UNIVERSITY OF KALYANI

UG 4 YEAR PHYSICS (HONOURS/ HONOURS WITH RESEARCH) SYLLABUS

(Under NEP 2020)

W.E.F. the Academic Session 2023-24

Course Structure Physics (NEP-2020)-KU

SEMESTER-I							
Course Code	Course Title	Nature of Course	Credit of Course	Class hours/ week	Evaluation		Total
					Internal	Semester End	
PHY-M-T -1 PHY-M-P-1	Mathematical physics- I (4+2)	Major	6	6	15	60	75
PHY-MI-T-1 PHY-MI-P-1	Mathematical Physics -I (3+1)	Minor	4	4	10	40	50
PHY-MU-T-1	Physics in everyday life	Multidisciplinary Course	3	3	10	35	45
PHY-SEC-T-1	Electrical circuit and network skills	Skill Enhancement Course	3	3	10	35	45
		Value Added Course	4	4	10	40	50
05			20	20	55	210	265

- Value Added Course will be common to all major

SEMESTER-II							
Course Code	Course Title	Nature of Course	Credit of Course	Class hours/ week	Evaluation		Total
					Internal	Semester End	
PHY-M-T-2 PHY-M- P-2	Mechanics (4+2)	Major	6	6	15	60	75
PHY-MI-T-2 PHY-MI-P-2	Mechanics (3+1)	Minor	4	4	10	40	50
PHY-MU-T-2	Weather forecasting	Multidisciplinary Course	3	3	10	35	45
		Ability Enhancement Course	4	4	10	40	50
PHY-SEC-T-2	Basic Instrumentation Skills	Skill Enhancement Course	3	3	10	35	45
		Summer Internship	4	4			
05			20	20			265

- Ability Enhancement Course will be common to all major

Semester-I

Major

PHY-M-T-1: MATHEMATICAL PHYSICS-I

Marks (Semester End - 40, Internal Assessment – 10)

Theory: (4 Credits) No. of Lectures - 60

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order Differential Equations and Integrating Factor. (5 Lectures)

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. (10 Lectures)

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. (5 Lectures)

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. (6 Lectures)

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates. (7 Lectures)

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proof) (10 Lectures)

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. (4 Lectures)

Matrices: Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Eigen-values and Eigenvectors (Degenerate and non-degenerate). Cayley-Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary homogeneous Differential Equations. Functions of a Matrix. (6 Lectures)

Introduction to probability:
Independent random variables: Sample space and Probability distribution functions. Binomial, Gaussian, and Poisson distribution with examples. Mean and variance. (5 Lectures)

Dirac Delta function and its properties:
Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. (2 Lectures)

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- Vector Analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outlines Series
- Fundamentals of Mathematical Physics, A.B. Gupta, Books & Allied Ltd; 5th edition
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Higher Enginering Mathematics, B. S. Grewal, Khanna Publisher
- Play with Graphs, Amit M. Agarwal, Arihant Publisher
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
- Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani, Kolkata

PHY-M-P-1: MATHEMATICAL PHYSICS-I

Marks (Semester End - 20, Internal Assessment – 5)
(Lab. Note Book - 05, Viva-Voce-05, Experiment -10)
Practical - (2 Credits) No. of Lectures - 60

- *The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.*
- *Highlights the use of computational methods to solve physical problems*
- *The course will consist of lectures (both theory and practical) in the Lab*
- *Evaluation done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved*

- *Students can use any one operating system Linux or Microsoft Windows*

Introduction and Overview

Computer architecture and organization, memory and Input/output devices

Basics of scientific computing

Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow-emphasize the importance of making equations in terms of dimensionless variables, Iterative methods

Errors and error Analysis

Truncation and round off errors, Absolute and relative errors, Floating point computations.

Introduction to programming in Python/Fortran/Matlab/C/C++:

Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements, lists, tuples, dictionaries and strings, basic ideas of object-oriented programming.

Introduction to plotting graphs with Matplotlib/Gnuplot/Origin/Excel

Basic 2D and 3D graph plotting - plotting functions and datafiles, fitting data using gnuplot's fit function, polar and parametric plots, modifying the appearance of graphs, Surface and contour plots, exporting plots

Programs:

Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search, Factorial of a number, sum of a power series e.g. sin, cosine, exponential series etc.

Random number generation

Area of circle, area of square, volume of sphere, value of pi (π),

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods

Solution of linear and quadratic equation, solving, $\theta = tan\,\theta$, $I = I_0\{\sin\alpha/\alpha\}^2$ in optics

Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation

Evaluation of trigonometric functions e.g. *sinθ, cosθ, tanθ* etc.

Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method

Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop. Monte-Carlo integration

Curve fitting, Least square fit, Goodness of fit, standard deviation
Ohms law to calculate R, Hooke's law to calculate spring constant

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Numerical Methods, Arun Kr Jalan, Utpal Sarkar, University Press
- Python Programming, Satyanarayana, Radhika Mani, Jagdesh, University Press
- Scientific Computing in Python, Abhijit Kar Gupta, Techno World
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006, Cambridge Univ. Press

Minor

PHY-MI-T-1: MATHEMATICAL PHYSICS -I

Marks (Semester End - 30, Internal Assessment – 5)
Theory – (3 Credits) No. of Lectures - 45

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order Differential Equations and Integrating Factor. (5 Lectures)

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. (10 Lectures)

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. (6 Lectures)

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian

operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates. (7 Lectures)

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proof) (10 Lectures)

Matrices: Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Eigen-values and Eigenvectors (Degenerate and non-degenerate). (5 Lectures)

Dirac Delta function and its properties:
Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. (2 Lectures)

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- Vector Analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outlines Series
- Fundamentals of Mathematical Physics, A.B. Gupta, Books & Allied Ltd; 5th edition
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Higher Enginering Mathematics, B. S. Grewal, Khanna Publisher
- Play with Graphs, Amit M. Agarwal, Arihant Publisher
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
- Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani, Kolkata

PHY-MI-P-1: MATHEMATICAL PHYSICS-I

Marks (Semester End - 10, Internal Assessment – 5)
Practical - (1 Credits) No. of Lectures - 30

Introduction to programming in Python/Fortran/Matlab/C/C++:
Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements, lists, tuples, dictionaries and strings, basic ideas of object-oriented programming.

Introduction to plotting graphs with Matplotlib/Gnuplot/Origin/Excel
Basic 2D and 3D graph plotting - plotting functions and datafiles, fitting data using gnuplot's fit function, modifying the appearance of graphs.

Programs:
Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search, Factorial of a number, sum of a power series e.g. sin, cosine, exponential series etc.

Random number generation
Area of circle, area of square, volume of sphere, value of pi (π),

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods
Solution of linear and quadratic equation, solving, $\theta = tan\,\theta$

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Numerical Methods, Arun Kr Jalan, Utpal Sarkar, University Press
- Python Programming, Satyanarayana, Radhika Mani, Jagdesh, University Press
- Scientific Computing in Python, Abhijit Kar Gupta, Techno World
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006, Cambridge Univ. Press

Multidisciplinary Course

PHY-MU-T-1: Physics in Everyday Life

Marks (Semester End – 35, Internal Assessment – 10)
Internal Assessment [(Class Test/ Assignment/ quiz etc) - 10]
Theory: (3 Credits) No. of Lectures - 45

Course Description: This course aims to introduce the fundamental principles of physics and explore their applications in various aspects of everyday life. Students will develop an

understanding of the physical laws governing the world around us and how they manifest in common phenomena and technologies by a qualitative approach.

Course Objectives:

- *To provide an overview of key physics concepts and principles.*
- *To demonstrate the relevance of physics in everyday life.*
- *To develop critical thinking skills in analysing and explaining real-world phenomena using physics principles.*
- *To foster an appreciation for the scientific method and the role of physics in advancing society.*

Introduction to Physics: Overview of Physics and its role in understanding the natural world. Scientific method and experimental design. Units and measurements. (6 Lectures)

Mechanics and Motion: Newton's laws of motion and their applications, Projectile motion, Forces in equilibrium, Friction and its effects, Physics of transportation and motion. (6 Lectures)

Energy and Its Transformations: Conservation of energy, Work and power, Potential and kinetic energy, Energy transfers and transformations, Physics in sports and recreational activities. (6 Lectures)

Waves and Sound: Properties of waves, Sound waves and their characteristics, Pitch, loudness, and the Doppler effect, Sound production and perception, Physics of music and musical instruments.(6 Lectures)

Light and Optics: Electromagnetic spectrum, Reflection, refraction, and diffraction, Lenses and optical instruments, Vision and the human eye. (6Lectures)

Electricity and Magnetism: Electric charge and electric fields, Electric circuits and Ohm's law, Magnetism and magnetic fields, Electromagnetic induction. (6Lectures)

Modern Physics: Atomic structure and quantum theory, Particle physics and the Standard Model.

Nuclear physics and radioactivity, Applications of modern physics in technology. (9 Lectures)

(All the above topics will be taught in qualitative approach and with examples as much as possible)

Reference Books:

- Mechanics Berkeley Physics, v.1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
- Physics - Resnick, Halliday & Walker 9/e, 2010, Wiley

- Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani, Kolkata
- Classical Mechanics and Properties of Matter, Gupta, Books and Allied (P) Ltd.
- Principles of Acoustics, Ghosh, Shreedhar Publisher.
- Snatak Padartha Bigyan (Part -1 & 2), Dasgupta, Book Syndicate
- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.

Additional Books for Reference:

- Modern Atomic and Nuclear Physics, A. B. Gupta, Books & Allied Ltd; 2nd Revised edn.
- A Text Book On Light By B.Ghosh& K.G Mazumdar, Sreedhar Publishers
- Nuclear Physics, Ghoshal, S. Chand

Skill Enhancement Courses

PHY-SEC-T-1: ELECTRICAL CIRCUITS & NETWORK SKILLS

Marks (Semester End – 35, Internal Assessment – 10)

Internal Assessment [(Class Test/ Assignment/ quiz etc) - 10]

Theory: (3 Credits) No. of Lectures - 45

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law, Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with digital multimeter (name of the circuit elements and their ranges), Analog voltmeter and analog ammeter. (6 Lectures)

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources (principle of generation, output wave form, advantage of using three- phase). Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. (8Lectures)

Generators and Transformers: DC Power sources (basic idea). AC and DC generators (basic principle of action). Inductance, capacitance, and impedance. Operationof transformers (Step-up and step-down).(4 Lectures)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Speed & power of ac motor.(3 Lectures)

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers (half wave and full wave rectifier with L, C, L-C filter arrangement, regulation). Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources. (4 Lectures)

Electrical Protection: Relays, Fuses and disconnect switches, Working principle of Circuit breakers, Miniature circuit breaker and its types. (3 Lectures)

Electrical Wiring: Conduit wiring (basic idea of house hold wiring). Basics of wiring: Star and Delta Connections. Preparation of extension board, Wiring Materials (Basic information about the wiring components). (2 Lectures)

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Semester-II

Major

PHY-M-T-2: MECHANICS

Marks (Semester End - 40, Internal Assessment – 10)

Theory: (4 Credits) No. of Lectures - 60

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.(6 Lectures)

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.(4 Lectures)

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.(3 Lectures)

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. (12 Lectures)

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire. (3 Lectures)

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Euler’s Equation. Bernoulli’s Theorem. (2Lectures)

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.(3Lectures)

Motion of a particle under a central force field: Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effectson astronauts. (6 Lectures)

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.(7 Lectures)

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. (4 Lectures)

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Four Vectors (definition and examples only). (10 Lectures)

Reference Books:

- Mechanics and general properties of matter, Satyendra Nath Maiti and Debiprasad Roychoudhury, New age international.
- Mechanics through Problems, Dhiranjan Roy, Ananda Dasgupta, 2022, Techno World.
- Problems in General Physics, I E Irodov, Arihant Publications.
- Mechanics, Berkeley Physics, vol. 1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani, Kolkata

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

PHY-M-P-2: MECHANICS

Marks (Semester End - 20, Internal Assessment – 5)
(Lab. Note Book - 05, Viva-Voce-05, Experiment -10)
Practical - (2 Credits) No. of Lectures - 60

List of Experiments:

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) g
5. To determine the Moment of Inertia of a Flywheel/ a rigid body.
6. To determine g and velocity for a freely falling body using Digital Timing Technique

7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of the material of a bar by flexure method
9. To determine the Modulus of Rigidity of a Wire by - Dynamic Method.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.
13. To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork
14. Measurement of coefficient of viscosity by Stoke's method.

Instruction : At least ten practical have to be done from the above list.

Reference Books

• Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

• Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House

• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

• A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, Kitab Mahal

Minor

PHY-MI-T-2: MECHANICS

Marks (Semester End - 30, Internal Assessment – 5)

Theory – (3 Credits) No. of Lectures - 45

Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(4 Lectures)**

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **(3 Lectures)**

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. **(6 Lectures)**

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. **(3 Lectures)**

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts. **(6 Lectures)**

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. (3 Lectures)

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillation. (4**Lectures)**

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia-Y, η and σ by Searle's method. **(5 Lectures)**

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Euler's Equation. Bernoulli's Theorem. **(3Lectures)**

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Length contraction. Time dilation. Relativistic transformation of velocity, Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. **(8 Lectures)**

Reference Books:

- Mechanics and general properties of matter, Satyendra Nath Maiti and Debiprasad Roychoudhury, New age international.
- Mechanics through Problems, Dhiranjan Roy, Ananda Dasgupta, 2022, Techno World.
- Problems in General Physics, I E Irodov, Arihant Publications.
- Mechanics, Berkeley Physics, vol. 1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani, Kolkata

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

PHY-MI-P-2: MECHANICS

Marks (Semester End - 10, Internal Assessment – 5)
Practical - (1 Credits) No. of Lectures - 30

List of Experiments:

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) g

5. To determine the Moment of Inertia of a Flywheel/ a rigid body.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of the material of a bar by flexure method
9. To determine the Modulus of Rigidity of a Wire by - Dynamic Method.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.
13. To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork
14. Measurement of coefficient of viscosity by Stoke's method.

Instruction: At least seven practical have to be done from the above list

Reference Books

• Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

• Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House

• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

• A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, Kitab Mahal

Multidisciplinary Course

PHY-MU-T-02: Weather Forecasting

Marks (Semester End - 35, Internal Assessment/Demonstration and Experiments – 10)

Internal Assessment [Class Test/ Assignment/Quiz/presentation)]

Theory: (Credits: 03) No. of Lectures - 45

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques.

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics. (9 Periods)

Measuring the weather: Wind; forces acting to produce wind; wind speed: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws. (4 Periods)

Weather systems: Global wind systems; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes. (3 Periods)

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate. (6 Periods)

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts. (8 Periods)

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports.
2. Working principle of weather station.
3. Processing and analysis of weather data:
   a) To calculate the sunniest time of the year.
   b) To observe the sunniest/driest day of the week.
   c) To examine the maximum and minimum temperature throughout the year.
   d) To evaluate the relative humidity of the day.
   e) To examine the rainfall amount.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non-aviation)
5. Simple experiment to measure rainfall amount using rain gauge.

Reference books:

- Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books

- The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
- Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
- Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
- Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
- Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.
- Solar Planetary System, Asit B. Bhattacharya and Jeffrey M. Lichtman, Taylor & Francis USA

Skill Enhancement Course

PHY-SEC-T-2 : Basic Instrumentation Skills

Marks (Semester End - 35, Internal Assessment (Lab Assessment) – 10)

(Theory +Lab) (Credits: 03) 45 Lectures

This course is to get exposure with various aspects of instruments and their usage through hands-on mode.

Experiments listed below are to be done in continuation of the topics.

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, acvoltage, ac current and resistance. Specifications of a multimeter and their significance. (6 Lectures)

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications ofan electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and theirsignificance. (6 Lectures)

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only- no mathematical treatment), brief discussion on screenphosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. (9 Lectures)

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle ofworking. (5 Lectures)

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications.Distortion factor meter, wave analysis. (5 Lectures)

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCRbridges. (5 Lectures)

Digital Instruments: Principle and working of digital meters. Comparison of analog& digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. (4 Lectures)

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracyand resolution. (5 Lectures)

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India