CLUSTER UNIVERSITY SRINAGAR

SYLLABUS- SEMESTER 1^{st} (CBCS) - INTEGREATED M.SC PHYSICS
CORE COURSE - THEORY

TITLE: **MATHEMATICAL PHYSICS -I**

COURSE CODE: IGPHY18-C101 **CREDITS**: 04
Total Marks: 56 + (4) Marks **Contact Hours**: 64 hrs

Objective: *The emphasis of course is on applications in solving problems of interest to physicists. The course focuses on calculus of scalar and vector functions. First and second order differential equations are also discussed. The students are to be examined preferably on the basis of problems, seen and unseen.*
Course Outcomes: *On completion of the course, students will be able to solve problems related to vector calculus with the help of differential operators like gradient, curl, divergence and laplacian. To apply the vector integration for finding line, surface and volume integrals and understanding different theorems based on it. The students shall also know basic differential equations, and Dirac delta function.*

UNIT I

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.
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.

UNIT II

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.

UNIT III

Orthogonal Curvilinear Coordinates: Derivation of Gradient, Divergence, Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.
Calculus: 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). Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

UNIT IV

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.
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

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn. Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012,
7. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
8. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
9. Mathematical Methods in Physical Sciences, M.L.Boas, Wiley.

CLUSTER UNIVERSITY SRINAGAR

SYLLABUS- SEMESTER 1^{st} (CBCS) - INTEGREATED M.SC PHYSICS
CORE COURSE - LAB

TITLE: **MATHEMATICAL PHYSICS -I LAB**

COURSE CODE: IGPHY18-C102 **CREDITS**: 02
Total Marks: 28 + 2 Marks **Contact Hours**: 64 hrs

Objective: *The emphasis of course is on applications of programming language in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.*
Course Outcomes: *At the end of the course, the students shall be able to write programs in C++ with arithmetic and logical operations, the if ... else statements shall allow students to write programs with decisions.*

UNIT I

Introduction to programming in C++: Simple Programs,The Output Operator, Characters And String Literals, String Length, Comments, Variables, Objects, And Their Declarations Keywords And Identifiers, Initializing In The Declaration, Chained Assignments, The Semicolon, Program Style, Integer Types, Simple Arithmetic Operators, Operator Precedence And Associativity, The Increment And Decrement Operators, Compound Assignment Expressions, Integer Overflow And Underflow, The Char Type

UNIT II

Conditional Statements and Integer Type: Input, The If Statement, The If.... else Statement, Relational Operators, Compound Statements, Keywords. Compound Conditions, Boolean Expressions, Nested Conditionals, The Switch Statement, The Conditional Expression Operator, Scope, Enumeration Types, Integer Type Conversions.

Reference Books:

1. Schaum's Outline of Theory and Problems of Programming with C++ John R. Hubbard,
2. C++ How to Program , P. Deitel & H Deitel, Prentice Hall
3. Ivor Horton's Beginning ANSI C++: The Complete Language ,3e,Ivor Horton, A press Media, LLC

CLUSTER UNIVERSITY SRINAGAR

SYLLABUS- SEMESTER 1^{st} (CBCS) - INTEGREATED M.SC PHYSICS
CORE COURSE - THEORY

TITLE: **MECHANICS**

COURSE CODE: IGPHY18-C103 **CREDITS**: 04
Total Marks: 56 + (4) Marks **Contact Hours**: 64 hrs

Objective: *The purpose of this course is to train the students in the Newtonian mechanics. The subject is treated from scratch and all translational, rotational and vibrational motion are discussed based on the approach of Newtonian theory.*
Course Outcomes: *On completion of the course, students will be able to understand the concept of co-ordinate systems, frame of reference, concept of Galilean transformation Coriolis force, non-inertial systems, dynamics of rotational bodies, central force motion, moment of inertia, centre and lab frame of reference .Students shall be also able to understand the concept of SHM, damped oscillation and forced oscillation.*

UNIT I

Coordinate Systems: Unit vectors, displacement, velocity, acceleration, area and volume elements in Cartesian, Spherical Polar and Cylindrical coordinate systems, Plane polar coordinates, Solid angle. Frames of Reference: Inertial and non-inertial frames of reference, Galilean transformations, Galilean invariance, Uniformly rotating frame, Coriolis force and centrifugal forces, Effect of coriolis force due to rotation of the earth, Coriolis force on a freely falling body, Geographical effects of coriolis force.

UNIT II

Rotational Dynamics: Translatory and rotatory motion, Angular momentum of a particle and system of particles, Torque, Principle of conservation of angular momentum, Rotation about a fixed axis, Kinetic energy of rotation, Moment of inertia, Theorems of parallel and perpendicular axes, Calculation of moment of inertia for (i) Thin rectangular lamina (ii) Circular disc (iii) Solid cylinder and (iv) Sphere, Gyroscope.

UNIT III

Collision of Particles: Concept of centre of mass, Elastic collision in laboratory and centre of mass systems, Relationship between displacement, velocities, kinetic energies and angles in lab and centre of mass system. Motion Under a Central Force: Concept of central and non-central forces, Equivalent one body problem, Angular momentum conservation in a central force field, motion in a plane, Energy of reduced mass and its conservation, Differential equation of the orbit, turning points of motion, Relation between eccentricity and energy, Kepler's laws, Satellite motion, Geosynchronous orbits, Weightlessness, Basic idea of global positioning system.

UNIT IV

Oscillations: Simple harmonic motion, Differential equation of SHM and its solution, Kinetic energy and potential energy of a simple harmonic oscillator, Examples of SHM: compound pendulum, torsional pendulum, bifilar oscillations, LC circuit, oscillations of two masses connected by a spring.
Damped oscillations: Differential equation of damped harmonic oscillator and its solution, Logarithmic decrement, Energy of damped oscillator, Power dissipation, Quality factor, Relaxation time, Forced oscillations: Transient and steady state behaviour, Resonance.

Reference Books:

1. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. AddisonWesley
2. Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
3. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley.
4. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn. 2015, Oxford University Press
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
6. Physics of Vibrations and Waves, H.J.Pain, Wiley.
7. Physics of Waves and Oscillations, N.K.Bajaj, Tata McGraw Hill

CLUSTER UNIVERSITY SRINAGAR

SYLLABUS- SEMESTER 1^{st} (CBCS) - INTEGREATED M.SC PHYSICS
CORE COURSE - LAB

TITLE: **MECHANICS LAB**

COURSE CODE: IGPHY18-C104 **CREDITS**: 02
Total Marks: 28 + 2 Marks . **Contact Hours**: 64 hrs

Objective: *This laboratory content compliments the theoretical course of Mechanics and hence, gives hands-on experience. Also, it provides the observational understanding of the subject.*
Instructions for Internal Assessment/External Examination: The student is supposed to have at least four experiments in this course.
List of Experiments:

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Moment of Inertia of a body using bifilar suspension method.
5. To determine the Young's Modulus of a Wire by Optical Lever Method.
6. To determine Young's Modulus of a rectangular bar by method of bending.
7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
8. To determine the Elastic Constants of a Wire by Searle's method.
9. To determine g by Bar Pendulum.
10. To determine g by Katter's Pendulum.
11. To determine g and velocity for a freely falling body using Digital Timing Technique
12. To study the Motion of a spring and calculate (a) Spring Constant (b) Value of g.

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
4. A Text Book of Practical Physics, InduPrakash and Ramakrishna, 11th Edition, 2011, KitabMahal, New Delhi.

CLUSTER UNIVERSITY SRINAGAR

SYLLABUS- SEMESTER 1^{st} (CBCS) - INTEGREATED M.SC PHYSICS
GENERIC ELECTIVE COURSE - THEORY

TITLE: **MECHANICS GE (THEORY)**

COURSE CODE: IGPHY18-G101 **CREDITS**: 04
Total Marks: 56 + (4) Marks **Contact Hours**: 64 hrs

Objective: *The purpose of this course is to train the students by applying the Newtonian mechanics to understand the concepts of momentum and energy in detail, besides the concepts in oscillations and elasticity. The subject is treated with a necessary mathematical background and motion of translational and vibrational type are discussed with an introduction to physical properties of materials.*
Course Outcomes:*On completion of the course, students will be able to understand how to use vector calculus and differential equations in the study of mechanics. In addition to this they will learn about the concepts of co-ordinate systems, frame of reference, Galilean transformation Coriolis force, non-inertial systems, dynamics of rotational bodies, central force motion, moment of inertia, centre and lab frame of reference . Students will be further using the necessary mathematical skills learnt in first unit and concepts of Newtonian mechanics to SHM, damped oscillation and forced oscillation besides concepts of elasticity.*

UNIT I

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **Ordinary Differential Equations:** 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

UNIT II

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. 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.

UNIT III

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.
Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

UNIT IV

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 - q, η and σ by Searles method.

Reference Books:

1. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. AddisonWesley
2. Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
3. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley.
4. Engineering Mechanics, Basudeb Bhattacharya, 2ndedn. 2015, Oxford University Press

CLUSTER UNIVERSITY SRINAGAR

SYLLABUS- SEMESTER 1^{st} (CBCS) - INTEGREATED M.SC PHYSICS
GENERAL ELECTIVE COURSE - LAB

TITLE: **MECHANICS GE LAB**

COURSE CODE: IGPHY18-G102 **CREDITS**: 02
Total Marks: 28 + 2 Marks . **Contact Hours**: 64 hrs

Objective: *This laboratory content compliments the theoretical course of Mechanics and hence, gives hands-on experience. Also, it provides the observational understanding of the subject.*
Instructions for Internal Assessment/External Examination: The student is supposed to have at least three experiments in this course.
List of Experiments:

1. Measurements of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11 th Edition, 2011, Kitab Mahal, New Delhi.