UNIVERSITY OF GOUR BANGA

(Established Under West Bengal Act XXVI Of 2007)

SYLLABUS

For

B.Sc. Physics Programme

Under NEP,2020

(Draft)

2023

Details Syllabi for Major Core Courses

Semester-I:

Paper: MC1- Mathematical Physics-I

Mathematical Physics-I (Theory): MC1T
Credit-3

Number of Lectures-54

1. Calculus:

   (a) 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.

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

2. Vector Calculus:

   (a) Preliminaries of Vector: Vector addition. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

   (b) 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.

   (c) 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 proofs)

3. Orthogonal Curvilinear Coordinates:

   Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

4. 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.

Referred Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- Mathematical Methods in the Physical Sciences, M. L. Boas, 3ed, 2006 Wiley
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press

Mathematical Physics-I (Practical):MC1P

Credit-1

Number of Lectures-36

1. Introduction to programming in python:

(a) Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, file handling, iterables, compound statements, indentation in python, the if-else block, for and while loops, nested compound statements.

(b) Elementary calculations with different type of data e.g., area and volume of regular shapes using formulae. Creation and handling of one and two dimensional arrays, sum and average of a list of numbers stored in an array, finding the largest and lowest number from a list, simple calculation of matrices e.g., addition, subtraction, multiplication. Introduction to three dimensional array.

Note: *Students need to execute simple python programs on the topics listed above.*

2. Introduction to plotting graphs with *Matplotlib*. Basic 2D graph plotting of functions and data files.

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Learning with Python-how to think like a computer scientist, J. Elkner, C. Meyer, and A. Downey, 2015, Dreamtech Press.
- Introduction to computation and programming using Python, J. Guttag, 2013, Prentice Hall India.
- Effective Computation in Physics- Field guide to research with Python, A. Scopatz and K.D. Hu , 2015, O'Rielly 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 Computational Physics, Darren Walker, 1st Edn., 2015, Scientic International Pvt. Ltd.

Paper: MC2- Mechanics

Mechanics (Theory): MC2T
Credit-3

Number of Lectures-54

1. **Fundamentals of Dynamics**
   (a) Review of Newtonian Dynamics: Dynamics of a single particle. Concepts of Inertial frames. Solution of the equations of motion (E.O.M.) in simple force fields. Motion of rockets. Variable mass problem & Rocket motion.
   (b) Work and energy: Conservation of energy with examples. Conservative Forces: Force as the gradient of a scalar field - concept of Potential Energy. Qualitative study of one dimensional motion from potential energy curve. Stable and unstable equilibrium. Other equivalent definitions of a conservative Force.
2. **Dynamics of System of particle:**

   (a) Dynamics of systems of particles: Difficulty of solving the E.O.M. for systems of particles. External and Internal forces. Momentum and Angular Momentum of a system. Torque acting on a system. Conservation of Linear and Angular Momentum. Centre of mass and its properties. Two-body problem.

   (b) Energy of a system of particles.

3. **Gravitation and Central Force:**
   (a) Central force. Reduction of the two-body central force problem to a one-body problem. Setting up the E.O.M. in plane polar coordinates.

   (b) Newton's Law of Gravitation. Gravitational potential energy. Potential and field due to spherical shell and solid sphere. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Inertial and gravitational mass. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness.

   (c) Kepler's Laws. Differential equation for the path of planetary motion.

4. **Non-Inertial Systems**

   (a) Galilean transformations and Galilean invariance.

   (b) Non-inertial frames and idea of fictitious forces. E.O.M with respect to a uniformly accelerating frame. E.O.M with respect to a uniformly rotating frame - Centrifugal and Corioli's forces. Foucault's pendulum.

5. **Rotational Dynamics**

   (a) The Rigid Body: Constraints defining the rigid body. Degrees of freedom for a rigid body;

   (b) Rotational motion about an axis, Relation between torque and angular momentum, Rotational energy, Moment of inertia (M.I): M.I of a rectangular lamina, disc solid cylinders etc. Flywheel, Theory of compound pendulum and determination of g.

   (c) Principal axes transformation. Transformation to a body fixed frame. E.O.M for the rigid body with one point fixed (Euler's equations of motion).

6. **Elasticity**
   (a) 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.
   (b) Beams, bending of beams, internal bending moment, cantilever, torsion of a cylinder, strain energy, elasticity in liquid and gas**.**

Referred Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw- Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education

- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. 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

Mechanics (Practical): MC2P

Credit-1

Number of Lectures-36

List of Experiments

1. To determine the height of a building using a Sextant.
2. To study the Motion of Spring and calculate, (a) Spring constant and (b) g.
3. To determine the Moment of Inertia of a regular shaped body.
4. To determine the Young's Modulus of the material of a beam the Method of Flexure.
5. To determine the Modulus of Rigidity of the material of a Wire by Statical method.
6. To determine the Young's modulus of the material of a wire by Searle's method.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum

General Topic

1. Discussion on random errors in observations.

2. Measurements of length (or diameter) using slide calipers, screw gauge and travelling microscope.

Referred Books:

- 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.
- Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Detailed Syllabi for Minor Core Courses

Paper: MnC1-Mechanics

Mechanics (Theory): MnC1T
Credits: 3

Number of Lectures-54

1. Mathematical Methods

(a) Vector Algebra: Vectors as directed line segments. Addition of vectors and multiplication by a scalar. Scalar and vector products. Basis and representation of vectors.

(b) Vector Analysis: Derivatives of a vector with respect to a parameter. Gradient, divergence and Curl. Vector integration, line, surface and volume integrals of vector fields. Gauss'-divergence theorem and Stoke's theorem of vectors (Statement only).

2. Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Conservation of momentum. Centre of Mass.

3. Work and Energy: Work-energy theorem. Conservative forces. Concept of Potential Energy. Conservation of energy.

4. Gravitation: Motion of a particle in a central force field. Conservation of angular momentum leading to restriction of the motion to a plane and constancy of areal velocity. Newton's Law of Gravitation. Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness.

5. Rotational Motion: Rotation of a rigid body about a fixed axis. Angular velocity and angular momentum. Moment of Inertia. Torque. Conservation of angular momentum.

6. Elasticity

(a) 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.

(b) Beams, bending of beams, internal bending moment, cantilever, torsion of a cylinder, strain energy, elasticity in liquid and gas**.**

7. Surface Tension

Synclastic and anticlastic surface. Excess of pressure - Application to spherical drops and bubbles - variation of surface tension with temperature.

8. Viscosity

Newton’s law of viscosity, Rate of liquid flow in a capillary tube - Poiseuille's formula.

Referred Books:

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison- Wesley

- Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw- Hill.
- Physics - Resnick, Halliday & Walker 9/e, 2010, Wiley.
- Engineering Mechanics, Basudeb Bhattacharya, 2 nd edn., 2015, Oxford University Press.
- Physics for Degree Students (For B.Sc. 1st Year); C.L. Arora & P.S. Hemme; S.Chand Publishing.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Mechanics (Practical): MnC-1P **Credits: 1**

Total Lecture-36

1. To determine the Moment of Inertia of a metallic cylinder/rectangular bar about an axis passing through its centre of gravity.
2. To determine the Young's Modulus of the material of a beam by the method of Flexure.
3. To determine the Modulus of Rigidity of the material of a Wire by Statical method.
4. To determine the Young's modulus of the material of a Wire by Searle's method.
5. To determine g by Bar Pendulum.
6. To determine g by Kater's Pendulum.
7. To study the Motion of a Spring and calculate (a) Spring Constant and (b) g.

Referred Books:

- 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
- Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Detailed Syllabi for Skill Enhancement Courses

Paper: SEC1-Basics of Programming, Plotting and Scientific Writing

Credits: 3

Number of Lectures: 54

1. Elements of Programming
   (a) An overview computers: History of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language.
   (b) Algorithms and Flowcharts:
      i. Algorithm - definition, properties and development.
      ii. Flowchart - Concept of flowchart, symbols, guidelines, types.

2. Basic programming in Python

(a) Application of user-defined Functions.

(b) Sorting of numbers in an array using bubble sort, insertion sort method. Calculation of term value in a series and finding the other terms with a seed (value of particular term) and calculation of different quantities with series. Convergence and accuracy of series.

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

3. Visualization

(a) Introduction to Gnuplot. Importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.

4. Scientific writing in LaTeX:

(a) Introduction to LaTeX TeX/LaTeX word processor, preparing a basic LaTeX document classes, Preparing an input for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages.

(b) Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents Bibliography and citation, Making an index and glossary, List making environments,

(c) Fonts, Picture environment and colours, errors.

Note: *Students need to execute simple python programs on the topics listed above.*

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi(1999)
- V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India, 1980.
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010).
- LaTeX A Document Preparation System , Leslie Lamport (Second Edi- tion, Addison- Wesley, 1994).