism, the origin of permanent magnetic moments, ferromagnetism, Weiss classical theory of ferromagnetism, Quantum theory of ferromagnetism, temperature dependence of spontaneous magnetization, ferromagnetic domains. Hysteresis curve of ferromagnetic materials, Bloch-Wall energy, antiferromagnetism -the two-sublattice model, ferrimagnetism, spin waves and magnons.

(10)

Text & Reference Books:

1. Applied Solid State Physics by Rajnikant
2. Introduction to Solids by Azaroff.
3. Crystallography Applied to Solid State Physics by Verma and Srivastava
4. Solid State Physics by M.A.Wahab
5. Elementary Solid State Physics by Omar

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS +	Syllabus to be covered in the	Time allotted for the	%Weightage

Subjective Test	examination	examination	(Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTC102 / P2PHTC302**
Credits: **4 (4-0-0)**
Maximum Marks : **100**
Major Test : **60**

Duration of Examination: **3 hours**
Title: **Nuclear & Particle Physics**
Minor Tests (I & II): **40**

Syllabus for the examinations to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives:

This course aims to provide a comprehensive understanding of nuclear structure, forces, and reactions, as well as the fundamentals of particle physics. It prepares students to apply theoretical models and experimental principles to analyze nuclear and subatomic phenomena.

Course Outcomes:

Upon successful completion of this course, students will be able to explain nuclear properties and forces, analyze nucleon interactions, and apply theoretical models like the shell and collective models to describe nuclear structure. They will understand nuclear reaction mechanisms and compute key parameters such as Q-values and cross sections. Foundational knowledge of cosmic rays and elementary particles, including the Standard Model and symmetry principles is also gained.

UNIT I: Atomic Nucleus

Historical development of nuclear physics: from the discovery of radioactivity and the nucleus (Becquerel, Rutherford) to major 20th-century milestones. Overview of nuclear properties; discovery of the neutron; nuclear composition: proton-electron and proton-neutron models.
Mass defect, packing fraction, binding energy curve; semi-empirical mass formula and nuclear stability.
Nuclear potentials: square well, harmonic oscillator, and Woods-Saxon; nucleon energy levels and decay of nuclear states. *(10)*

UNIT-II Nuclear forces and two body problem

Meson exchange theory of nuclear forces; mass of exchange particles; exchange and tensor potentials. Charge independence and charge symmetry of nuclear forces; concept of isospin. Ground state of the two-nucleon system (deuteron); low-energy nucleon-nucleon scattering (<10 MeV); scattering length and effective range theory. Spin dependence of nuclear forces; scattering of neutrons by ortho and para hydrogen molecules. *(10)*

UNIT-III: Nuclear Models

Fermi gas model; nuclear shell model including experimental evidence for shell effects and magic numbers, square well and harmonic oscillator potentials, spin–orbit coupling; Schmidt model predictions for magnetic dipole moments and ground state angular momentum and parity; collective model covering vibrational and rotational spectra; Nilsson's unified model for deformed nuclei.

UNIT IV: Nuclear Reactions

Kinematics of nuclear reactions in lab and center-of-mass frames; Q-value, threshold energy, and cross sections (scattering and reaction) with partial wave analysis.
General features of nuclear reactions: energy spectra, angular distributions, and cross sections. Elastic scattering and nuclear size via electron scattering and the optical model.
Classification of nuclear reactions; stages of nuclear processes (pre-equilibrium, equilibrium, post-equilibrium); direct and compound reaction mechanisms, including scattering and transfer reactions; Bohr's theory of the compound nucleus.
Concept of Nuclear fission (spontaneous and induced) and nuclear fusion. (10)

UNIT-V Cosmic rays and Elementary Particles

Cosmic rays: Discovery, origin, primary and secondary components, and geomagnetic effects (latitude, altitude, east–west asymmetry).

Elementary particles: Overview of the Standard Model, particle types (leptons, baryons, bosons), quark model and color charge, conservation laws, and fundamental interactions (strong, weak, and electromagnetic), unification of fundamental forces. Symmetry principles including parity (Wu's experiment), isospin, hypercharge, Gell-Mann–Nishijima scheme, CP and CPT violations.

Text & Reference Books:

1. Nuclear Physics: Principles and Applicatios, John Lilley Wiley student edition.
2. Nuclear Physics, Dr. S.N. Ghoshal, S.Chand
3. Particles and Nuclei: An introduction to the Physical Concepts, Povh, Rith, Scholz, Zetsche, Springer
4. Nuclear Physics : R. R. Roy and B. P Nigam
5. Nuclear Physics : D. Halliday
6. Nuclear Physics : I. Kaplan
7. Concepts of Nuclear Physics : B. L. Cohen
8. Introductory Nuclear Physics By K. S. Krane

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTE103 / P2PHTE303** Duration of Examination: **3 hours**
Credits: **4 (4-0-0)** Title: **Physics of Materials (Elective)**

Maximum Marks : **100** Minor Tests (I & II): **40**
Major Test : **60**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The objective of this course is to apprise the students with basic knowledge of materials science, so that they would be able to understand and distinguish between variety of materials based on their structure and properties.

Course Outcomes: Students will acquire the knowledge needed to understand, analyze, and manipulate materials for diverse technological applications. This course will prepares them for careers in research, industry, and academia while fostering an appreciation for the role of materials in modern society.

UNIT-I: Classification of Materials

Introduction, Classification of Materials, Engineering requirements, metals and alloys, metallic glasses – preparation and properties, ceramics, polymeric materials, composite materials, electronic materials, biomaterials, smart materials, materials with nano-dimension, aerospace materials, material structure, selection of materials, mechanical properties, electrical properties, thermal properties and their relations with structure of materials. (10)

UNIT-II: Ceramics, polymers and composites

Ceramics- Synthesis and processing of ceramic powders, sintered ceramics and its characteristics, inorganic glasses, glass ceramics, processing and applications of clay products, refractories, applications.
Polymers – classification, addition and condensation polymerization, degree of polymerization, thermoplastics, mechanical properties of thermoplastics, elastomers, adhesives
Composite materials – dispersion strengthened, particulate, fiber-reinforced, laminar and sandwich structures, insulating materials. (10)

UNIT-III: Nanomaterials

History and scope, effect of nano-dimensions on materials behavior, synthesis routes for nanostructured materials: bottom-up and top-down approaches, tools to characterize nanomaterials, quantum dots and its applications.
The world of carbon – Introduction, graphite related materials, Fullerenes, carbon nanotubes, applications of carbon nanotubes. (10)

UNIT-IV: Calamitic and polymer Liquid Crystals

Introduction, classification of liquid crystals, thermotropic liquid crystals (rod like molecules), chirality in liquid crystals, nematic, cholesteric and smectic mesophases, the blue phases, polymer liquid crystals, main chain liquid crystal polymers, side chain liquid crystal polymers, combined liquid crystal polymers, applications of polymer liquid crystals. (10)

UNIT-V: Discotic, Lyotropic Liquid Crystals and Liquid Crystal Technology

Discotic liquid crystals, discotic mesophase structures-the columnar liquid crystal, the discotic nematic phase. Lyotropic liquid crystals, constituents of lyotropic liquid crystals, structures of lyotropic liquid crystal phases, liquid crystal displays, the twisted nematic liquid crystal displays, applications of liquid crystals. (10)

Text & Reference Books:

1. Essentials of materials science and engineering by D.R.Askeland and P.P.Fulay
2. Material science by S.L.Kakani and Amit Kakani
3. Introduction to nanotechnology by C.P.Poole,Jr. and F.J.Owens
4. Carbon-the future material for advanced technology applications

   by G.Messina and S.Santangelo.
5. Supercarbon- Synthesis,properties and applications by S.Yoshimura and R.P.H.Chang
6. Liquid Crystals by S.Chandrasekhar
7. Introduction to Liquid Crystals: Chemistry and Physics by Peter J.Coolings and Michael Hird

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTE104 / P2PHTE304**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**
Title: **Advanced Nuclear Structure (Elective)**
Maximum Marks : **100**
Minor Tests (I & II): **40**
Major Test : **60**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The main objective of this course is to impart students the knowledge about nuclear properties, deformations and nuclear models to understand the complex world of atomic nucleus and its interactions.

Course outcomes: After completion of this course the students shall have detailed knowledge of nuclear excitations and how they relate to fundamental properties of nuclei such as nuclear shape and shell structure. They shall also have a good understanding of fundamental nuclear structure models, nuclear structure phenomena and can interpret experimental observables and spectroscopic information with the help of nuclear structure models. Besides, they would acquire knowledge of current research topics in nuclear structure physics.

Unit I: Nuclear global properties

Concepts, nuclear extension: densities and radii, proton and neutron charge distributions, angular momentum in the nucleus, nuclear moments, dipole magnetic moments, electric moments - electric quadrupole moment, one particle quadrupole moments, Nucleon-nucleon interaction, introduction, methods of approach, general aspects of the two-body interactions

Unit II: Collective Models

Introduction, semi empirical Mass Formula, Nuclear Surface Deformations, General parameterization, Types of Multipole deformations, Quadrupole deformations, Symmetries in Collective space, rotational motion of deformed shapes, the Bohr Hamiltonian, the axially symmetric case, the asymmetric rotor

Unit III: Phenomenological Single Particle Models

The Shell Model, introduction and general considerations, experimental evidence for shell effects, the average potential of the nucleus, spin orbit coupling, the shell model approach to the many body problem, ground state spin of nuclei, electromagnetic moments and transitions, the deformed Shell Model, experimental evidence, General deformed potential, the Anisotropic Harmonic Oscillator, Nilsson Hamiltonian, Quantum Numbers of the ground state in odd nuclei

Unit IV: Nuclear Physics at the extremes of stability
Introduction, nuclear structure at the extremes of stability, Theoretical concepts and extrapolations: changing mean fields, Dripline physics, nuclear halos, neutron skins, proton rich nuclei and other exotica

Unit-V: Relativistic mean field models
Relativistic quantum mechanics: Klein-Gordon and Dirac equations and their solutions, Gamma matrices, non-relativistic limit of Dirac equation; Parity inversion and time reversal, Introduction to relativistic mean field models, Formulation of the Models and applications

Text and Reference books:

1. Basic ideas and concepts in Nuclear Physics by K. Heyde
2. Theory of Nuclear structure by M.K Pal
3. Shapes and Shells in Nuclear Structure by S.G. Nilsson and I. Ragnarsson
4. Nuclear Models by W. Greiner and J.A. Maruhn
5. The Nuclear Many Body Problem by Peter Ring and Schuck
6. Nuclear structure by A. Bohr and B.R. Mottelson (Volume I)
7. Mean Field Description of Nuclei by Y.K. Gambhir
8. Introductory Nuclear Physics by Y.R. Waghmare
9. Concepts of Nuclear Physics by B.L. Cohen
10. Nuclear data, a primer, D.G. Jenkins and J.L. Wood

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test
The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from

each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTE105 / P2PHTE305** Duration of Examination: **3 hours**
Credits: **4 (4-0-0)** Title: **Condensed Matter Physics (Special-I) (Elective)**
Maximum Marks : **100** Minor Tests (I & II): **40**
Major Test : **60**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The main objective of this course is to introduce towards the theoretical and experimental part of the condensed matter physics.

Course Outcomes: The students will get information about concept of phonon, its interaction with electron, experimental solid state physics with understanding of the low temperature phenomenon like superconductivity, Mossbauer effect of the solids and optical phenomenon.

UNIT-I: Lattice Dynamics and thermal properties of solids

Lattice waves, Vibrations of one- dimensional monatomic lattice (chain), Linear diatomic lattice, Measurement of dispersion relation, Quantization of lattice vibrations - concept of phonon, Characteristics of phonons, Classical and quantum model for thermal properties of solids, Debye's quantum model, Anharmonic crystal interactions, Thermal expansion, Thermal conductivity, Mean-free path of phonons. (10)

UNIT-II: Electron – Phonon Interaction

Introduction, Hartree-Fock Approximation, Correlation energy, Plasmons, Plasma optics, Transverse optical modes in Plasma, Longitudinal Plasma oscillations, Polaritons, Long wavelength optical phonon in isotropic crystal (Lyddans, Sachs and Teller relation), Electron-phonon interaction in polar solids- polarons, Electron- phonon interaction in metals. (10)

UNIT-III: Superconductivity

Introduction, Zero resistance state, Magnetic field effects, Meissner effect, Theoretical aspects- London's theory, Thermodynamics of superconducting transitions, Type I and type-II superconductors, BCS theory of Superconductivity, Copper pairing due to phonons, Josephson's tunneling effect (a.c & d.c), Elementary idea of high temperature superconductivity, Some applications of superconductivity. (10)

UNIT-IV: Mossbauer Effect

Resonant absorption, Mechanism of Mossbauer effect- recoil energy, natural line width, thermal line width: Doppler's broadening, Experimental description, Classical theory, Debye-Waller factor, Quantum theory, Mossbauer effect and lattice dynamics, Mossbauer effect and magnetism, Applications of Mossbauer effect. (10)

UNIT-V: Optical Properties

Optical properties of metals and nonmetals, application of optical phenomenon, Model of luminescence in Sulphide Phosphorous, Thalium activated alkali halides, Electro-luminescence, Photoconductivity, Electronic transitions in photoconductors, Model of photoconductivity, Influence of traps, Excitons, Trapping and its effect. (10)

Text & Reference Books:

1. Introduction to Solid State Physics – Charles Kittel
2. Elementary Solid State Physics - M. A. Omar
3. Applied Solid State Physics - Rajnikant
4. Quantum Theory of Solid State - Joseph Callaway
5. Introduction to Solid State Theory – Otfried Madelung
6. Solid State Physics - R. K. Singhal

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from

each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTE106 / P2PHTE306**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**
Title: **High Energy Nuclear & Particle Physics (Elective)**
Maximum Marks : **100**
Minor Tests (I & II): **40**
Major Test : **60**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The objective of this course is to apprise and equip the students with the knowledge of about various Resonances and also get understanding and usage of Feynman Diagrams and TOY theory and Bhabha Scattering.

Course Outcomes: The students will know about Symmetries. They get understanding of SU(2) Symmetry breaking , SU(3) generators, Quark model in detail. They also get concepts of Heavy Meson spectroscopy, Zweig rule, Isospin, Parity etc.

UNIT-I: Symmetries

Introduction to particles and their classifications, Standard Model, Isospin : SU(2) Symmetry, its mathematical formulation and breaking.SU(3), generators of SU(3), I-U-V spins, Casimir operator, Young's tableaux for irreducible representation, Gell-Mann Okubo mass formulae, magnetic moment of baryon, the mixing and mass formula. (10)

UNIT-II: Static Quark Model of Hadrons

The Baryon Decouplet, Quark spin and color, Baryon Octet, Quark-Antiquark combinations :- The pseudoscalar mesons, the vector mesons, leptonic decay of vector mesons, Baryon Magnetic Movements, Heavy-meson spectroscopy and the quark model. J/ψ and upsilon states; Zweig Rule, Quark confinement and search for free quarks. (10)

UNIT-III: Applications of symmetries and invariance principles

Isospin of two nucleon systems and Pion- nucleon system. Parity, Intrinsic Parity, Parity due to angular momentum, parity of Particle and Antiparticle, Parity Conservation and Non-Conservation, Charge conservation, G-Parity, Gauge invariance and photons. Charge conjugation invariance, Eigen States of the charge conjugation operator, Positronium decay, K_0 decay, CP violation in K_0 decay, K^0 - K_L^0 system oscillations, K_0 regeneration, Time Reversal invariance, CPT theorem and its consequences, Wave optical discussion of hadron scattering. (10)

UNIT-IV: Relativistic kinematics and Scattering-Resonances

Resonances (ρ, η, ώ, φ, Δ) and their Quantum numbers – Production and formation experiments. Relativistic kinematics and Invariants – Mandelstam variables, phase space, decay of one particles into three particle – Dalitz plot. (10)

UNIT-V: Feynman Calculus and Quantum Electrodynamics

The Feynman Rules for a TOY theory, Feynman diagrams, Feynman Higher order diagrams.

Electromagnetic Interactions : Elastic scattering of spinless Electrons by Nuclei, Four Momentum transfer, scattering of Electrons by spinless nuclei, Electron scattering by nucleons. The process $e^+e^- \rightarrow \mu^+\mu^-$, Bhabha scattering: $e^+e^- \rightarrow e^+e^-$. (10)

Text & Reference Books:

1. Introduction to High Energy Physics by Donald H. Perkins.
2. Nuclear and Particle Physics by E Burcham.
3. Elementary Particles by I. S. Hughes.
4. Quarks, Leptons and Gauge Fields by Kerson Huang.
5. Introduction to Particle Physics by M. P. Khanna.
6. Particle Physics by B. R. Martin and G. Shah.
7. The big and small by G. Venkataraman.
8. Elementary Particles and their Interactions concepts and phenomena by Quang Ho-Kim, Pham Xuan Yam.
9. Introduction to Elementary Particle Physics by David Griffith.
10. Elementary particles and symmetries by Lewis Ryder

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTE107 / P2PHTE307**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**
Title: **Nuclear Theory (Special-I) (Elective)**
Maximum Marks : **100**
Minor Tests (I & II): **40**
Major Test : **60**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: It is an essential course for the students of M.Sc. Physics with Nuclear Theory specialization. The main objective of the course is to equip the students with the ability to understand and utilize group theory concepts to analyze symmetries in physical systems.

Learning outcomes: After completion of this course, the students will be able to apply group theory to solve problems in different areas of theoretical physics.

Unit–I: Abstract Group Theory

Group postulates, Finite and Infinite groups, Order of a group, subgroup, permutation group, group table, Isomorphism and Homomorphism, Cayley's theorem and its application for finding the group structures of groups of order 3,4,5 and 6. Cosets, Lagrange's theorem and its application for determining the group structures of groups of order 4,5 and 6. Conjugate elements and classes, Invariant subgroup, Factor or Quotient groups, self-conjugate sub-groups.

Unit–II: Theory of Group Representations

Matrix representation, Equivalent representation, Unitary representation, Reducible and irreducible representations, characters of irreducible representation, Schur's Lemmas, Orthogonality theorem for irreducible representation of a group- statement and proof, interpretation of Orthogonality theorem, orthogonality of characters, Continuous groups, Lie Groups- general properties and examples of Lie groups.

Unit–III: Group theory in Quantum mechanics-I

General concept of symmetries, Space and time displacements, Symmetry of Hamiltonian, Time-reversal symmetry, Time-reversal operator for spinless particles, Time-reversal operator for particles with spin, Kramers' theorem, Space-inversion symmetry, The axial rotation group SO(2), Generators of SO(2), 3-dimensional rotation group SO(3), its generators and irreducible representation.

Unit-IV: Group theory in Quantum mechanics-II

O(4) and SO(4) groups, SO(4) as a direct product of two SO(3) groups, Special unitary group SU(2) and its irreducible representations, Homomorphism of SU(2) on SO(3), Generators of U(n) and SU(n), Generators of SU(2), physical applications of SU(2).

Unit-V: Applications of Group theory

Special unitary group SU(3), physical applications of SU(3), Gell-Mann's representation of SU(3) and quarks, Detailed study of Lorentz group, application of group theory to Isotropic Harmonic Oscillator and Hydrogen atom.

Text and Reference Books

1. Quantum Mechanics/Symmetries (2^{nd} edition) by W. Greiner and B. Muller.
2. Group Theory and its application to physical problems by M. Hamermesh.
3. Group theory and Quantum Mechanics by M. Tinkham.
4. Introduction to Group theory by A.W. Joshi.
5. Applied group theory by G.G. Hall.
6. Introduction to Group theory, European Mathematical Society by O. Bogopalski.
7. Problems and solutions in group theory for physicists, World Scientific by Zhang-Qi Ma and Xiao-Yan Gu.

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (Ist Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHTE108 / P2PHTE308** Duration of Examination: **3 hours**
Credits: **4 (4-0-0)** Title: **Electronics (Special-I) (Elective)**
Maximum Marks : **100** Minor Tests (I & II): **40**
Major Test : **60**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: This course deals with some important modern applications in the electronic communication systems. The topics include microwaves, transmission lines, optical fibers, computer networking, RADAR and Satellites. The successful completion of the course would help the students to work in the communication industry as well as taking up research in some frontlines in the field of communication electronics.

Course outcomes: Upon successful completion of this course, students will be able to understand and apply key concepts in modern communication systems, including microwaves, transmission lines, optical fibers, computer networks, RADAR, and satellites, preparing them for careers in the communication industry or research in communication electronics.

Unit - I Signal Analysis

Sinusoidal signals (Frequency and time Domain), Fourier series expansion of periodic sequence of impulses, Sampling function, Normalized power, Power Spectral density (of Digital data, sequence of random pulses), Effect of Transfer function on power spectral density, Fourier transform (example v(t) = cos wt), Convolution, Parseval's Theorem, Power and Energy Transfer through a network. Correlation between waveforms and Autocorrelation, (10)

Unit-II Noise Analysis

Various Sources of Noise, Frequency-domain representation of noise, Spectral components of noise, Effect of Filter on the Power spectral density of Noise, Mixing of Noise, Linear Filtering, Quadrature components of noise $n_c(t)$, $n_s(t)$, (Power spectral Density) (10)

Unit-III Electronic Communication and Modulation

Types of electronics communication Systems, (Simplex, Duplex, Analog, Digital, Base band and modulated signals)
Modulation Systems: Need of Modulation, Amplitude Modulation, Frequency (Spectrum of an Amplitude Modulated signal, Low- level AM Modulator), Power relations, Single Sideband (SSB) Modulation, Generation of SSB signal (Filter and Phase Method), Vestigial-Sideband (VSB) Modulation, Demodulation of AM Waves (Square-law Detectors, Diode Detector)

Frequency Modulation, FM generation (Direct, Indirect method), FM Demodulation (Slope Detector and ratio detector) (10)

Unit –IV Communication Channels

Fundamentals of Transmission Lines, Losses in Transmission lines, Standing Waves and SWR, Slotted Lines.

Waveguides, Dominant Modes of Operation in rectangular waveguides, Advantages of waveguides over transmission lines, Cavity resonator, Strip line and Basic SAW resonator.

Introduction to optical fibres, Structures of Optical Fibres, types of optical fibers (Step and graded Index Fibe, Single mode and multimode Fibres, Acceptance angle and cone, Numerical aperture, mode of propagation, comparison of conventional transmission cables with optical fibres, Propagation in fibers using Ray's model, Bandwidth requirements in optical fibres, optical fiber splices and connectors, signal degradation; signal attenuation and dispersion.

(10)

Unit -V Microwave Devices and Circuits

Introduction to EM spectrum, Basic principle of operation of a Klystron (Multicavity and Reflex Klystron), Principle of operation of Cavity Magnetron, Helix Traveling Wave Tube, Velocity Modulation, Wave Modes and Microwave Antennas,

Transferred Electron Devices, New live Gunn Effect, Gunn Diode, IMPATT Diode and TRAPATT Diode, BARITT Diode, Schottky Barrier Diode, thermal equilibrium condition, Schottky–Mott Theory

Basic Concepts of Terahertz Electronics

(10)

Text and Reference Books:

1. **Principles of Communication Systems** by H. Taub and D.L. Schilling, 2e. Tata McGra- Hill Edition
2. **Electronic Communication Systems** by G. Kennedy and B. Davis, 4e, Tata McGra-Hill Edition
3. **Electronic Communication Systems Fundamentals through Advanced** by Wayne Tomasi, 3e, Pearson Education
4. **Communication Electronics, Principles and Applications** by Louis E. Frenzel, 3e Tata McGra-Hill Edition.

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90	100%	3 hours	60

days)			
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (1st Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHPE109 / P2PHPE309** Duration of Examination: **4 hours**
Credits: **08 (0-0-8)** Title: **Practicals in Condensed Matter Physics**
Maximum Marks: **200** Internal: **100**
External: **100**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The practicals have been designed so as to provide hands-on exposure to students in various experimental aspects of the physics of crystals. The students shall have to perform a variety of experiments to validate theoretical predictions.

Course outcomes: Students will gain experience in using experimental techniques and instruments commonly used in condensed matter physics and develop skills to analyze and interpret experimental data to extract meaningful physical parameters.

List of practicals

1. Indexing of a Zero layer Weissenberg Photograph and Cell Parameter elucidation.
2. Indexing of planes of a Laue pattern by using spot intensity of diffracted peaks.
3. Rotation X-ray method for the elucidation of cell parameters.
4. To find the frequency of ultrasonic waves in water Toluene and Benzene.
5. To find the dislocation etchant of a given crystal and to find the etch pit density.

6. Dielectric constant of a given material and to find its Curie temperature.
7. Magnetic permeability of a given magnetic material.
8. Polarization versus electrical field (PE) loop
9. Seebeck Co-efficient measurement system and dc resistivity measurement system.

Note:
Addition and deletion in the list of practicals may be made from time to time by the department.
Minimum of 06 practicals have to be performed in a given semester.

Scheme of Examination:

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (1st Semester-one year programme)/ (3rd Semester-two year programme)

Practical / Research (thesis/project/patent)	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	4 hours	50% (100 Marks)
External Examination	100%	4 hours	50% (100 Marks)
Total			200 Marks

Course No. **P1PHPE110 / P2PHPE310**
Duration of Examination: **4 hours**
Credits: **08 (0-0-8)**
Title: **Practicals in Nuclear & Particle Physics**
Maximum Marks: **200**
Internal: **100**
External: **100**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The HEP Experiments have been designed so as to provide exposure to students in various experimental aspects of High Energy Physics Experiments. The dept. is part of International Collaborations like ALICE experiment at CERN, Geneva and NOVA experiment at Fermilab, USA . The HEP Experiments will give the students a training to get good grasp of Experimental techniques, so that they are ready for working in environment of huge High Energy Physics Experiments like ALICE etc.

Practical / Research (thesis/project/patent)	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	4 hours	50% (100 Marks)
External Examination	100%	4 hours	50% (100 Marks)
Total			200 Marks

List of experiments

1. To find the total cross section of K^+d interaction at 110 Gev using Big European Bubble chamber.
2. To find the total cross-section of pp^- interactions at 700 Mev
3. To study some of the basic techniques used for measuring γ rays with a Na(I) detector interfaced to a MCA whose settings and the data acquisition are connected to a computer to study the characteristics of GM counter and calculate operating voltage of the tube
4. To verify inverse square law for the gamma-radiations
5. To find the resolving time of GM counter hence find the dead time correction factor and also to study Inverse square law of GM counter.
6. To study the effect of quenching and characteristics curve of GM counter and finding Operating voltage.
7. To study the statistical behaviour of radioactive process to evaluate the behaviour of counter statistically by means of chi-square root test
8. To study measurement of muon life time using cosmic rays
9. Working of multiwire propotional chamber
10. Measure Photo current as a fun of irradiance at constant voltage.
11. Current Vs voltage characteristics of cds photo-resistor at constant irradiance
12. Detecting Gamma radiation with scint. Counter, Detecting Energy resolution, Multichannel scaling and half life, Recording and calibrating Gamma Spectrum
13. Investigate the deflection of an electron beam by a magnetic field.
14. Plotting G.Plateau characteristic curve
15. Observe Zeeman splitting of green mercury line
16. Simple Alpha Spectrum & Energy Calibration with a Pulser

Scheme of Examination:

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (1st Semester-one year programme)/ (3rd Semester-two year programme)

Course No. **P1PHPE111 / P2PHPE311**
Duration of Examination: **4 hours**
Credits: **08 (0-0-8)**
Title: **Practicals in Nuclear Theory**
Maximum Marks: **200**
Internal: **100**
External: **100**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: This is a Lab oriented course explicitly for the students of Nuclear theory specialization. This course introduces the basic concepts of numerical methods for solving algebraic, transcendental and system of linear, non-linear equations and to understand the methods used for numerical differentiation and integration. The main emphasis would be on the development and understanding of computer codes for solving problems in physics that are not analytically soluble.

Course outcomes: After completion of this course the students would be able to write and understand computer codes for solving many body problems in Nuclear theory**.**

List of practicals

1. To write a computer code for finding the solution of a non-linear equation by using Secant Method.
2. To write a computer code for finding the solution of bi-quadratic (cubic) equation by using Bisection Method.
3. To write a computer code for evaluating a definite integral by using Trapezoidal Rule.
4. To write a computer code for finding the solution of given transcendental equation by using successive approximation method.
5. To write a computer code for evaluating a definite integral by using Simpson's 1/3rd rule.
6. To write a computer code for finding the wave functions of linear Harmonic Oscillator.
7. To write a computer code for evaluating the Clebsch-Gordan (C.G.) Coefficients.
8. To calculate the quadrupole and triaxial deformation parameters of even-even nuclei by using self-consistent mean field codes.
9. To calculate the average binding energies, mass defect and two neutron separation energies of even-even nuclei by using self-consistent mean field codes.
10. To calculate the root mean square neutron (proton) radii and charge radii of even –even nuclei by using computer codes.
11. To calculate the energy spectra of rotational bands of axially deformed nuclei by using computer code.
12. To find the structure of degenerate bands of triaxially deformed nuclei by using computer code.
13. Gamma-Ray spectroscopy by using thallium-activated sodium iodide NaI(Tl) detector.

14. Alpha Spectroscopy with Surface Barrier detectors.
15. Determination of the range and energy of alpha particles by using Spark Counter.

Note: Addition or deletion of experiments in the list of practicals may be made from time to time by the department. Minimum of six (06) practicals have to be performed by the students in a given semester.

Scheme of Examination:

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (1^{st} Semester-one year programme)/ (3^{rd} Semester-two year programme)

Course No. **P1PHPE112 / P2PHPE312** Duration of Examination: **4 hours**
Credits: **08 (0-0-8)** Title: **Practical in Electronics**
Maximum Marks: **200** Internal: **100**
External: **100**

Practical / Research (thesis/project/patent)	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	4 hours	50% (100 Marks)
External Examination	100%	4 hours	50% (100 Marks)
Total			200 Marks

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Objectives: The objective of the course has been to get basic training on the experiments of the various topics such as operational amplifiers and familiarization with the communication systems which the students have studied in the theory. The purpose is to train the students to do the things experimentally.

List of Practicals:

1. To study the process of amplitude modulation and demodulation
2. To study R-2R digital to analog convertor (DAC)
3. To study the process of pulse amplitude modulation and demodulation
4. To study the process of pulse position modulation and demodulation
5. To study the operational amplifier as Schmitt trigger.
6. (a) To study the working of a 741 IC operational amplifier with inverting

and non inverting configuration.

(b) To study the working of operational amplifier 741IC as a summing scales and average Amplifier.

(c) To study operational amplifier as differentiator. (d).To study operational amplifier as integerator.

(e).To study operational amplifier as voltage follower and differential amplifier.

7. To study the process of Satellite communication
8. To study the process of Antenna Training System
9. To study the process of Transmission Line
10. To study the working of Radio detection and ranging.
11. To study the working of Wave and Propagation
12. To study the working of Optical Fiber Communication
13. To study the working of Connection splice
14. To study the working of Mode characterization in fiber optics
15. To study the working of Wireless digital comm.
16. To study the working of Frequency modulation
17. To study synthesis method for formation of nanoparticles.

Note: Addition or deletion of experiments in the list of practicals may be made from time to time by the department. Minimum of six (06) practicals have to be performed by the students in a given semester.

Scheme of Examination:

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (3rd Semester-two year programme)

Course No. **P2PHMO351**
Credits: **04 (0-0-4)**

Syllabus for the examination to be held in Dec 2026, Dec 2027, Dec 2028.

Practical / Research (thesis/project/patent)	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	4 hours	50% (100 Marks)
External Examination	100%	4 hours	50% (100 Marks)
Total			200 Marks

Objectives:

Annexure - A

SWAYAM/ MOOCs(Study Web of Active Learning by Young and Aspiring Minds)

To widen the access to higher education and to promote use of ICT in Teaching Learning, Massive Online Open Courses (MOOCs) have emerged as viable model for imparting conventional and online education. Indian version of MOOC has been launched on an indigenous platform known as SWAYAM (Study Web of Active Learning by Young and Aspiring Minds) which has been initiated by Government of India to achieve the three cardinal principles of Education Policy- Access, Equity and Quality. The Academic Council and the University Council of the University of Jammu have approved the adoption of the MOOCs through SWAYAM. From the academic session 2020-21, UGCSWAYAM courses have been made mandatory at both UG and PG Levels. PG students are required to earn a minimum of 4 Credits from SWAYAM courses and UG students are required to earn minimum 2 Credits from SWAYAM. These courses are being offered by the faculty from the prestigious institutions of the country. These will add value to the degrees being obtained by the students and make them more employable. Each Department has a Departmental SWAYAM Coordinator who shall help the students in selection of courses and hand hold them throughout their course. The facilities of the Department like Computers, internet and libraries will be made available to the students for enrolment registration and completion of course on/from the SWAYAM Portal of the UGC. Information to all concerned will be available on the Portal https://ugmoocs.inflibnet.ac.in&https://swayam.gov.in

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHTE201 / P2PHTE401** Duration of Examination: **3 hours**
Credits: **4 (4-0-0)** Title: **Condensed Matter Physics (Elective)**
Maximum Marks: **100** Minor Tests (I & II): **40**
Major Test: **60**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The main objective of this course is to introduce to students towards various facets of condensed matter physics which include the preparation and properties of a given solid.

Course Outcomes: This course gives strong concepts regarding preparation of materials in the form of a solid as crystals, atomic diffusion mechanism in solids, color centers, materials in the form of alloys and polymers, dielectric ferroelectric properties of the solids.

Unit-I: Preparation of Materials – Crystal Growth

Theoretical concept of crystal growth (supercooling and nucleation), Homogeneous and Heterogeneous Nucleation, Crystal Growth Techniques- Solution growth: Water solution, Gel, Flux method, Hydrothermal growth; Melt technique: Czochralski pulling, Bridgeman Stockbarger, Zone melting, Verneuil flame fusion. (10)

Unit-II: Materials: Alloys and Polymers

Alloys: Binary alloys, Solid solution, Families of Engineering alloys, Hume – Rothery's rule, Phase diagram, Gibb's Phase rule, , Concept of Eutectic, Order –disorder transformation, Elementary theory of order, Magnetic Alloys and Kondo effect.
Polymer: Introduction, Types, Effect of temperature, Properties: Mechanical and electrical (10)

Unit-III: Atomic Diffusion and Colour Centres

Atomic diffusion, Ficks 1st and 2nd law of diffusion, Diffusion through plane, cylindrical & spherical under steady state condition, Diffusion under non steady state condition, Random-Walk treatment of diffusion, The Kirkendall effect, Diffusion in alkali halide, Ionic conductivity in alkali halide,
Colour centers, Types of colour centers, Generation of colour centers. (10)

Unit-IV: Dielectric and Ferroelectric Properties

The Dielectric constant and polarizability, Induced polarization, Measurement of dielectric constant, Clausius - Mossotti relation, Polarization Polar and Non polar molecules, Characteristics of polarizability, Dipolar polarization in solids, Ionic polarazibility, Electronic polarazibility, Dielectric breakdown, Ferroelectricity, Ferroelectric domains, Applications of ferroelectrics. (10)

Unit-V: Electrons in Solids

Introduction, An overview of classical models, Conductivity in metals, The Matthiesen's Rule, The Drude's Model for electrical properties of solids, Degenerate electron gas, Fermi-Dirac statistics of electron gas (Quantized free electron theory), Thermal conduction in solids, The Wiedemann - Franz Ratio, General properties of metals. (10)

Text and Reference Books

1. Introduction to Solid State Theory – Otfried Madelung
2. Solid State Physics – Charles Kittel
3. Applied solid state physics - Rajnikant
4. Solid State Physics (structure and properties of materials) - M. A. Wahab
5. Art and science of growing crystals - J. J. Gilman
6. Elementary Solid State Physics – M. A. Omar

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHTE202/ P2PHTE402**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**
Title: **Nuclear & Particle Physics (Elective)**
Maximum Marks: **100**
Minor Tests (I & II): **40**
Major Test: **60**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The course aims to provide a thorough introduction to nuclear physics concepts and their real-world applications. This course aims to equip students with a foundational understanding of nuclear processes, including beta decay, fission, and fusion. It covers reactor operations, nuclear applications in various fields, principles of nuclear astrophysics. radiation-based technologies. Emphasis is also placed on safety practices and the detection methods used in nuclear and particle physics.

Course Outcomes

By the end of this course, students will be able to:

- Explain the mechanisms of nuclear decay, fission, and fusion.
- Describe the principles, components, and types of nuclear reactors, including their control mechanisms and safety features.
- Understand the role of nuclear reactions in astrophysical phenomena
- Describe peaceful nuclear applications
- Assess the effects of ionizing radiation and apply appropriate safety protocols.
- Identify and explain the working principles of common nuclear and particle detectors.

UNIT-I: Nuclear Beta Decay

Overview of beta decay and observed beta spectrum; discovery of continuous energy distribution. Neutrino hypothesis to explain the spectrum. Fermi's theory of beta decay: weak interaction model and transition probability. Derivation of total decay rate; comparative halflives; Fermi-Kurie plots. Selection rules: Fermi and Gamow-Teller transitions. Neutrino properties (mass and helicity); neutrino-less beta decay; introduction to double beta decay. (10)

UNIT-II: Nuclear Fission & Nuclear Fusion

Discovery of Nuclear fission, energy released in fission, nature of the fission fragments and their energy distribution, emission of neutrons in the nuclear fission and energetics of fission process, Bohr-Wheeler theory of nuclear fission, Fissile and Fertile materials, Nuclear fission Chain reaction and four factor formula.

Nuclear Fusion, thermonuclear reaction, controlled fusion.

UNIT-III: Nuclear Power & Nuclear Astrophysics

Principles of nuclear reactors; neutron moderation and control; reactor components and operation. Types of reactors: thermal, fast, and breeder reactors. Reactor kinetics, safety systems, and emergency procedures. Peaceful use of fusion energy – prospects and challenges.

Evolution of Stars, Source of energy in stars, nucleosynthesis, Chandershekhar Limit and White Dwarfs, Neutron Star and Supernova. (10)

Unit IV: Hazards, Safety and Peaceful Applications

Physical and chemical effects of ionizing radiation.–Radiation hazards, effects of Nuclear weapon effect, safety protocols, shielding, waste management, and environmental impact.

Industrial: Material testing, food irradiation. Agricultural: Mutation breeding and pest control. Energy: nuclear batteries and space power systems for satellites and interplanetary missions, Environmental Applications: Water and waste water treatment using radiation technologies, Monitoring pollution and ecosystems with radiotracers. (10)

UNIT V: Particle Detectors

Detector properties: Sensitivity, energy and time resolution, response function, detection efficiency, and dead time. Role of detectors in nuclear and particle physics experiments.

Overview of nuclear emulsions, Cloud chamber, G.M. Counters, proportional counters TPC, Basic construction and working of Solid State Detectors detectors, Scintillation Counter (principle, PMT), Cerenkov counters, Calorimeters; introduction and types of calorimeters. *(10)*

Text & Reference Books:

1. Nuclear Physics: Principles and Applications *John Lilley,* Wiley Student Edition
2. Physics of Particle Detectors *Dan Green*
3. Nuclear Physics, *S.N. Ghoshal,* S. Chand
4. Fundamentals of Nuclear Physics, *Jahan Singh,* A Pragati oublication
5. Basics of Nuclear Physics, *B.N. Srivastava*
6. Introduction to Nuclear and Particle Physics, *V.K. Mittal, R.C. Verma, S.C. Gupta*

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHTE203/ P2PHTE403**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**
Title: **Quantum Electrodynamics (Elective)**
Maximum Marks: **100**
Minor Tests (I & II): **40**
Major Test: **60**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: It is an elective course for M.Sc. students to impart them the knowledge of second quantization and relativistic quantum mechanics for solving relevant physical problems.

Course outcomes: After completion of this course the students will be able to explain the relativistic quantum mechanical equations, describe second quantization and related concepts.

Unit–I: Second Quantization

Creation and annihilation operators for Bosonic and Fermionic states, Field operators, Commutation and anti-commutation relations of the Field operators, Second quantized operators (One-particle density operator and kinetic energy operator), Pair correlation function (Pauli's Exclusion Principle and Boson Condensation), Lagrangian densities for Schrodinger and electromagnetic fields, Second Quantization of Schrodinger field, Expression for Hamiltonian operator.

Unit-II: Klein- Gordon (K.G.) Equation

Klein- Gordon (K.G.) equation for a free particle, Charge and Current densities for K.G. equation and equation of continuity, Difficulties due to the existence of negative energy states, Correct expression for probability density, Plane wave solutions of K.G. equation, Klein-Gordon equation for a charged particle in an electromagnetic field and its solution for a particle with coulomb potential V_o (Hydrogen atom problem), First order K.G. equations and its solution.

Unit-III: Dirac equation

Derivation of Dirac equation, α and β-matrices and their anti-commutation relations and their representations, Plane wave solutions of Dirac equation (Positive energy and Negative energy solutions), Projection operator for energy and spin. Physical interpretation of free particle solutions, Dirac equation with a central potential and Hydrogen atom problem.

Unit-IV: Covariance of Dirac Equation

Covariant form of Dirac equation (Feynman and Dirac Pauli covariant form), Dirac's gamma-matrices and their properties, γ_5-matrix and properties, Covariance of Dirac equation under Lorentz transformations and Rotations, Construction of Plane wave solutions of Dirac equation by Lorentz Boost of Particle at rest, Bilinear covariants.

Unit-V: Heisenberg Representation in Dirac Theory

Dirac operators in Heisenberg representation, Heisenberg equation of motion, constants of motion and existence of electron spin for a Dirac particle, Velocity in Dirac theory, Zitterbewegung, Negative energy states of an electron (theory of Positron), Hole theory and charge conjugation. Vacuum Polarization, Time Reversal and other symmetries.

Text and reference books

1. Lectures on Quantum Mechanics by Baum.
2. Modern Quantum Mechanics by J.J. Sakurai and J. Napolitano.
3. Quantum Mechanics (Third edition) by Eugyen Merzbacher.
4. Quantum Physics by L. I. Schiff.
5. Relativistic Quantum Mechanics by W. Greiner.

6. Relativistic Quantum Fields by J.D. Bjorken and S.D. Drell.
7. Quantum electrodynamics by Landau and Lifshitz.
8. The Quantum theory of fields by Steven Weinberg.

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme) / (4th Semester-two year programme)

Course No. **P1PHTE204/ P2PHTE404**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**
Title: **Physics of Photonic Devices**
Maximum Marks: **100**
Minor Tests (I & II): **40**
Major Test: **60**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: This course aims to equip students with a strong foundation in the physical principles underlying the operation of photonic components such as lasers, LEDs, photodetectors, modulators, and waveguides. It emphasizes the interaction of light with matter, the behavior of light in dielectric and semiconductor media, and the design principles of optoelectronic and integrated photonic devices.

Course outcomes: By the end of the course, students will be able to analyze and design basic photonic systems, understand the role of semiconductor materials in light generation and detection, and explore advanced topics like nanophotonics, photonic crystals, and 3D printed optical devices. The course prepares students for applications in optical communication, sensing, and renewable energy systems, fostering the ability to engage with current and emerging technologies in photonics.

Unit 1: Fundamentals of Photonic Materials

Introduction to photonic materials; Energy bands and electronic states in semiconductors; Semiconductor materials for optoelectronics (Si, GaAs, InP); Direct vs. indirect bandgap materials; Spontaneous and stimulated emission, absorption processes; Excitons and their role in photonic devices; Quantum confinement in low-dimensional structures; Defects and impurities in photonic materials; Optical properties of III-V, II-VI, and organic semiconductors

Unit 2: Photodetectors and Solar Cells

Principles of photodetection and photoconductivity; p-n junction photodiodes: PIN, avalanche photodiodes; Schottky and MSM photodetectors; Quantum well and quantum dot photodetectors; Infrared detectors: HgCdTe, quantum cascade detectors; Fundamentals of solar cells and photovoltaic conversion; Silicon, perovskite, and organic solar cells; Tandem and multi-junction solar cells; Efficiency limits and loss mechanisms in solar cells

Unit 3: Light Emitting Devices and Lasers

Fundamentals of light-emitting diodes (LEDs); Semiconductor LEDs: Structure, efficiency, and color tuning; Organic LEDs (OLEDs) and quantum dot LEDs (QLEDs); Fundamentals of laser physics: Population inversion, gain; Semiconductor lasers: Fabry-Pérot, DFB, and VCSELs; Quantum well, dot, and cascade lasers; Mode locking, Q-switching, and tunable lasers; Nonlinear optics in laser applications; Optical feedback and laser beam shaping; Advanced laser systems: UV, mid-IR, and THz lasers

Unit 4: Light-Matter Interaction in Quantum Materials

Introduction to quantum materials (graphene, TMDs, perovskites, topological insulators); Optical absorption and emission in low-dimensional systems; Photocarrier generation and separation in 2D semiconductors; Light harvesting and charge transport in perovskite and quantum dot materials; Applications in solar cells, photodetectors, and quantum light sources

Unit 5: Emerging Photonic Devices and Applications

Introduction to Integrated Photonics; Basics of quantum dot and organic photonic devices; Nanoparticles, quantum dots, and their optical properties; Photonic crystals and plasmonic materials; Tunable and nonlinear optical materials; Microscale and Nanoscale Light Devices;

Terahertz Technology; Brain-Inspired Light Devices; Flexible and Energy-Saving Light Devices; Next-Generation Optoelectronics

Text and reference books

1. Physics of Photonic Devices – Shun Lien Chuang
2. Principles of Optics – Max Born and Emil Wolf
3. Semiconductor Optoelectronic Devices – Pallab Bhattacharya
4. Fundamentals of Photonics – Bahaa E. A. Saleh and Malvin C. Teich
5. Optoelectronics and Photonics: Principles and Practices – S.O. Kasap
6. Photonics: Optical Electronics in Modern Communications – Amnon Yariv and Pochi Yeh
7. Photonic Devices – Jia-Ming Liu
8. Introduction to Solid State Physics – Charles Kittel
9. Photonic Crystals: Molding the Flow of Light – John D. Joannopoulos et al.
10. Advances in Photonic Crystals and Devices – Narendra Kumar and Bhuvneshwer Suthar
11. Solar Cells: Types and Applications – Sandeep Arya and Prerna Mahajan

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme) / (4th Semester-two year programme)

Course No. **P1PHTE205/P2PHTE405** Duration of Examination: **3 hours**
Credits: **4 (4-0-0)** Title: **Condensed Matter Physics (Special-II) (Elective)**
Maximum Marks: **100** Minor Tests (I & II): **40**
Major Test: **60**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: This course is designed such that the students are exposed to the most basic **Single Crystal / polycrystalline X-ray Diffraction** techniques employed for molecular and crystal structure determination of materials.

Course Outcomes: Students will gain proficiency in using experimental methods to determine and analyze crystal structures. Students will develop a comprehensive understanding of how imperfections in materials influence their behavior, performance, and applications.

UNIT-I: Diffraction of X-rays by crystals

Basic properties of X-rays, interference of scattered waves, scattering by atomic electrons, scattering by atoms, scattering by a molecule, diffraction by a crystal, diffraction intensities, atomic scattering factor, structure factor, polarization factor, multiplicity factor, Lorentz factor, Absorption factor, temperature factor, general equation for the intensity. (10)

UNIT-II: Laue Technique

Introduction, Collimators, Specimens and specimen holders, Choice, mounting and alignment of a single crystal, The transmission Laue technique, Back reflection Laue technique, Laue spot shapes, indexing of Laue photographs, Interpretation of Laue patterns, The Reciprocal Lattice in the interpretation of Laue patterns, Applications of Laue method. (10)

UNIT-III: Powder Technique

Introduction, choice of radiation for powder technique, background radiation, crystal monochromators, Photographic technique: Debye Scherrer Camera, Specimen preparation indexing of powder photographs and lattice parameter determination, Powder diffractometer: Direct recording of the profiles, Applications of powder method. (10)

UNIT-IV: Rotating crystal and Weissenberg Techniques

Film methods for intensity measurement: The oscillation method, (single/double oscillation), Rotation method, Measurement of identity period, Interpretation of Rotation patterns, Limitations of rotation method, Weissenberg method, indexing of zero and higher layer

Weissenberg photographs, determination of unit cell parameters and equi-inclination setting for obtaining higher layer Weissenberg photographs, Weissenberg uses, Counter methods for intensity measurement: Single detector, Area detector. (10)

UNIT-V: Study of Imperfections

Introduction, X-ray topography: Direct investigation of Macro defects, Berg Barrett technique, Lang's Technique, X-ray diffraction topography camera, double crystal diffractrometry, Etching techniques, An overview of Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) for materials characterization. (10)

Text & Reference Books:

1. Applied Solid State Physics by Rajnikant.
2. Crystallography for Solid State Physics by A.R. Verma and O.N. Srivastava.
3. Solid State Physics by Kittle.
4. Crystal Structure Determination by G.H. Stout, L.H. Jensen.
5. Elementary Solid State Physics by Omar

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from

each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme) / (4th Semester-two year programme)

Course No. **P1PHTE206/P2PHTE406** Duration of Examination: **3 hours**
Credits: **4 (4-0-0)** Title: **High Energy Nuclear & Particle Physics (Special-II) (Elective)**
Maximum Marks: **100** Minor Tests (I & II): **40**
Major Test: **60**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The objective of this course is to concepts of Quark Chromo Dynamics, which deals with quark-quark and quark-gluon Interactions. Finally they study most advanced concepts like Weinberg-Salam SU(2) x U(1) Model, spontaneous symmetry breaking, Higgs mechanism, Standard Model & Grand unification.

Course Outcomes: In this course, the students will know about Weak Interactions, Beta Decay and Fermi model. They get also understanding of Cabbibbo theory and GIM model and also Neutrino Oscillations in detail.

UNIT-I: Weak Interactions-I

Classification of weak interactions, Nuclear β decay-Fermi theory, inverse β decay, Parity non conservation in Neutrino, Helicity of the Neutrino, Helicity States, Dirac theory to β-decay, The V-A interaction, parity violation in weak decay, Pion and Muon decay. (10)

UNIT-II: Weak Interactions-II

Weak Decays of Strange Particles-Cabibbo Theory, weak neutral currents, Absence of S=1 neutral currents, second order weak interactions. The GIM model and charm. Weak mixing angles with six quarks, Observation of $W^{\pm}$ and Z^0 Bosons, Neutrino masses and Neutrino oscillations. (10)

UNIT-III: Quark Patron Model

Evidence for partons, Deep inelastic electron-nucleon scattering, Scale invariance and Partons (Bjorken scaling), Neutrino-nucleon inelastic scattering, Lepton-quark scattering: Parton spin, Parton charges, antiquark contents of the nucleon, gluon constituents, Electron-Positron annihilation to hadrons, Lepton pair production in hadron collisions-The Drell-Yan Process. (10)

UNIT-IV: Quantum Chromodynamics

Quantum chromodynamics and Quark-Quark interactions, QCD potential at short distances, QCD potential at large distances (String model), Multijet events in e^+e^- annihilation, Effects of quark interactions in Deep-Inelastic lepton-Nucleon Scattering, Running Coupling constant: quantitative predictions of QCD, q^2 Evolution of Structure Functions, Comparison of Quark and Gluon Distribution. (10)

UNIT-V: Unification of Interactions

Renormalizability in Quantum Electrodynamics, Divergence in weak interactions, Introduction of Neutral currents, Gauge Invariance in QED, Generalized Gauge Invariance. The Weinberg-Salam SU(2) x U(1) Model. Yang-Mils fields and SU(2) symmetry, spontaneous symmetry breaking. Neutral current coupling of Fermions, Higgs mechanism, The standard Model. Grand unification: - proton decay, the cosmic baryon asymmetry. (10)

Text & Reference Books:

1. Introduction to High Energy Physics by Donald H. Perkins.
2. Nuclear and Particle Physics by E. Burcham.
3. Elementary Particles by I. S. Hughes.
4. Quarks, Leptons and Gauge Fields by Kerson Huang.
5. Introduction to Particle Physics by M. P. Khanna.
6. Particle Physics by B. R. Martin and G. Shaw.
7. The big and small by G. Venkataraman.
8. Modern particle physics by Mark Thomson
9. Elementary Particles and their Interactions concepts and phenomena Q. H. Kim, Pham Xuan Yam.
10. Introduction to Elementary Particle Physics by David Griffith.

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be**

provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHTE207/ P2PHTE407**
Duration of Examination: **3 hours**
Credits: **4 (4-0-0) (Elective)**
Title: **Nuclear Theory (Special-II)**
Maximum Marks: **100**
Minor Tests (I & II): **40**
Major Test: **60**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: To impart knowledge of classical and quantum field theories for solving relevant physical problems.

Course outcomes: The students shall be able to apply the methods of advanced quantum theory to understand and solve many body problems in theoretical physics.

Unit-I: Classical Field Theory

Transition from a discrete to a continuous system, Lagrangian and Hamiltonian Formulations for continuous systems, Euler Lagrange equations and Hamilton's equations of motion, Applications of Lagrangian and Hamiltonian Formulations to Schrodinger and Electromagnetic fields, Derivation of Schrodinger and Maxwell's equations.

Unit-II: Second Quantization

Equations of motion, Schrodinger and Heisenberg pictures, Quantum equations for the field, Fields with more than one component, Complex field, Quantum equations, Occupation number representation, Creation and destruction operators (anticommutation), number operator, second quantization of Schrodinger and electromagnetic fields, Plane wave representation, quantized field energy and momentum, commutation relations for E and H.

Unit-III: Perturbation theory

The Brillouin-Wigner Perturbation series, Interaction representation, Time integral expansion series, Scattering (S) Matrix and its properties, S-matrix expansion, Chronological pairing of operators, Wick's theorem, diagrammatic representation, applications of Wick's theorem (Feynman diagrams), momentum representation.

Unit-IV: Many body Problems

Density matrix and operator, equation of motion of density operator, Thomas Fermi model, Hartree self-consistent field, The Hartree-Fock (HF) Method, Derivation of HF equations, Symmetries of HF Hamiltonian, Choice of expansion for the HF orbits, Single major shell HF-calculations.

Unit-V: Pairing Theory

General aspects, pair creation and annihilation operators, one body and two body potentials in second quantized formalism, pairing interaction in second quantized form. Pairing theory for degenerate configuration, commutation relations of pair creation operators with pairing Hamiltonian and Number operators. Calculation of pairing matrix for two and four particles in J=5/2 shell, Generalization to non-degenerate configurations, The BCS formalism, Normalization of BCS wave function, Application of the BCS wave function to the pure j- shell. Derivation of expression for occupation probability and pairing gaps, Uniform model.

Books Recommended:

1. Classical Mechanics by H. Goldstein (for Unit I).
2. Quantum mechanics by L.I. Schiff (for Unit II)
3. Elements of Advanced Quantum Theory by J.M. Ziman (for Unit III)
4. Field Quantization by W. Greiner and J. Reinhardt.
5. The Quantum theory of fields by Steven Weinberg (Volume I)
6. Advances in Nuclear Physics Vol 1 edited by M. Baranger and E. Vogt (Unit IV) (Chapter on "The Hartree-Fock Theory of deformed Light nuclei by G. Ripka)
7. Shapes and Shells in nuclear structure by S.G Nilsson and I. Ragnarsson. (Unit V)
8. A first book of Quantum Field Theory by A. Lahiri and P.B. Pal

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall**

be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHTE208/ P2PHTE408**	Duration of Examination: **3 hours**
Credits: **4 (4-0-0)**	Title: **Electronics (Special-II) (Elective)**
Maximum Marks: **100**	Minor Tests (I & II): **40**
Major Test: **60**	

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The course provides a comprehensive understanding of pulse modulation systems, digital modulation techniques, radar systems, and semiconductor fabrication processes. It covers topics like sampling, quantization, PCM, DPCM, PSK, FSK, radar performance, satellite communication, and fabrication techniques such as crystal growth, photolithography, and metallization.

Course outcomes: By the end of the course, students will be able to analyze communication and radar systems, design semiconductor devices, and apply fabrication techniques to modern electronics and communication technologies.

Unit – I: Pulse Modulation Systems

The Sampling theorem (Low-pass Signals, Band-pass Signals), Pulse-Amplitude Modulation (PAM), Channel Bandwidth for a PAM signal, Natural sampling, Flat-top sampling, Signal recovery through Holding, Quantization of signals, Quantization Error

Pulse-Code Modulation (PCM), Electrical representation of Binary Digits, Differential Pulse-Code Modulation (DPCM), Delta Modulation (DM), Adaptive Delta Modulation (ADM) (10)

Unit –II: Digital Modulation Techniques

Binary Phase-Shift Keying (BPSK) (Reception, Spectrum, Geometrical Representation), Differential Phase-Shift Keying (DPSK), Differentially-Encoded PSK, Quadrature Phase-Shift Keying (transmitter, Receiver, signal space representation), M-ARY PSK. QASK. Binary Frequency-Shift Keying (Spectrum, Receiver), The Baseband Signal receiver, Optimum Filter, Matched Filter (10)

Unit -III: Radar

Fundamentals of RADAR system: Block Diagram, Frequencies and Powers used in RADAR, RADAR performance Factors, Effects of Noise, Basic Pulse RADAR systems (Block Diagram and Description), Antenna and Scanning, Moving target Indication (Doppler Effect), Other RADAR systems (RADAR Beacons, Phased RADAR), RADAR applications.
Introduction to Satellite Communication
Frequency Division Multiple Access–(FDMA), Time Division Multiple Access (TDMA), Carrier Sense Multiple Access (CSMA), CDMA. (10)

Unit -IV: Semiconductor Growth Techniques

Basic Fabrication Steps, Crystal Growth: CZ Method, Float Zone Method, Thin Film deposition Techniques: Thermal and Sputtering, Epitaxy: Vapour Phase and Liquid phase epitaxy (MBE) Diffusion, ion implantation and Oxidation (10)

Unit-V Fabrication of Semiconductor Devices

Photolithography and etching: Dry and Wet etching, metallization, IC Manufacturing and Processing. Basics of 2D and nanostructured Devices and Applications, Memory Devices using MOSFET Technology. (10)

Text and Reference Books:

1. Principles of Communication Systems by H. Taub and D.L. Schilling, 2e. Tata McGraw-Hill Edition
2. Electronic Communication Systems by G. Kennedy and B. Davis, 4e, Tata McGraw- Hill Edition
3. Electronic Communication Systems Fundamentals through Advanced by Wayne Tomasi, 3e, Pearson Education
4. Communication Systems, Analog & Digital by R.P. Sing and S.D. Sapre 2e, Tata McGraw-Hill Edition
5. Fundamentals of Semiconductor Fabrication by Gary S. May and Simon M. Sze, Wiley Semiconductor Devices: Physics and Technology by S. M. Sze John Wiley international

Scheme of Examination: (having five units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60 days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60

Total	100

The Subjective Tests of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHRE209/P2PHRE409**
Duration of Examination: **4 hours**
Credits: **16 (0-0-16)**
Title: **Project work in Condensed Matter Physics**
Maximum Marks: **400**
Internal Exam: **100**
External Exam: **300**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The projects have been designed to characterize material properties of selected materials and analyze and interpret experimental data.

Course outcomes: Students will **develop skills to compare experimental data with theoretical models** and critically evaluate any discrepancies. Students will **build a strong foundation for** communicating scientific results effectively, through written reports, presentations, and discussions, using proper scientific language and visualization tools.

During this semester, the students will be assigned a mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation duly checked for plagiarism.

Scheme of Examination:

Practical / Research (thesis/project/patent)	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	4 hours	25% (100 Marks)
External Examination	100%	4 hours	75% (300 Marks)
Total			100% (400 Marks)

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHRE210/P2PHRE410** Duration of Examination: **4 hours**
Credits: **16 (0-0-16)** Title: **Project work in Nuclear & Particle Physics**
Maximum Marks: **400** Internal Exam: **100**
External Exam: **300**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The Projects have been designed so as to provide exposure to students in various experimental aspects of High Energy Physics Experiments. The dept. is part of International Collaborations like ALICE experiment at CERN, Geneva and NOVA experiment at Fermilab, USA. The projects will give the students a training to get good grasp of these International Experiments, so that they are ready for doing Research in High Energy Physics.

During this semester, the students will be assigned a mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation duly checked for plagiarism.

Scheme of Examination:

Practical / Research (thesis/project/patent)	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	4 hours	25% (100 Marks)
External Examination	100%	4 hours	75% (300 Marks)
Total			100% (400 Marks)

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2nd Semester-one year programme)/ (4th Semester-two year programme)

Course No. **P1PHRE211/P2PHRE411**
Duration of Examination: **4 hours**
Credits: **16 (0-0-16)**
Title: **Projects in Nuclear Theory**
Maximum Marks: **400**
Internal Exam: **100**
External Exam: **300**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The aim of the projects in nuclear theory is to deepen the understanding of the nucleus, its structure, and the forces governing it. These projects involve fundamental research, theoretical modeling and interpretation of experimental data by using nuclear models.

Course outcomes: The students will have a deep understanding of nuclear structure, stability, and interactions. Specifically, students would be able to explain different nuclear models, their limitations, and apply them to explain observed nuclear properties. They would also develop skills in analyzing nuclear data by using different nuclear models and communicating scientific findings through written reports, presentations and discussions.

During this semester, the students will be assigned a mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of a dissertation duly checked for plagiarism.

Scheme of Examination:

Practical / Research (thesis/project/patent)	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	4 hours	25% (100 Marks)
External Examination	100%	4 hours	75% (300 Marks)
Total			100% (400 Marks)

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

POST GRADUATE DEPARTMENT OF PHYSICS, UNIVERSITY OF JAMMU

DETAILED SYLLABUS

M.Sc. Physics (2^{nd} Semester-one year programme)/ (4^{th} Semester-two year programme)

Course No. **P1PHRE212/P2PHRE412**
Credits: **16 (0-0-16)**
Maximum Marks: **400**
External Exam: **300**

Duration of Examination: **4 hours**
Title: **Project work in Electronics**
Internal Exam: **100**

Syllabus for the examination to be held in May 2027, May 2028, May 2029.

Objectives: The objective of this course is to train the students of electronics specialization for successful implementation of the concepts into practical applications which have a direct bearing in the industry and R&D programmes.

During this semester, the students will be assigned a mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation duly checked for plagiarism.

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/ dissertation of the students.

Scheme of Examination:

Practical / Research (thesis/project/patent)	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	4 hours	25% (100 Marks)
External Examination	100%	4 hours	75% (300 Marks)
Total			100% (400 Marks)