Kumaun University Nainital
M. Sc. Syllabi in Physics
(Session 2017-18 Onwards)
(Total Marks = 2000)

Semester System Course Structure

(Total Four Semesters, 100 marks in each Paper followed by practical carrying 100 marks each in each Semester and Grade system in dissertation/project)

(100=75 marks external+ 25 marks internal for each paper)

Semester–wise Distribution of Papers with Marks

I. First Semester :

Paper 1: Mathematical Methods	(PHY-4911)	100 Marks
Paper 2: Classical Mechanics	(PHY-4912)	100 Marks
Paper 3: Quantum Mechanics	(PHY-4913)	100 Marks
Paper 4: General Theory of Relativity and Cosmology	(PHY-4914)	100 Marks
Paper 5: Communication Electronics	(PHY-4915)	100 Marks
Practical	(PHY-5181)	100 Marks
	Total =	600 Marks

II. Second Semester :

Paper 6: Statistical Mechanics	(PHY-4921)	100 Marks
Paper 7: Atomic and Molecular Spectra	(PHY-4922)	100 Marks
Paper 8: Electrodynamics	(PHY-4923)	100 Marks
Paper 9: Digital Electronics and Computer Architecture	(PHY-4924)	100 Marks
Practical	(PHY-5281)	100 Marks
	Total =	500 Marks

III. Third Semester :

Paper 10: Advanced Quantum Mechanics	(PHY-4931)	100 Marks
Paper 11: Nuclear Physics	(PHY-4932)	100 Marks
Paper 12: Elementary Particle Physics	(PHY-4933)	100 Marks
Paper 13: Condensed Matter Physics	(PHY-4934)	100 Marks
Paper 14: Plasma Physics	(PHY-4935)	100 Marks

Practical	(PHY-6381)	100 Marks
	Total =	600 Marks

IV. Fourth Semester :

Paper 15: Special Paper (Part I)

(a) Advanced Electronics I	(PHY-4941)	100 Marks
(b) High Energy Physics I	(PHY-4942)	100 Marks
(c) Spectroscopy I	(PHY-4943)	100 Marks
(d) Astrophysics I	(PHY-4944)	100 Marks
(e) Advanced Condensed Matter Physics I	(PHY-6405)	100 Marks

Paper 16: Special Paper (Part II)

(a) Advanced Electronics II	(PHY-4951)	100 Marks
(b) High Energy Physics II	(PHY-4952)	100 Marks
(c) Spectroscopy II	(PHY-4953)	100 Marks
(d) Astrophysics II	(PHY-4954)	100 Marks
(e) Advanced Condensed Matter Physics II	(PHY-4955)	100 Marks

Paper 17: Dissertation / Project work with Grade System (Out of Maximum 100 marks)

Marks	Grade
91 or above	**A+**
81 to 90	**A**
71 to 80	**B+**
61 to 70	**B**
51 to 60	**C+**
41 to 50	**C**
40 or Less	**FAIL**

Practical 100 Marks

Total = 300 Marks

Note: Only those special papers will be allowed where at least three experiments are available.

IMPORTANT- Educational tour for scientific laboratories and physics research institutes has been included as per university norms in the syllabus of M. Sc. (Physics). A Tour report will be submitted to the HOD after visit.

M.Sc. Physics Syllabus (Semester System 2017 -18 Onwards)
Kumaun University Nainital

M. Sc. (Physics) III Semester

Paper X: Advanced Quantum Mechanics

Paper XI: Nuclear Physics

Paper XII: Elementary Particle Physics

Paper XIII: Condensed Matter Physics

Paper XIV: Plasma Physics

Practical

Syllabus for M. Sc. Physics III Semester
Paper 10
(PHY-4931) Advanced Quantum Mechanics 75 Marks

Unit-I: **Non-Relativistic Theory of Quantum Scattering**

Scattering Theory, Scattering cross section, method of partial wave analysis, phase shift, Optical theorem, scattering length, effective range; low energy scattering, Resonance, scattering from a square potential well and a rigid sphere, Born approximation, Validity of Born approximation, Born approximation through time dependent perturbation, its application to square well potential, Elementary idea of S and T Matrix .

Unit-II: **Free particle Dirac equation**

Discrepancies faced by Schrödinger equations, Klein-Gordon equation and its drawbacks, Dirac's equation for a free particle, Dirac matrices, covariant form of Dirac equation, Probability and current densities, Free particle solutions of Dirac equation, Non conservation of Orbital Angular momentum and idea of spin, Interpretation of negative energy and hole theory.

Unit-III: **Dirac particle in Electromagnetic Fields**

Dirac equation in electromagnetic fields, Magnetic moment of charged particle, Gauge invariance of Dirac equation in electromagnetic fields, Non- relativistic correspondence of Dirac equation; Pauli equation, Adjoint spinors; Discrete Symmetries of Dirac Equation: Parity, Time reversal and Charge Conjugation, Difference between Dirac-Pauli and Majorana spinors; Lorentz covariance of Dirac Equation, , Bilinear covariants

Unit-IV: **Identical Particles and Second Quantization of Schrödinger's field**

Identical particles, Exchange degeneracy, Symmetric and Anti-symmetric functions, Pauli Exclusion Principle;
Schwinger's action principle and rules of quantization,, Lagrangian and Hamiltonian densities, Field equation, quantum structure of free fields and the particle concept, Quantization relations, Quantization of non relativistic Schrödinger matter field, System of identical bosons and fermions, Commutation and anti-commutation relations, Occupation number representation, creation and annihilation operators.

Books Recommended:

Davydov : Quantum Theory
Messiah : Quantum Mechanics Vols. I & II
Rajput B. S. : Advanced Quantum Mechanics
Roman : Advanced Quantum Mechanics
Trigg : Quantum Mechanics
Thankappan : Quantum Mechanics
Sakurai : Quantum Mechanics

Syllabus for M. Sc. Physics III Semester
Paper- 11

(PHY-4932) Nuclear Physics 75 Marks

Unit-I: Nuclear Properties and Nuclear Models

Concepts of Atomic Nuclear-Size, Shape, charge distribution, Spin & parity, Magnetic moment; Electric quadrupole moment; Binding energy; Semi-empirical mass formula, Mirror nuclei, Liquid drop model, Experimental evidence for shell effects, Shell model, Magic numbers, Spin orbit coupling, Single particle shell model-its validity and limitations; collective model.

Unit-II: Nuclear Forces and Nuclear Interactions

Theory of Deuteron and nuclear level properties, nucleon - nucleon interactions, low & high-energy nucleon-nucleon scattering, Yukawa's Meson theory of nuclear forces, Spin dependence and charge independence of nuclear forces.

Unit-III: Nuclear Reactions

Kinds of nuclear reactions; Conservation laws; Nuclear reaction Kinematics; Charge particle reaction spectroscopy; Neutron spectroscopy; Nuclear cross-section; Compound nucleus; Nuclear transmutations, continuum theory of nuclear reaction, Nuclear fission, Chain reactions, Nuclear fusion, Thermonuclear reactions.

Unit-IV: Nuclear Decays

Basic understanding and Formulations for $\alpha-$, $\beta-$ and γ -decays Gamow theory of alpha-decay , Fermi theory of beta decay, selection rules in β -decay, Neutrino hypothesis, Parity violation in beta decay, K-capture and internal conversion.

Book Recommended:

Nuclear Physics – W. E. Bercham
Nuclear Physics – Ervin Kapallan
Nuclear Physics – Roy Nigam
Atomic and Nuclear Physics – S. N. Ghoshal
Nuclear Physics – H.A.Enge
Nuclear Physics –Evans
Problem based Nuclear Physics- H. M. Agrawal

Syllabus for M. Sc. Physics III Semester
Paper 12
(PHY-4933) Elementary Particle Physics 75 Marks

Unit-I: Elementary Particles

History of elementary particles, Classification of elementary particles, Fundamental interactions, Resonances, Lepton and Baryon number; Isospin, Strangeness, Hypercharge, Gell-Mann Nishijima relations, Symmetries and conservation laws, Parity, Time reversal and charge conjugation, Parity violation, CP violation in mesons, CPT invariance.

Unit II: Unitary Symmetries

Basics of Unitary groups, Fundamental representation, generators and Weight diagrams of SU(2) and SU(3) groups, Young tableaux and unitary symmetries, standard arrangements of Young tableaux, Dimensionality of the representation of SU(N), Simple product representation using Young tableaux techniques.

Unit III: Quark Model

Fermi Yang model, Sakata model, Eight fold way and its shortcomings, Necessity of Quark model, Gell - Mann Zweig model, Quark lepton symmetry, and structure of Hadrons, Elementary idea of SU(6) Quark model, charm, bottom, and top quarks, Exotic Quarks, Experimental status of Quarks .

Unit – IV: Nuclear and Particle Detectors

Basic principle of particle detectors, Ionization chamber, Proportional detector, Geiger-Muller detector, Scintillation detector and gamma-ray spectrometer, Semiconductor detector, Nuclear emulsion technique, Cloud chamber, Bubble chamber.

Book Recommended:

D. H. Perkins: Introduction to High Energy Physics
S. N. Ghoshal: Atomic and Nuclear Physics
D. Griffiths : Introduction of Elementary Particles
DB Lichtenberg : Unitary Symmetry and Elementary Particles
Hughes: Elementary Particles
Blatt and Weiskopff : Theoretical Nuclear Physics
FE Close: Quarks and Patrons
T.P.Cheng and G.LF Li : Gauge Field Theory:
W. E. Burcham : Nuclear Physics
R. M. Singru: Introduction to experimental nuclear physics

Syllabus for M. Sc. Physics III Semester
Paper 13
(PHY-4934) Condensed Matter Physics 75 Marks

Unit I: **Crystal structure**

Interaction of radiation with matter (for elastic and en elastic scatterings of x- ray). Concept of reciprocal lattice point, calculation of reciprocal lattice point of SC, BCC. and FCC lattices, Application of reciprocal lattice point in diffraction techniques.

Unit II: **Bonding in Solids**

Different types of bonding in solids, covalent, metallic, Vander Waal, hydrogen bonding & ionic bonding, Madelung constant of ionic crystals, cohesive energy.

Unit III: **Lattice Vibrations and theory of metals**

Concept of dispersion relation, quantization of lattice vibrations (Phonons), normal modes & normal coordinates, longitudinal and transverse modes of vibration, modes of vibration of monatomic and diatomic lattices. Density of states (Phonons) , Theory of specific heat of solids : classical theory , Einstein theory and Debye theory .Theory of metals : Classical theory , free electron theory and F-D distribution function , Hall effect.

Unit IV: **Crystal Defects, Superconductivity & Magnetism**

Point defects (Schottky & Frankel Defects) Imperfections, Line defects (Edge& Screw dislocations), Burger vector & Burger Circuit, Role of dislocation in plastic deformation and crystal growth. Elementary idea of super conductivity nearly zero resistivity, Meissner effect, Tc, Hc type I, & II, superconductors & BCS theory, ferri, ferro, and anti ferromagnetism.

Books Recommended:

A. J. Dekker: Solid State Physics
S.O. Pillai : Solid State Physics
C. Kittle : Introduction to Solid State Physics
Verma & Srivastava : Crystallography for Solid State Physics
L.V. Azaroff: Introduction to solid
Ashcroft & Mermin: Solid State Physics
J.M. Ziman: Solid State Physics

Syllabus for M. Sc. Physics III Semester
Paper- 14
(PHY-4935) Plasma Physics 75 Marks

Unit-I: **Introduction to Plasma**

Elementary concept of Plasma, Debye Shielding, Plasma parameter, Single particle motions in presence of Uniform and non uniform electric and magnetic field, Drift of guiding center, Gradient drift, Curvature drift, Magnetic mirror, Adiabatic invariants in Plasma, Techniques of Plasma confinement.

Unit-II: **Magneto-Hydrodynamics and Fluid Plasma**

Hydro-dynamical description of Plasma, Concept of convective derivative, Fluid equations of plasma, Diamagnetic drift of plasma, Electron-ion plasma waves, Upper and Lower hybrid frequency, Single fluid M. H. D. equations, Pinch effect and instabilities in plasma, Hydromagnetic waves, Magneto-sonic and Alfven waves.

Unit-III: **Magneto Plasma**

Wave phenomena in Magneto plasma: Polarization, Phase velocity, group velocity, cutoff and resonance For electromagnetic wave in parallel and perpendicular to the magnetic field. Concept of ordinary and extraordinary waves in Plasma, Left and right handed circularly polarized waves in plasma, Whistler mode, Faraday rotation,

Unit-IV: **Plasma Propagation**

Propagation of waves through ionosphere and magnetosphere, Propagation at finite angle and CMA diagram, Helicon, Kinetic theory description of Plasma, Moments of Boltzmann equation**,** Continuity equation**,** Momentum balance equation**,** Two-fluid description of Plasma, Plasma resistivity.

Book recommended:

Jackson: Classical Electrodynamics; Wiley Estern, New Delhi
Bittencourt: Plasma Physics
Chen: Plasma Physics
Robert J Goldston and Paul H. Rutherford: Introduction to Plasma Physics

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III Semester

List of Experiments

1. Verification of Richardson's law.
2. Study of ESR spectra of a given sample.
3. Hall Effect
4. RCS Spectrometer
5. gamma ray spectrometer
6. Radio Receiver
7. e by Millikan's oil drop method.
8. Temperature dependence of diode characteristics.
9. Elastic constants of a cubic crystal by ultrasonic waves.
10. Study of Multivibrators .
11. Study of transistor amplifier cum feed back amplifiers.
12. Study of absorption of $KMnO_4$ by Spectrophotometer
13. Study of different FETs and MOSFETs.
14. Study of Thermo luminance .
15. Study of VTVM.