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) I Semester

Paper I: Mathematical Methods

Paper II: Classical Mechanics

Paper III: Quantum Mechanics

Paper IV: General Theory of Relativity and Cosmology

Paper V: Communication Electronics

Practical

Syllabus for M. Sc. Physics I Semester
Paper 1
(PHY-4911) Mathematical Methods 75 Marks

Unit I: **Special Functions**

Series solution of differential equations, Legendre, Bessel, Hermite, and Laguerre differential equations and related polynomials, Physical integral form of polynomials and their orthogonality relations, Generating Function and recurrence relation.

Unit II: **Curvilinear Coordinates and Tensors**

Curvilinear Coordinates and various operators in circular, Cylindrical and Spherical co-ordinate systems, classification of Tensors, Rank of a Tensor, Covariant and Contra-variant tensors, Symmetric and anti-symmetric Tensors, Kronecker delta symbol. Contraction of Tensor, metric Tensor and Tensor densities, Covariant differentiation and Geodesic equation (variational Method).

Unit III: **Complex Variables**

Function of complex variable, Cauchy's Riemann differential equation, Cauchy's integral theorem, residues and Cauchy's residues theorem, singularities, evolution of residues and definite integral.

Unit IV: **Integral Transform**

Fourier Integral and Fourier Transform, Fourier integral theorem, Finite and infinite integral, Laplace transform of elementary function (Dirac delta & Green's function), Solution of simple differential equations.

Book recommended:

Rajput BS: Mathematical Physics: Pragati Prakashan, Meerut
Pipes LI: Mathematical Physics: McGraw Hill .
Chattopadhyay P K: Mathematical Physics: Wiley Eastern, New Delhi
Afriken G.: Mathematical methods for Physics
Charlie Harper: Introduction to Mathematical Physics
Mathews and Walker: Mathematical Methods of Physics – Benjamin
Morse and Feshbach : Methods of Theoretical Physics – McGraw Hill

Syllabus for M. Sc. Physics I Semester
Paper 2
(PHY-4912) Classical Mechanics 75 Marks

Unit I: **Mechanics of a system of particles**

Constraints and generalized coordinates, D Alembert's principle, Lagrange equations for holonomic and non holonomic systems and their applications, Conservation laws of linear momentum, Energy and angular momentum.

Unit II: **Hamiltonian formulation and Hamilton Jacobi theory**

Hamiltonian equations of motion and their physical significance, Hamilton's principle, principle of least action, Canonical transformations Hamilton-Jacobi theory, Poisson brackets, Properties of Poisson bracket, Poisson's Theorem, Lagrange bracket.

Unit III : **Dynamics of a Rigid body**

Motion of a rigid body, body and space Reference system, angular momentum and Inertia tensor, Principle axes- Principle moments of Inertia, spinning tops, Euler angles, Infinitesimal rotations.

Unit IV : **Central Force Problem**

Action and angle variables, phase integral, Small oscillations, Kepler's laws of Planetary motion and their deduction, Scattering in a Central field, Rutherford scattering cross section.

Book recommended:

Mathematical Physics: B S Rajput
Classical Mechanics – H. Goldstein
Classical Mechanics – N.C. Rana & P. S. Jog
Landau and Lifshitz : Mechanics - Pergamon
Sommerfeld : Mechanics – Academic Press
Whittaker : Analytical Dynamics of Particles and Rigid Bodies - Cambridge
Raychaudhuri : Classical Mechanics – Oxford
Bhatia : Classical Mechanics – Narosa.

Syllabus for M. Sc. Physics I Semester
Paper 3
(PHY-4913) Quantum Mechanics 75 Marks

Unit I: Operator formulation of Quantum Mechanics

State vectors and operators in Hilbert Space, Eigen values and Eigen vectors of an operator, Hermitian, Unitary and Projection operators, Commuting operators, BRA and KET Notations, Postulates of Quantum Mechanics, co-ordinate Momentum and Energy representations, Dynamical behavior, Heisenberg, Schrödinger and interaction Pictures.

Unit II: Schrödinger equation and Theory of Angular momentum

Probability and current densities associated with Schrödinger's equation, Ehrenfest's theorem, Three dimensional Schrödinger's equation in Cartesian and Curvilinear Coordinate systems, Centrally symmetric square well and harmonic potentials, harmonic oscillator and its wave functions, Hydrogen atom.
Orbital Angular momentum operator, its eigen value and eigen functions, Pauli's theory of spin, Addition of angular momentum, Clebsch-Gordan coefficients.

Unit III: Approximation Methods and Time independent Perturbation theory

Stationary Perturbation, first and second order corrections, WKB approximation methods, connection formula and boundary conditions, Bohr Sommerfeld quantization rule, Penetration of potential barrier, Time independent perturbation theory and anomalous Zeeman Effect, variation method and its application to the ground state of helium atom, and harmonic oscillator

UNIT- IV: Time Dependent Perturbation Theory

Time dependent perturbation theory, Constant perturbation, Fermi Golden rule, Coulomb excitation, Sudden and adiabatic approximation, Harmonic perturbation, Radiative Transition in atoms. Einstein's A and B coefficients and Spontaneous emission of radiation
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Books recommended:

B. S. Rajput - Quantum Mechanics
L. I. Schiff - Quantum Mechanics
V. K. Thankppan - Quantum Mechanics
Loknathan & Ghatak - Quantum Mechanics

Syllabus for M. Sc. Physics I Semester
Paper 4
(PHY-4914) General Theory of Relativity and Cosmology 75 Marks

Unit- I: **Foundations of General Relativity**

Elements of Special relativity, Tensors as geometrical objects, Mach's Principle, Non-inertial frames of reference, Gravity and space-time, Principle of equivalence and principle of general covariance, Metric tensor and gravity, Geodesics and Affine parameters (Christoffel symbols), Covariant derivative and its geometrical interpretation, Parallel transport, Space- time curvature and curvature tensor, Riemann curvature tensor, Bianchi identity, Ricci tensor, Classification of space-time curvature (in different dimensions).

Unit -II: Einstein's Field Equations and Gravitational Dynamics

Christoffels connection as Einstein's connection, Gravitational action, field equations and their general properties, Newtonian limit of Einstein's field equations, Metric in spherically symmetric space-time (Schwarzchild metric), Orbits in the Schwarzschild metric, gravitational collapse of a dust sphere, Schwarzschild black holes.

Unit-III: Gravitational Radiation

Introduction of Gravitational radiation, Wave equation in linearized theory and plane waves, Propagating modes of gravity, Gravitational waves in a flat space-time background, Propagation of gravitational waves in the curved space-time, Energy and momentum of the gravitational waves, Detection of gravitational waves.

UNIT- IV: Cosmology

Basic Concepts and elementary idea of big-bang and steady state cosmologies, Seagull static models, Cosmological principle, Friedmann space-time, Robertson-Walker line element, Weyl's postulate, expansion of the universe, Hubble's law, dynamical equation of cosmology and their consequences, The primordial fire and the remnant radiation, Big-bang and steady state models of the universe.

Book Recommended:

R.R. Patharia : Theory of Relativity
S.K. Bose : An Introduction to General Relativity
J.V. Narlikar : An Introduction to Cosmology
C. Moller: The theory of Relativity
T. Padmanabhan: Gravitation
Raychaudhuri: Theoretical cosmology
M. Carmeli: Classical fields: General Relativity and Gauge Theory

Syllabus for M. Sc. Physics I Semester
Paper 5

(PHY-4915) Communication Electronics **75 Marks**

Unit I: **Modulation**

AM and FM (Transmission and reception): Modulation, AM generation, Power consideration, Balanced modulator, SSB transmission, AM detection, AGC, Radio receiver characteristics, Signal to noise ratio, FM analysis, Noise considerations, Generation, Direct method and reactance tube method, FM transmitter, AFC, FM Propagation, Phase discriminator.

Unit II: **Propagation of Radio Waves**

Ground wave, Sky wave and Space wave propagation,. Ionosphere (Ecclr- larmer theory, magneto ionic theory.

Unit III: **Antenna and TV**

Antenna, HF antenna, Yagi antenna, loop antenna, Satellite communication, parabolic reflector, dish antenna, Fundamentals of image transmission, vestigial transmission, TV camera tubes, image orthicon, vidicon, TV transmitter, TV receiver and picture tubes.

Unit IV: **Transmission Lines**

Voltage and current relations on transmission line, Propagation constant, Characteristic impedance, impedance matching, Quarter wave T/L as impedance transformer, Attenuation along coaxial cable, cables of low attenuation, Propagation of radio waves between two parallel lines, Wave guide modes, TE10 mode and cut off wavelength, Cavity resonator, light propagation in cylindrical wave guide, Step index and Graded index fibers, Attenuation and Dispersion in fibers.

Books Recommended:

George Kennedy & Davis: Electronics Communication Systems
Millar & Beasley: Modern Electronics Communication
R.R Gulani: Monochrome and colour television (Wiley Eastern Limited)
Taub and Schilling: Principle of Communication Systems (TMH)
Simon Gaykuti: Communication Systems (John Wiley & Sons Inc. 1994)

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

List of Experiments

1. Study of RC circuit with an AC source using phase diagrams.
2. Absorption Spectrum of $KMnO_4$ using Hilger-Nutting Photometer.
3. Young's modulus by Interference method.
4. NPN and PNP Transistor Characteristics with (a) Common base (b) Common emitter configurations/ h – parameter.
5. Study of RC- coupled/ Transformer Coupled Amplifier.
6. Study of B-H curve.
7. Study of Amplitude Modulation /Demodulation.
8. Verification of the Hartmann's Formula.
9. Frank-Hertz experiment.
10. Determination of susceptibility.
11. Study of CRO.
12. Velocity of Ultrasonic waves.
13. Linear Air track.
14. Leacher Wire