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M.Sc (Syllabus) For [2026-27]

DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the Program:
M.Sc./BSc- Four Year Subject: Physics

w. e. f. Session 2026-27

Structure of Syllabus Developed by			
Name of BOS Convener/ BOS Member	**Designation**	**Department**	**College/ University**
Prof S. S. Mishra	Dean	Faculty of Science	Dr R.M.L. Avadh University, Ayodhya
Prof. Rajeev Kumar Srivastava	Convener	Physics	Ganpat Sahay P G College, Sultanpur
Dr. Anoop Kumar Pandey	Member	Physics	K.S. Saket P.G. College Ayodhya
Dr. Gaurav Mishra	Member	Physics	K.S. Saket P.G. College Ayodhya
Prof. Prabhakar Singh	External Expert	Physics	I.I.T. BHU Varanasi
Prof. (Smt.) Anchal Srivastva	External Expert	Physics	University of Lucknow
Prof. Lallan Yadav	External Expert	Physics	D.D.U. University Gorakhpur

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Dr. Ram Manohar Lohia Avadh University
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Syllabus for FYUP B.Sc. (Hons) Sem VII/and M.Sc. Sem-I

Course Code	Paper Type	Course Title	Credits	T/P	Evaluation	
					CIE	ETE
A	B	C	D	E	F	G
FYUP B.Sc. Sem VII /and M.Sc. Sem-I						
B010701T	CORE	Mathematical Methods for Physics	4	T	25	75
B010702T	CORE	Atomic & Molecular Spectroscopy	4	T	25	75
B010703T	CORE	Quantum Mechanics	4	T	25	75
B010704T	CORE	Physics in Daily Life	4	T	25	75
B010705P	CORE	Physics Lab-1	4	P	50	50
		Total	20			

Abbreviations: FYUP – Four Year Undergraduate Programme, T – Theory, P – Practical, R – Research Project, CIE – Continuous Internal Evaluation, ETE – End term examination.

Note:

1. Research Project can be replaced by Dissertation or Internship or field/Survey work.
2. Research Project will be annually (Sem. III & IV), evaluated half yearly (Sem III) and finally in Sem. IV same will be applicable for Dissertation or Internship or field/Survey work.
3. For FYUP UG. (Hons. with Research), Students will do one annual Research Project in place of last CORE theory papers of semester VII & VIII. Credit and evaluation will be same as Research Project of PG Semester III & IV.

For FYUP Apprenticeship Embedded UG, Students have to do 12 months Apprenticeship of 1200 Hrs from National Apprenticeship Training Scheme (NATS) through NATS 2.0 Portal or from equivalent organisation /Industry/Institute. For this 40 Credit will be earned by the students.

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B010701T: Mathematical Methods for Physics

Course Outcomes (COs):

At the end of this course, students will be

1. Able to understand the application of mathematics in solving the problems related to Physical Sciences.
2. Use of Residue theorem and Integral formula to evaluate various integrals.
3. Use of Laplace Transform to solve the differential equation.
4. Able to inculcate the habit of mathematical thinking and lifelong learning.

Unit I

Indian Concepts of Space, Time and Matter

Fundamental concepts of space, time, and matter as described in ancient Indian knowledge systems and their connection with modern mathematical physics. Introductory idea of Vaisheshika philosophy of Kanada, which classifies reality into categories (Padarthas) such as substance, quality, motion, and time. The concept of Paramanu (atom) is discussed as the smallest indivisible unit of matter, along with its combination principles. Indian understanding of space (Akasha) and time (Kala) as fundamental entities, including their continuous and discrete interpretations. Concepts of motion (Karma) and causality are analyzed in the context of early physical thinking. A comparative study is made between these ideas and modern concepts such as classical mechanics and spacetime frameworks. Mathematical interpretations of motion and cyclic time (Yugas), emphasizing periodicity and symmetry. The philosophical logic of Nyaya system is briefly introduced to understand inference and reasoning in scientific analysis.

Unit-II

Special Functions:

Second order ordinary differential equations and their role in physical problems. Legendre's differential equation, Legendre polynomials and their properties, including orthogonality and recurrence relations. Bessel's differential equation, Bessel functions of first and second kind, and their important properties and applications. Laguerre's differential equation, its solutions and properties with applications in physics. Hermite differential equation and Hermite polynomials, including their properties and applications in quantum mechanics. Green's function and its application in solving boundary value problems

Unit-III

Complex Variables:

Functions of a complex variable, including single-valued and multi-valued functions. Analytic functions and the Cauchy–Riemann conditions. Study of singular points and their classification. Cauchy's integral theorem and Cauchy's integral formula with applications. Expansion of functions using Taylor and Laurent series. Zeros and poles of complex functions and their significance. Residue theorem and its application to the evaluation of definite integrals.

Unit-IV

Laplace and Fourier Transform:

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Laplace transforms and their properties, with applications to the solution of linear differential equations with constant coefficients. Fourier integral and its significance. Fourier transforms, including Fourier sine and cosine transforms, their properties and applications., Convolution theorem and its applications in solving physical problems.

References:

1. Mathematical method for Physicists, Arfken & Weber, Elsevier Academic Press
2. Mathematical Method for Physics and Engineers, K. F. Reily, M. P. Hobson and S. J. Bence, Cambridge University Press
3. Advanced Engineering Mathematics, E. Kreyszig, John Wiley & Sons
4. Special Functions, E.D. Rainville, Chelsea Publication Co.
5. Special Functions for Scientists and Engineers, W.W. Bell, Dover Publications
6. Kim Plofker – *Mathematics in India*
7. G.G. Joseph – *The Crest of the Peacock*
8. B. Datta & A.N. Singh – *History of Hindu Mathematics*
9. Debiprasad Chattopadhyaya – *Science and Society in Ancient India*
10. B.V. Subbarayappa – *Indian Astronomy: A Source Book*
11. UGC / AICTE – Indian Knowledge System (IKS) Modules

B010702T: Atomic & Molecular Spectroscopy

Course Outcomes (COs):

After completion of this course, a student will be able to:

CO1: Understand Classical and Quantum models of atom.

CO2: Learn different types of interactions in atom and their physical significance.

CO3: Learn importance of molecular rotational and vibrational spectra.

CO4: Distinguish among atomic, molecular and electronic structures and spectra.

UNIT-I

Quantum mechanical treatment of one-electron atoms with special reference to the hydrogen atom. Detailed study of the fine structure of the hydrogen atom including relativistic corrections and spin–orbit interaction. Spectra of alkali elements with emphasis on the role of a single valence electron in determining spectral characteristics. Singlet and triplet states of the helium atom and their significance in understanding electron spin and energy level splitting.

UNIT-II

Spin–orbit interaction and its effect on atomic energy levels. Coupling schemes including L–S (Russell–Saunders) coupling and J–J coupling. Derivation and application of Landé g-factor for L–S coupling and Landé interval rule. Selection rules governing atomic transitions and intensity relations. Interaction of atoms with external fields including Zeeman effect (normal and anomalous), Paschen–Back effect and Stark effect.

Hyperfine structure and isotopic shift, along with the study of Lamb shift and its significance.

UNIT-III

Spectra of diatomic molecules with emphasis on rotational and vibrational transitions. Rotational spectra explained through rigid rotator and non-rigid rotator models. Vibrational spectra discussed using harmonic and anharmonic oscillator models. Molecular symmetry with special reference to symmetric top molecules. Vibrating rotator model and its role in explaining combined rotational-vibrational spectra. Isotopic shift in molecular spectra.

UNIT-IV

Raman spectra studied through both classical and quantum mechanical approaches. Electronic spectra of molecules including vibrational structure of band systems and fine structure within band systems. Intensity distribution in band systems explained through the Franck–Condon principle and its applications in molecular spectroscopy.

Books for Study:

1. H.E. White, Introduction to Atomic spectra
2. C.N. Banwell, Fundamental of Molecular spectroscopy, TMH.
3. G. Herzberg, Atomic spectra & Structure
4. Bransden and Joachain, Physics of Atoms and Molecule
5. Rajkumar, Atomic & Molecular Spectroscopy
6. Gupta, Kumar & Sharma, Elements of Spectroscopy

Books for Reference:

1. J. M. Brown, Molecular spectroscopy
2. G. M. Barrow, Introduction to Molecular spectroscopy
3. P.F. Bernath, Spectra of Atoms and Molecule
4. B. P. Straughan and S. Walker, Spectroscopy, Vol I, II and III.
5. G. K. Woodgate, Elementary atomic structure, Claredon Press.
6. M. Karplus, Atoms and Molecules, Benjamin-Cumming Pub. Co

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B010703T: Quantum Mechanics

Course Outcomes (COs):

After completion of this course, a student will be able to:

CO1: Students will be able to correlate the classical and quantum ideas.

CO2: They will learn different representations used in quantum mechanics and their physical significance.

CO3: They will learn importance of angular momentum observable in quantum mechanics.

CO4: They will be able to know about time-independent perturbation theory and their applications.

UNIT-I

Basic formalism

Wave functions for a free particle and their physical interpretation, including conditions on acceptable wave functions. Postulates of quantum mechanics and formulation of the Schrödinger equation. Expectation values of physical observables and Ehrenfest's theorem. Concept of stationary states and their properties. Hermitian operators corresponding to dynamical variables and their significance. Eigenvalues and eigenfunctions, along with their physical interpretation. Heisenberg uncertainty principle and its implications.

UNIT-II

One Dimensional and Three-Dimensional Problems

One-dimensional quantum systems including the particle in a box, simple harmonic oscillator, square well potential, and barrier penetration problems. Extension to three-dimensional systems including orbital angular momentum and spherical harmonics. Central force problems and reduction of the two-body problem. Particle in a spherical well and detailed study of the hydrogen atom.

UNIT-III

General formalism

Mathematical structure of quantum mechanics including Hilbert space and Dirac notation. Representation theory with coordinate and momentum representations. Time evolution of quantum systems in different pictures, namely Schrödinger, Heisenberg, and interaction representations. Symmetries and conservation laws in quantum mechanics. Unitary transformations associated with translations and rotations.

UNIT-IV

Approximation methods

Approximation techniques in quantum mechanics with emphasis on time-independent perturbation theory for both non-degenerate and degenerate systems. Applications to physical problems such as the ground state of the harmonic oscillator and the Stark effect in the hydrogen atom.

References:

1. Introduction to Quantum Mechanics by David J. Griffiths, Pearson (2005).
2. Quantum Mechanics by G. Aruldhas, PHI, India.
3. Quantum Mechanics: Concepts and Applications by N. Zettili, Wiley
4. Quantum Mechanics by L.I. Schiff, Tata Mcgraw Hill Education Private Limited Tata Mcgraw Hill Education Private Limited (2010).
5. Modern Quantum Mechanics by J. J Sakurai, Pearson (1994).
6. Quantum Mechanics: Theory And Applications by A. Ghatak, Macmillan India Limited (2004).
7. Quantum Mechanics: An Introduction by Walter Greiner, Springer (India) Pvt. Ltd. (2008)
8. Quantum Physics of Atoms Molecules Solids Nuclei and Particles by Robert Resnick and Robert Eisberg, Wiley India Pvt Ltd (2006).

B010704T: Physics in Daily Life

Course Outcomes (COs):

This course is intended for students of disciplines other than Physics. The prerequisite of this course is the secondary level of knowledge in mathematics and physics. Through this course, students can appreciate their surroundings by understanding the basic rules of Nature and able to connect some daily life observations to Physics principles.

Unit I

Units, Dimensions and Errors: Fundamental and derived quantities. Units and dimensions, dimensional analysis, order of magnitude, significant figures, errors.

Light: Reflection, refraction, diffraction, interference, scattering (elementary ideas only) – examples from daily life – apparent depth, blue color of sky, twinkling of stars. Total internal reflection, mirage, sparkling of diamond, primary and secondary rainbow, optical fibers. Concave and convex mirrors, lenses, focal length, power of a lens, refractive index, prism, dispersion. Human eye, defects of the eye- myopia, hypermetropia, presbyopia and astigmatism and their correction by lens.

Unit II

Motion: Velocity, acceleration, momentum, Idea of inertia, force- laws of motion. Newton's law of gravitation, acceleration due to gravity, mass and weight, apparent weight, weightlessness. Rotational motion, Moment of inertia, torque, centripetal and centrifugal acceleration examples- banking of curves, centrifugal pump etc.

Unit III

Electricity: Voltage and current, ohms law, electric energy, electric power, calculation of energy requirement of electric appliances- transformer, generator, hydroelectric power generation- wind power, solar power, nuclear power.

Matter and energy: Different phases of matter, fluids- surface tension, viscosity, capillary rise, Bernoulli's theorem and its applications. Heat energy, temperature, different temperature scales- degree Celsius, Fahrenheit and Kelvin. Waves- transverse and longitudinal waves, sound waves, Doppler Effect. Lasers, fluorescence, phosphorescence, electromagnetic waves- applications- microwave oven, radar, super conductivity.

Unit IV

Universe: Planets, solar system, moon- faces of moon, lunar and solar eclipses, constellations, Different types of stars, Galaxies, black hole. Satellites, Artificial satellites, Global positioning system. Geo stationary satellite.

Reference Texts

- Fundamentals of Physics with Applications by Arthur Beiser
- Conceptual Physics by Paul G. Hewitt

B010705 P: Physics Lab-I

A. List of Experiments

1. To determine Planck's constant by photocell
2. Michelson Interferometer - Thickness of mica sheet.
3. Verification of Stefan's law for black body radiation
4. Determination of the velocity of Ultrasonic waves in solids/liquids.
5. Specific charge of an electron -Thomson's method / Magnetron method

B. Project Presentation / Seminar on an assigned topic.

**Marks distribution:*

ETE: One practical – 50

CTE: Practical record (20) + Seminar (30) = 5