UNIVERSITY OF GOUR BANGA

Undergraduate **PHYSICS** syllabus

(As per NEP-2020 guidelines)

With effect from the academic session 2023-2024

Proposed Course Structure for 4 Year Bachelor Programme in Physics (up to Sem-IV)

Semester	Major Core	Multidisciplinary (MDC)	Minor Core	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Apprentice-ship/ Project/ Community outreach	Value addition Course (VAC)	Total Credits
Sem-I	**MC-1** (4) Mathematical Physics - I	**MDC-1** (3) Physics for Everyone *(not for Physics major students)*	**MnC-1** (4) Mechanics	MIL-1 (2)	**SEC-1** (3) Basics of Programming		ENVS (2)	22
	MC-2 (4) Mechanics							
Sem-II	**MC-3** (4) Electricity and Magnetism			MIL-2 (2)	**SEC-2** (3) Scientific Word Processing and Presentation	IAPC Internship/ Apprentice-ship/ Project/ Community outreach (2)* (optional)	Choose from a pool of courses (2)	22 +2*
	MC-4 (4) Optics							
			Students on exit shall be awarded Undergraduate Certificate (in the Field of Study/Discipline) after securing the requisite 44 +2*= 46 credits in Semesters I and II after completion of Summer Internship (2)(optional)*					
Sem-III	**MC-5** (4) Mathematical Physics- II and Acoustics		**MnC-2** (4) Electricity and Magnetism	English Language-1 (2)	**SEC-3** (3) Renewal Energy and Energy Harvesting			20
	MC-6 (4) Thermal Physics							
Sem-IV	**MC-7** (4) Thermal Physics– II and Statistical Mechanics			English Laguage-2 (2)		IAPC Internship/ Apprentice-ship/ Project/ Community outreach (2) **		18 +2**
	MC-8 (4) Elements of Modern Physics							
	MC-9 (4) Digital Systems and Applications							
Students on exit shall be awarded Undergraduate Diploma (in the Field of Study / Discipline) after securing the requisite 84 credits in Semester IV after completion of Summer Internship (2) (either in Semester II* or in Semester IV) (Candidates already perused IAPC in Semester II, need not to pursue IAPC in Semester IV)**								

Details of

MAJOR CORE PAPERS

Distribution of marks for each paper

25(Theory) + 15(Practical) + 10(Internal Assessment) = 50(Total)

Semester - I

MC-1: Mathematical Physics - I

MC-1T: Theory
Credits - 3, Number of lectures - 48

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, 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.
- Vector analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, 2009, McGraw Hill Education Pvt. Ltd.
- Theory and problems of Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill Education Pvt. Ltd.
- 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.
- Mathematical Physics. B. Bhattacharyya, 2010, New Central Book Agency (P) Ltd.
- Mathematical Methods in the Physical Science. M. L. Boas, 2018. Willey.
- 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 and M.P.Hobson, 2011, Cambridge Univ. Press

MC-1P: Practical
Credit - 1

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 arrays.

2. **Graph Plotting:** Introduction to plotting graphs with Matplotlib. Basic 2D graph plotting using data file and functions.

Note: Students need to execute simple python programs and generate plots.

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.

- Scientific computing in python, 2nd Edn, A. K. Gupta, 2021, Techno World.
- 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.

MC-2: Mechanics

MC-2T: Theory
Credits - 3, Number of lectures - 48

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, Variable mass problem and 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 particles:**

   (a) Dynamics of systems of particles: Difficulty of solving the E.O.M. for systems of particles. External and internal forces. Torque acting on a system. Conservation of linear and angular momentum. Centre of mass of a system of particles and its properties.

   (b) Energy of a system of particles.

3. **Gravitation and Central Force:**

   (a) Newton's law of Gravitation. Gravitational potential energy. Potential and field due to spherical shell and solid sphere. Inertial and gravitational mass. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness.

   (b) 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. 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 of planetary motion and its application.

4. **Non-Inertial Systems:**

(a) Inertial frames of reference, Galilean transformations and Galilean invariance.

(b) Non-inertial frames of reference 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 Coriolis 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). Calculation of M.I of a rectangular lamina, disc, solid cylinder, Flywheel, etc. Theory of compound pendulum and determination of g.

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

6. **Elasticity:**

(a) Hooke's law - Stress-strain diagram. Elastic constants and relation between them. 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 of 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.
- Classical Mechanics, 3rd Edn, H. Goldstein, C. P. Poole, J. Safko, 2011. Pearson.
- Classical Mechanics, N. C. Rana, P. S. Joag, 2018, McGraw Hill Education Pvt. Ltd.

- Introduction to classical mechanics., R. G. Takwale & P. S. Purnik, 2016, McGraw Hill Education Pvt. Ltd.
- 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.
- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000 University Physics.

MC-2P: Practical
Credit - 1

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 Static method.
6. To determine the Modulus of Rigidity of the material of a Wire by dynamic method.
7. To determine the Young's modulus of the material of a wire by Searle's method.
8. To determine the value of g using Bar Pendulum.
9. 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 Edn, 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.
- Advanced practical physics, volume-1, B. Ghosh, K. G. Mazumder, 2009. Sreedhar Publishers.
- Advanced practical physics, volume-2, B. Ghosh, 2009. Sreedhar Publishers.
- Laboratory Manual of physics vol-1, M. Jana, 220. Books & Allied (P) Ltd.
- An advance course in practical physics, D. Chattopadhyay, P. C. Rakshit, 2009, New Central Book Agency (P) Ltd.

Semester - II

MC-3: Electricity and Magnetism

MC-3T: Theory
Credits - 3, Number of lectures - 48

1. **Electrostatics:**
   (a) Coulombs law and Principle of superposition leading to the definition of electrostatic field and field lines.
   (b) Divergence of an electrostatic field. Flux, Gauss's theorem of electrostatics. Applications of Gauss theorem to determine electric field due to charge configurations with spherical, cylindrical and planar symmetry.
   (c) Curl of an electrostatic field and its conservative nature. Electric potential. Potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.
   (d) Laplace's and Poisson equations. Uniqueness theorem. Method of Images and its application to: Point charge in front of an earthed conducting (i) infinite plane and (ii) sphere.
   (e) Conductors: Electric field and charge density inside and on the surface of a conductor. Conductors in an electrostatic field. Force per unit area on the surface. Capacitance of a conductor. Capacitance an isolated spherical conductor.
   (f) Electrostatic energy of system of charges. Electrostatic energy of a charged sphere.
   (g) Energy per unit volume in electrostatic field.
2. **Dielectric properties of matter:**
   (a) Electric potential and field due to an electric dipole. Electric dipole moment. Force and torque on a dipole.
   (b) Electric fields inside matter: Electric Polarization. Bound charges. Displacement vector. Relations between E, P and D. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric Susceptibility and Permittivity. Capacitor (parallel plate, spherical, cylindrical) with dielectric.

3. **Magnetostatics:**

   (a) Biot-Savart's law. Force on a moving point charge due to a magnetic field: Lorentz force law. Application of Biot-Savart's law to determine the magnetic field of a straight conductor, circular coil. Force between two straight current carrying wires.

   (b) Divergence of the magnetic field - its solenoidal nature. Magnetic vector potential.

   (c) Curl of the magnetic field. Ampere's circuital law and its application to

      i. Infinite straight wire

      ii. Infinite planar surface current

      iii. Solenoid

4. **Magnetic properties of matter:**

   (a) Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole in a uniform magnetic field.

   (b) Magnetization. Bound currents. The magnetic intensity - H. Relation between B, H and M. Linear media. Magnetic Susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials. B-H curve and hysteresis.

5. **Electro-magnetic induction:**

   (a) Ohms law and definition of E.M.F. Faraday's laws of electromagnetic induction. Lenz's law. Self- Inductance and mutual inductance. Reciprocity theorem. Introduction to Maxwell's equations. Charge conservation. Displacement current and equation of Continuity.

   (b) Energy stored in a magnetic field.

6. **Electrical circuits:** AC circuits: Kirchhoff's laws for AC circuits. Complex reactance and impedance. Series LCR circuit: (i) Resonance, (i) Power dissipation (iii) Quality factor, and (iv) Band width. Parallel LCR circuit.

7. **Network theorems:** Ideal constant voltage and constant current sources. Thevenin's theorem. Norton's theorem. Superposition

theorem. Reciprocity theorem. Maximum power Transfer theorem and their applications to dc circuits.

Referred books

- Introduction to Electrodynamics, D.J. Grifiths, 3rd Edn., 1998, Benjamin Cummings.
- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill.
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
- Feynman Lectures Vol.2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, D. Chattopadhyay and P. C. Rakshit, New Central Book Agency, 2011.
- Foundation of electricity and magnetsm, B. Ghosh, 2010. Books & allied (P) Ltd.
- Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

MC-3P: Practical
Credit - 1

List of Experiments:

1. To determine an unknown Low Resistance using Carey Foster's Bridge.
2. To verify the Thevenin's and Norton's theorems.
3. To verify the Maximum power transfer theorems.
4. To determine self-inductance of a coil by Anderson's bridge.

5. To study I -V characteristics of a series RC circuit with AC source.
6. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Band width, and (c) Quality factor.
7. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor.

Referred books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.
- Advanced practical physics, volume-I, B. Ghosh, K. G. Mazumder, 2009. Sreedhar Publishers.
- Advanced practical physics, volume-II, B. Ghosh, 2009. Sreedhar Publishers.
- Laboratory Manual of physics vol-I, M. Jana, 220. Books & Allied (P) Ltd.
- An advance course in practical physics, D. Chattopadhyay, P. C. Rakshit, 2009, New Central Book Agency (P) Ltd.

MC-4: Optics

MC-4T: Theory
Credits - 3, Number of lectures - 48

1. **Fermat's principle:** Application of Fermat's principle to reflection and refraction at plane and curved boundaries. Cardinal points of an optical system. Thick lens. Two thin lenses separated by a distance. Equivalent lens. Different types of magnification. Helmholtz - Lagrange equation. Paraxial approximation (matrix methods may be used).

2. **Optical Instruments:** Field of view of optical instruments. Ramsden and Huygens eyepieces. Construction of high power immersion objectives. Telescope and microscope.

3. **Dispersion:** Dispersive power of optical instruments. Dispersive power of prism. Chromatic aberration –methods of reduction, achromatic lens combination. Seidel aberrations (Only qualitative discussions), methods of reducing them.

4. **Wave optics:** Wave nature of light. Wave front. Huygens Principle. Temporal and spatial coherence.

5. **Interference:** Coherent sources. Conditions for observing interference. Young's double slit experiment. Division of amplitude and wave front. Lloyd's Mirror and Fresnel's Bi-prism. Measurement of thickness of a thin film by Fresnel biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge- shaped films. Fringes of equal inclination (Haidinger fringes). Fringes of equal thickness (Fizeau fringes). Newton's rings: Measurement of wavelength and refractive index.

6. **Interferometers:**

   (a) Michelson Interferometer: Idea of form of fringes (No theory required). Application of Michelson Interferometer: Determination of wavelength, Wavelength Difference, Refractive Index.

   (b) Fabry-Perot interferometer: Working principle, construction and uses.

7. **Diffraction:**

   (a) Fraunhofer diffraction: Single slit. Double slit. Plane diffraction grating. Diffraction in a circular aperture.

   (b) Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Use of zone plate.

   (c) Resolving Power of optical instruments: Rayleigh criterion, resolving power of prism, telescope, microscope, grating.

Referred books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw- Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill.
- A text on light. B. Ghosh & K. G. Mazumdar, 2006. Sreedhar Publishers.
- Optics, 4th Edn., Eugene Hecht, Pearson Education Limited, 2014.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.
- A textbook of Optics; N Subramanyam, B. Lal and M.N. Avadhanulu; S.Chand. Publishing.

MC-4P: Practical
Credit - 1

List of Experiments:

1. Familiarization with: Schuster's focusing; determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine the wavelength of sodium source using Michelson's interferometer.
5. To determine wavelength of sodium light using Fresnel bi-prism.
6. To determine wavelength of sodium light using Newton's rings.
7. To determine wavelength of (i) Na source and (ii) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffraction grating.

General Topic: In the practical classes, students should be thoroughly familiarized with Schuster's focusing for their general proficiency with spectrometers.

Referred books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson, and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

- Advanced practical physics, volume-I, B. Ghosh, K. G. Mazumder, 2009. Sreedhar Publishers.
- Advanced practical physics, volume-II, B. Ghosh, 2009. Sreedhar Publishers.
- Laboratory Manual of physics vol-I, M. Jana, 220. Books & Allied (P) Ltd.
- An advance course in practical physics, D. Chattopadhyay, P. C. Rakshit, 2009, New Central Book Agency (P) Ltd.

Semester - III

MC-5: Mathematical Physics-II and Acoustics

MC-5T: Theory
Credits - 3, Number of lectures - 48

1. **Partial Differential Equations:** Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical, and spherical symmetry. Wave equation and its solution for rectangular membrane. Diffusion Equation.

2. **Fourier Series:** Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions.

3. **Oscillations:** Simple Harmonic Motion (SHM). 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.

4. **Superposition of Harmonic Oscillations:**

   (a) Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (i) equal frequencies and (ii) different frequencies (beats). Superposition of N collinear Harmonic Oscillations with (i) equal phase differences and (ii) equal frequency differences.

   (b) Superposition of two perpendicular Harmonic Oscillations: Graphical and analytical methods. Lissajous figures with equal an unequal frequency and their uses.

5. **Wave motion:**

(a) Plane and spherical waves. Longitudinal and transverse waves. Plane progressive (traveling) waves. Wave equation. Particle and wave velocities. Differential equation. Pressure of a longitudinal wave. Energy transport. Intensity of wave.

(b) Water Waves: Ripple and gravity waves.

6. **Velocity of Waves:**

   (a) Velocity of transverse vibrations along a stretched string.

   (b) Velocity of longitudinal waves in a fluid within a pipe. Newton's formula for velocity of sound. Laplace's correction.

7. **Superposition of Harmonic Waves:**

   (a) Standing (Stationary) waves in a string: Fixed and free ends. Analytical treatment. Changes with respect to position and time. Energy of vibrating string. Transfer of energy. Normal modes of stretched strings. Plucked and struck strings. Melde's experiment.

   (b) Longitudinal standing waves and normal modes. Open and closed pipes.

   (c) Superposition of N harmonic waves. Phase and group velocities.

8. **Doppler Effect:** Calculation of Doppler shift, Doppler effect and stationary waves.

9. **Ultrasonics & Building Acoustics:** Ultrasonics – basic principles of generation, detection (no technical details) and application. Requirements of a good auditorium. Reverberation. Sabine's formula for reverberation time. Reverberation time in dead room. Absorption coefficient and its measurement.

Referred books

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books.
- Principles of acoustics. B. Ghosh, 2010, Sreedhar Publishers.
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

MC-5P: Practical
Credit - 1

List of Experiments:

1. determine the frequency of an electrically maintained tuning fork by Melde's experiment.
2. To verify $\lambda^2 - T$ law by Melde's experiment.
3. To investigate the motion of coupled oscillators.
4. To verify the laws of transverse vibration in a string using sonometer.
5. To determine (i) the density of the material of a wire using sonometer (ii) the speed of transverse waves in the wire of the sonometer.
6. To study the Lissajous figures formed by superposition of two mutually perpendicular simple harmonic oscillations using CRO.

Referred books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson, and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.
- Advanced practical physics, volume-I, B. Ghosh, K. G. Mazumder, 2009. Sreedhar Publishers.
- Advanced practical physics, volume-II, B. Ghosh, 2009. Sreedhar Publishers.
- Laboratory Manual of physics vol-I, M. Jana, 220. Books & Allied (P) Ltd.
- An advance course in practical physics, D. Chattopadhyay, P. C. Rakshit, 2009, New Central Book Agency (P) Ltd.

MC-6: Thermal Physics-I

MC-6T: Theory
Credits - 3, Number of lectures - 48

1. **Kinetic Theory of Gases-I:** Distribution of velocities: Maxwell-Boltzmann law of distribution of velocities in an ideal gas and its experimental verification. Mean, RMS and most probable speeds. Degrees of freedom. Law of equipartition of energy (no proof required). Specific heats of gases.

2. **Conduction of Heat:** Thermal conductivity. Diffusivity. Fourier's equation for heat conduction and its solution for rectilinear flow of heat.

3. **Introduction to Thermodynamics:**

   (a) Zeroth and First law of Thermodynamics: Extensive and intensive thermodynamic variables. Thermodynamic equilibrium. Zeroth law of Thermodynamics & concept of temperature. Concept of work & heat. State functions. Internal energy and First law of Thermodynamics. Its differential form. First law & various processes. Applications of first law: General relation between C_P and C_V, Work done during isothermal and adiabatic processes. Compressibility and expansion co-efficient.

   (b) Second law of Thermodynamics: Reversible and irreversible process with examples. Conversion of work into heat and heat into work. Heat engines. Carnot's cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, Second law of Thermodynamics: Kelvin-Planck and Clausius statements and their equivalence.

   (c) Carnot's theorem. Applications of Second law of Thermodynamics. Thermodynamic scale of temperature and its equivalence to perfect gas scale.

   (d) Entropy: Concept of entropy. Clausius theorem. Clausius inequality, Second law of Thermodynamics in terms of entropy.

Entropy of a perfect gas. Principle of increase of entropy. Entropy changes in reversible and irreversible processes with examples. Entropy of the universe. Third law of Thermodynamics. Unattainability of absolute zero.

4. **Thermodynamic Potentials:**

   (a) Thermodynamic Potentials: Internal energy. Enthalpy. Helmholtz free energy. Gibb's free energy. Their definitions, properties and applications. Surface films and variation of surface tension with temperature. Magnetic work. Cooling due to adiabatic demagnetization. First and second order phase transitions with examples, Clausius-Clapeyron equation and Ehrenfest equations.

   (b) Maxwell's Thermodynamic Relations. Derivations and applications of Maxwell's relations. Determination of the following using Maxwell's relations: (i) Clausius Clapeyron equation (ii) values of $C_p - C_v$, (iii) $T - dS$ equations (iv) Joule-Kelvin coefficient for ideal and Van der Waal gases (v) Energy equations (vi) Change of temperature during adiabatic process.

Referred books

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw- Hill.
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw- Hill.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermal physics (heat & thermodynamics), A. B. Gupta, H. P. Roy, 2009, Books and allied (P) Ltd.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Edn., 2012, Oxford University Press.
- Thermodynamics and an introduction to thermo statistics, H. B. Callen, 1985, Wiley.

- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

MC-6P: Practical
Credit - 1

List of Experiments:

1. To determine mechanical equivalent of heat J by Callender and Barne's constant flow method.
2. To determine the coefficient of thermal conductivity of glass in the form of tube.
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
4. To determine the temperature coefficient of resistance by platinum resistance thermometer (PRT).
5. To study the variation of thermo-emf of a thermocouple with difference of temperature at its two junctions.
6. To calibrate a thermocouple to measure temperature in a specified range using null method to determine neutral temperature

Referred books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

- Advanced practical physics, volume-I, B. Ghosh, K. G. Mazumder, 2009. Sreedhar Publishers.
- Advanced practical physics, volume-II, B. Ghosh, 2009. Sreedhar Publishers.
- Laboratory Manual of physics vol-I, M. Jana, 220. Books & Allied (P) Ltd.
- An advance course in practical physics, D. Chattopadhyay, P. C. Rakshit, 2009, New Central Book Agency (P) Ltd.

Semester - IV

MC-7: Thermal Physics-II and Statistical Mechanics

MC-7T: Theory
Credits - 3, Number of lectures - 48

1. **Kinetic Theory of Gases-II:**

   (a) Molecular Collisions: Mean free path. Collision probability. Estimates of mean free path. Transport phenomenon in ideal gases: (i) Viscosity (ii) Thermal conductivity and (iii) Diffusion. Brownian motion and its significance.

   (b) Real Gases: Behaviour of real gases. Deviations from the ideal gas equation. The virial equation. Andrew's experiments on CO2 gas. Critical constants. Continuity of liquid and gaseous state. Vapour and gas. Boyle temperature. Van der Waal's equation of state for real gases. Values of critical constants. Law of corresponding states. Comparison with experimental curves. P-V diagrams. Joule's experiment. Free adiabatic expansion of a perfect gas. Joule-Thomson porous plug experiment. Joule- Thomson effect for real and Van der Waal gases. Temperature of inversion.

2. **Classical Statistical Mechanics:**

   (a) Macrostate & Microstate. Elementary concept of ensemble and ergodic hypothesis. Phase space.

   (b) Microcanonical ensemble, Postulate of equal a-priori probabilities. Boltzmann hypothesis: Entropy and thermodynamic probability.

   (c) Canonical ensemble. Partition function. Thermodynamic functions of an ideal gas. Classical entropy expression. Gibbs paradox.

   (d) Maxwell-Boltzmann distribution law. Law of equipartition of energy (with proof)- Applications to specific heat and its limitations. Thermodynamic functions of a two-energy level system. Negative temperature.

(e) Grand canonical ensemble and chemical potential.

3. **Classical Theory of Radiation:** Properties of Thermal Radiation. Blackbody radiation. Pure temperature dependence. Kirchhoff's law. Radiation pressure.

4. **Bose-Einstein Statistics:** B-E distribution law. Thermodynamic functions of a strongly degenerate Bose gas, Bose-Einstein condensation. Properties of liquid He (qualitative description), Radiation as a photon gas and thermodynamic functions of photon gas. Bose derivation of Planck's law. Stefan-Boltzmann law. Wien's displacement law. Wien's distribution law. Rayleigh- Jean's law.

5. **Fermi-Dirac Statistics:** Fermi-Dirac distribution law. Thermodynamic functions of a completely and strongly degenerate Fermi gas, Fermi energy, Electron gas in a metal. Specific heat of metals.

Referred books

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed.,1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw- Hill.
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Fran- cis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Thermal physics (Heat & Thermodynamics), A. B. Gupta, H. P. Roy, 2009, Books & allied (P) Ltd.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.

- Fundamentals of statistical mechanics, B. B. Laud, 2018, New Age International Publishers.
- Statistical Mechanics: An elementary outline, A. Lahiri, 2008, Universities Press.

MC-7P: Practical
Credit - 1

List of Experiments:

1. Computational analysis of the behaviour of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
   (a) Study of local number density in the equilibrium state (i) average (ii) fluctuations.
   (b) Study of transient behaviour of the system (approach to equilibrium).
   (c) Relationship of large N and the arrow of time.
   (d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution.
   (e) Computation and study of mean molecular speed and its dependence on particle mass.
   (f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed.
2. Computation of the partition function $Z(\beta)$ for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi- Dirac, and Bose- Einstein statistics:
   (a) Study of how $Z(\beta)$, average energy $\langle E \rangle$, energy fluctuation ΔE, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.

(b) Ratios of occupation numbers of various states for the systems considered above.

(c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck's law for Black Body radiation and compare it with Raleigh- Jeans law at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law (b) Einstein distribution function (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures (a) Maxwell- Boltzmann distribution (b) Fermi-Dirac distribution (c) Bose-Einstein distribution.

Referred books

- Elementary Numerical Analysis, K.E.Atkinson, 3rd Edn . 2007, Wiley India Edition.
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Edn., 1996, Oxford University Press.
- Introduction to Modern Statistical Mechanics, D. Chandler, Oxford Uni- versity Press, 1987
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Scientific computing in python, A. K. Gupta, 2021, Techno World.
- Statistical and Thermal Physics with computer applications, HarveyGould and Jan Tobochnik, Princeton University Press, 2010.
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernandez. 2014 Springer ISBN: 978- 3319067896

MC-8: Elements of Modern Physics

MC-8T: Theory
Credits - 3, Number of lectures - 48

1. **Foundation of Quantum Mechanics:**

   (a) Blackbody Radiation, Planck's quantum, Planck's constant. Photo- electric effect and Compton scattering. Davisson-Germer experiment. De- Broglie wavelength and matter waves. Wave-particle duality. Wave description of particles by wave packets. Group and phase velocities and relation between them. Probability interpretation: Normalized wave functions as probability amplitudes.

   (b) Two-Slit experiment with photons and electrons. Linear superposition principle as a consequence.

   (c) Position measurement- gamma ray microscope thought experiment. Heisenberg- uncertainty principle (statement with illustrations). Impossibility of a particle following a trajectory.

   (d) Basics Postulates of quantum mechanics. Time dependent and time independent Schrodinger equations. Particle in a one dimensional infinite potential well.

2. **Atomic Physics:**

   (a) Determination of electronic charge: Millikan oil-drop method. Determination of e/m by Thompson's method. Discovery and properties of positive rays. Thomson's parabola method. Aston's mass spectrograph.

   (b) Bohr atom Model, Bohr's correspondence principle. Bohr Sommerfeld atomic model, Pauli exclusion principle. Qualitative discussions on quantum numbers. Franck & Hertz experiment, Stern –Gerlach experiment, Zeeman Effect, Paschen-Back effect, Stark effect.

3. **Nuclear Physics:**

   (a) Structure of the Nucleus: Size, mass, charge, spin of atomic nucleus and its relation with atomic weight. Impossibility of

an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph. Magic Number.

(b) Radioactivity: stability of the nucleus. Law of radioactive decay. Mean life and half-life. Alpha decay and beta decay (brief qualitative discussions). Energy released spectrum and Pauli's prediction of neutrino. Gamma ray emission. Energy- momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

(c) Fission and Fusion: Mass deficit, relativity, and generation of energy. Fission - nature of fragments and emission of neutrons. Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Referred books

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Atomic Physics, S. N. Ghoshal, 2011, S. Chand & Company Ltd.
- Nuclear Physics, S. N. Ghoshal, 2011, S. Chand & Company Ltd
- Primer of Quantum Mechanics; M. Chester; John Wiley & Sons, 1987.
- Introduction to Quantum Mechanics, David J. Griffiths, 2005, Pearson Education.
- Physics for Scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill.
- Modern atomic and nuclear physics. A. B. Gupta 2014. Books and allied (P) Ltd.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan Additional Books for Reference
- Modern Physics, J.R. Taylor, C.D. Za ratos, M.A. Dubson, 2004, PHI Learning.

- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Nuclear Physics; S.N.Ghosal; S. Chand Publishing.

MC-8P: Practical
Credit - 1

List of Experiments:

1. Measurement of Planck's constant using black body radiation and photo- detector.
2. Photo-electric effect: study photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
8. To determine the wavelength of laser source using diffraction of single slit.
9. To determine the wavelength of laser source using diffraction of double slits.

10. To determine (a) wavelength and (b) angular spread of He-Ne or any type of laser source using plane diffraction grating

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.
- Advanced practical physics, volume-I, B. Ghosh, K. G. Mazumder, 2009. Sreedhar Publishers.
- Advanced practical physics, volume-II, B. Ghosh, 2009. Sreedhar Publishers.
- Laboratory Manual of physics vol-I, M. Jana, 220. Books & Allied (P) Ltd.
- An advance course in practical physics, D. Chattopadhyay, P. C. Rakshit, 2009, New Central Book Agency (P) Ltd.

MC-9: Digital Systems and Applications

MC-9T: Theory
Credits - 3, Number of lectures - 48

1. **Digital Circuits:** Difference between analog and digital circuits. Binary numbers. Decimal to binary and binary to decimal conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT gates (realization using diodes and transistor). NAND and NOR gates as universal gates. XOR and XNOR gates and application as parity checkers.

2. **Boolean Algebra:** De Morgan's theorems. Boolean laws. Simplification of logic circuit using boolean algebra. Fundamental products. Idea of minterms and maxterms. Conversion of a truth table into equivalent logic circuit by (1) Sum of products method and (2) Karnaugh map.

3. **Data Processing Circuits:** Basic idea of Multiplexers. Demultiplexers. Decoders. Encoders.

4. **Circuits:** Arithmetic circuits: Binary addition. Binary subtraction using 2's complement. Half & full adders. Half & full Subtractors, 4-bit binary adder / subtractor. Sequential circuits: SR, D, and JK flip-fops. Clocked (level and edge triggered) flip-flops. Preset and clear operations. Race-around conditions in JK flip-flop. M/S JK flip-flop.

5. **Timers ICs:** IC 555: Block diagram and applications: A stable multivibrator and Mono-stable multivibrator.

6. **Shift Registers:** Serial-in-serial-out, Serial-in-parallel-out, Parallel-in-serial-out and Parallel-in- parallel-out shift registers (only up to 4 bits).

7. **Counters (4 bits):** Ring counter. Asynchronous counters, Decade counter. Synchronous counter.

8. **Computer Organization:** Input / Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory interfacing. Memory map.

Referred books

- Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw.
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press.
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning.
- Fundamental Principles of Electronics, B. Ghosh, 2014, Books and allied (P)Pvt. Ltd.
- lectronic Fundamentals and Applications, Chattopadhyay, P. C. Rakshit, 2015, New Age International (P) Ltd.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

MC-9P: Practical
Credit - 1

List of Experiments:

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To design a combinational logic system for a specified truth table.
3. To convert a Boolean expression into logic circuit and design it using logic gate ICs.

4. To minimize a given logic circuit.
5. Half Adder, Full Adder and 4-bit binary Adder.
6. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder IC.
7. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
8. To build JK Master-slave flip-flop using Flip-Flop ICs.
9. To build a 4-bit Counter using D-type / JK Flip-Flop ICs and study timing diagram.
10. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.

Referred books

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata Mc-Graw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Advanced practical physics, volume-I, B. Ghosh, K. G. Mazumder, 2009. Sreedhar Publishers.
- Advanced practical physics, volume-II, B. Ghosh, 2009. Sreedhar Publishers.
- Laboratory Manual of physics vol-I, M. Jana, 220. Books & Allied (P) Ltd.
- An advance course in practical physics, D. Chattopadhyay, P. C. Rakshit, 2009, New Central Book Agency (P) Ltd.

Details of

SKILL ENHANCEMENT COURSES

Distribution of marks for each paper

15(MCQ) + 25(Practical) + 10(Internal Assessment) = 50(Total)

Semester - I

SEC-1: Basics of Programming

Credits - 1 (MCQ) + 2 (Prac), Number of lectures - 32

1. **Elements of Programming:**
   (a) An overview computer: History of computers, overview of architecture of computer. Compiler. Assembler. Machine language. Programming language. High level language. Object-oriented 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 ending 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:** 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.

Mode of practical examination:
Students need to execute simple python programs and generate plots based on the syllabus.

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.
- Scientific computing in python, 2nd Edn, A. K. Gupta, 2021, Techno World.
- 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.

Semester - II

SEC-2: Scientific Word Processing and Presentation

Credits - 1 (MCQ) + 2 (Prac), Number of lectures - 32

1. **Word Processing:** Document creation. Saving. Editing. Formatting text and paragraphs. Header and footers. Clipart. Tables. Inserting images. Mail merge. Margins. Hyphenation. Page setups. Index and references. Comments. Templates. Print process.
2. **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.
3. **Spreadsheet:** Workbook. Worksheets. Cell. Address. Entering. Editing. Formatting. Filtering. Sorting worksheet data. Charts. Functions and formulas. Importing, exporting files. Filtering data and printing a presentation.
4. **Presentation:** Introduction to presentation using slides. Creating Templates-Fonts and color editing. Adding Multimedia effects. Formatting. Wizard, layout, word art, animation. Saving and printing a presentation.
5. **LaTeX:** Introduction to LaTeX. Preparing a basic LaTeX document classes and mathematical expressions.

Mode of practical examination:

Preparation and presentation of a project work.

Referred books

- 1. Office 2016 All-in-One For Dummies (Office All-in-One for Dummies) 1st Edition, Peter Weverka
- 2. LaTeX A Document Preparation System, Leslie Lamport (Second Edition, Addison- Wesley, 1994).

Semester - III

SEC-3: Renewable Energy and Energy Harvesting

Credits - 1 (MCQ) + 2 (Prac), Number of lectures - 32

1. **Fossil fuels and Alternate Sources of energy:** Fossil fuels and nuclear energy, their limitation. Need of renewable energy. Non-conventional energy sources. An overview of developments in ocean shore wind Energy. Tidal energy. Wave energy systems. Ocean thermal energy conversion. Solar energy. Biomass. Biochemical conversion. Biogas generation. Geothermal energy. Hydroelectricity.
2. **Solar energy:** Solar energy, its importance, storage of solar energy, solar pond, non- convective solar pond, applications of solar pond and solar energy, solar water heater, at plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.
3. **Wind Energy harvesting:** Fundamentals of Wind energy. Wind turbines and different electrical machines in wind turbines. Power electronic interfaces and grid interconnection topologies.
4. **Ocean Energy:** Ocean Energy. Potential against wind and solar. Wave characteristics and statistics. Wave energy devices. Tide characteristics and statistics. Tide energy technologies. Ocean thermal energy. Osmotic power. Ocean bio-mass.
5. **Geothermal Energy:** Geothermal Resources. Geothermal Technologies.
6. **Hydro Energy:** Hydropower resources, hydropower technologies, environmental impact of hydropower sources.

Mode of practical examination:

Preparation and presentation of a project work.

Referred books

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi.Solar energy - M P Agarwal - S Chand and Co. Ltd.
- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- Godfrey Boyle, Renewable Energy, Power for a sustainable future, 2004, Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009.
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

Details of

MINOR CORE PAPERS

Distribution of marks for each paper

25(Theory) + 15(Practical) + 10(Internal Assessment) = 50(Total)

Semester - I/II

MnC-1: Mechanics

MnC-1T: Theory
Credits - 3, Number of lectures - 48

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 orbits. 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 within a curved surface- 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. Reynold's number.

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.
- Snatok padarthabigyan, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- A Handbook of degree Physics, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- Sanatak Padarthavidya, Semester-1, D. Jana, S. K. Bera, S. Pal, 2021, Santra Publication.
- Snatikiyo Padarthavidya, Vol-1. A. Bhattacharjee, R. Bhattacharjee, 2018, New Central Book Agency.

MnC-1P: Practical
Credit - 1

List of Experiments:

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 static method.
4. To determine the Modulus of Rigidity of the material of a wire by dynamic method.
5. To determine the Young's modulus of the material of a wire by Searle's method.
6. To determine g by bar pendulum.
7. To determine g by Kater's pendulum.
8. 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.

- Parikhagare Padarthavidya (Practical Physics), S. das & M. das, 2021, Santra Publication.
- Snatok Baboharik Padarthabigyan, C. dasgupta, S. Maity, 2014, Books Syndicate Pvt. Ltd.
- Baboharik Padarthavidya, S. K. Ghosh, 2014. New Central Book Agency.

Semester - III/IV

MnC-2: Electricity and Magnetism

MnC-2T: Theory
Credits - 3, Number of lectures - 48

1. **Electrostatics:**

   (a) Coulombs law. Principle of superposition. Electrostatic field.

   (b) Divergence of an electrostatic field. Flux. Gauss's theorem of electrostatics. Applications of Gauss theorem to determine electric field due to- (i) point charge, (ii) infinite line of charge, (iii) uniformly charged spherical shell (iv) solid sphere, (v) plane charged sheet, and (vi) charged conductor.

   (c) Curl of an electrostatic field. Electric potential as line integral of electric field. Potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Electric potential and field due to an electric dipole. Electric dipole moment. Force and torque on a dipole.

   (d) Conductors: Electric field and charge density inside and on the surface of a conductor. Force per unit area on the surface. Capacitance of a conductor. Capacitance an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field.

   (e) Electric fields inside matter: Electric Polarization. Bound charges. Displacement vector. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric susceptibility and permittivity. Parallel plate capacitor completely filled with dielectric.

2. **Magnetism:**

   (a) Biot-Savart's law and the Lorentz force law. Application of Biot-Savart's law to determine the magnetic field due to: (i) a straight conductor, (ii) circular coil, and (iii) solenoid carrying current. Force between two straight current carrying wires.

   (b) Divergence of the magnetic field. Magnetic vector potential.

(c) Curl of the magnetic field. Ampere's circuital law. Determination of the magnetic field of a straight current carrying wire. Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole.

(d) Magnetic fields inside matter: Magnetization. Bound currents. The magnetic intensity - H. Linear media. Magnetic susceptibility and permeability. Brief introduction of dia-, para- and ferro-magnetic materials.

3. **Electromagnetic Induction:** Ohm's law and definition of E.M.F. Faraday's laws of electromagnetic induction. Lenz's law. Self inductance (L) of a coil, mutual inductance (M) of two coils. Energy stored in magnetic field.

4. **Linear Network:** Impedance of L, C, R and their combinations. Thevenin & Norton's theorem. Maximum power transfer theorem and superposition theorem. De Sauty's bridge.

Referred books

- Introduction to Electrodynamics, David J Griffiths 3rd Edn, 1998, Benjamin Cummings.
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks.
- Electricity and Magnetism; R.Murugeshan; S. Chand Publishing.
- Snatok padarthabigyan, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- A Handbook of degree Physics, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- Sanatak Padarthavidya, Semester-2, D. Jana, S. K. Bera, S. Pal, 2021, Santra Publication.

- Snatikiyo Padarthavidya, Vol-2. A. Bhattacharjee, R. Bhattacharjee, 2018, New Central Book Agency.

MnC-2P: Practical
Credit - 1

List of Experiments:

1. To compare capacitances using De Sauty's bridge.
2. To study the I-V Characteristics of a series RC circuit.
3. To study a series LCR circuit and determinants
   (a) Resonant frequency
   (b) Quality factor
4. To study a parallel LCR circuit and determine its:
   (a) Anti-resonant frequency and
   (b) Quality factor Q
5. To determine a Low Resistance by Carey Foster's Bridge.

Referred books

- Advanced Practical Physics for students, B.L.Flint & 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 Ed.2011, Kitab Mahal.
- Parikhagare Padarthavidya (Practical Physics), S. Das & M. Das, 2021, Santra Publication.
- Snatok Baboharik Padarthabigyan, C. Dasgupta, S. Maity, 2014, Books Syndicate Pvt. Ltd.
- Baboharik Padarthavidya, S. K. Ghosh, 2014. New Central Book Agency.

Details of

MULTIDISCIPLINARY COURSE

For the students with major subject other than Physics

Marks distribution

40 (Theory) + 10 (Internal Assessment) = 50 (Total)

Semester - I/II/III

MDC-1: Physics for Everyone

MDC-1T: Theory
Credits - 3, Number of lectures - 32

1. **Measurement, Units and Dimensions:** Importance of Measurement. Units of measurement. Types of Units – fundamental and derived. Fundamental units of SI system. Measurement of length, mass and time. Dimensions of physical quantities. Dimensional analysis.

2. **Kinematics and Laws of Motion:**

   (a) Scalars and vectors. Distance and displacement. Speed and velocity. Acceleration.

   (b) Different types of motion- Translational, rotational and oscillatory. Uniform and non uniform motion.

   (c) Newton's laws of Motion and their application. Inertia. Action and reaction. Conservation of linear momentum and its applications.

   (d) Uniform circular motion. Centripetal forces with examples.

   (e) Friction- static, kinetic, and rolling friction. Advantages and disadvantages of friction.

3. **Work, Power and Energy:** Work. Power. Kinetic energy. Potential energy. Conservation of energy. Conservative and dissipative forces.

4. **Waves, Optics and Acoustic:**

   (a) Concept of waves- frequency, wavelength, velocity, and amplitude.

   (b) Types of waves- Transverse including Electromagnetic waves. Longitudinal.

   (c) Electromagnetic spectrum. Reflection. Refraction. Interference and diffraction (Qualitative discussion only) and applications.

(d) Lenses and optical instruments, Human Eye. Defects of vision and correction.

(e) Sound waves, characteristics of sound waves, Pitch and Loudness, Echoes, Doppler Effect.

5. **Electricity and Magnetism:**

(a) Concept of charge, current, electric potential and electric field. Ohm's law. Electrical Power. DC and AC (quantitative discussion only). Electrical resistance. Capacitance. Inductance. Impedance. Series and parallel combination.

(b) Magnetism. Magnetic fields. Permanent and electromagnets.

(c) Concept of electromagnetic induction.

6. **Material Physics:**

(a) Concepts of conductors, insulators, semiconductors, and superconductors.

(b) Crystalline solids, amorphous solids. Liquid crystals.

7. **Modern Physics:**

(a) Structure of atoms. Electrons. Nucleus, protons and neutrons. Bohr's model of atoms. Absorption and emission of electromagnetic radiation by atoms. X-rays– origin and application.

(b) Radioactivity. Alpha, beta and gamma rays. Nuclear fission- and fusion.

(c) Introduction to particle physics- Classification of elementary particles. Quark concept.

All the above topics will be taught in a qualitative approach. The principles learned should be connected to natural phenomena for an illustrative understanding.

Referred books

- Mechanics Berkeley Physics, Vol.1: Charles Kittel et. al. 2007, Tata McGraw-Hill.
- Physics, vol 1 & 2 -David Halliday, Robert Resnick and Kenneth S Krane, Wiley.

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Undergraduate Physics Companion, Vol 1. S.Pal, 1st Edition 2022, Suhrid Prakashani, Kolkata.
- Concepts of Physics, H C Verma, Vol 1 & 2, Bharati Bhawan.
- New Simplified Physics, S L Arora, Dhanpat Rai & Co. Pvt. Ltd, Vol 1, 2020.
- Snatok padarthabigyan, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- A Handbook of degree Physics, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- Sanatak Padarthavidya, Semester-1, 2, 3, 4, D. Jana, S. K. Bera, S. Pal, 2021, Santra Publication.
- Snatikiyo Padarthavidya, Vol- 1 & 2. A. Bhattacharjee, R. Bhattacharjee, 2018, New Central Book Agency.