# NARAJOLE RAJ COLLEGE

*(NAAC Accredited 'B' Grade Govt. Aided College)*
*NARAJOLE: PASCHIM MEDINIPUR: WEST BENGAL: Pin-721211*
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# Course Outcome

## Physics (Hons.)

| Semester | I |
|---|---|
| Title of Course | Foundation of Physics – 1 (MJ-1) |
| Paper Code | MJ-1T (Theory) |
| Credits | 04 |
| Hours | 04 hours/week |

*The students of Physics (H) of Semester-I will acquire the knowledge about Unit – I: Preliminary Math. Methods and Unit – II: Introduction to Thermodynamics by studying this course. Unit – I: Preliminary Math. Methods contains Vector Analysis, Vector Integration, Orthogonal Curvilinear Coordinates, Analytic Functions, Differential Equation, Partial Differential Equation as course modules and Unit – II: Introduction to Thermodynamics contains Basics of Kinetic Theory, Thermodynamic Description of System, First Law of Thermodynamics, Second Law of Thermodynamics, Entropy, Third Law of Thermodynamics, Theory of Radiation as course modules.*

***The theory paper (MJ-1T) of this course (MJ-1) provides the student with-***

*Unit – I: Preliminary Math. Methods*

CO1: Fundamentals of vector algebra, gradient of scalars, divergence and curl of vector fields and their physical significance.

CO2: Physical concept of solenoidal and irrational vector, conservative vector field and scalar field, concept of vector potential and identities involving gradient, divergence and curl.

CO3: Concept and theory of ordinary integrals of vectors, multiple integrals, Jacobian.

CO4: Concept of line, surface and volume integrals of vector field along with solution of different mathematical problems on these topics.

CO5: Statements of Gauss' divergence theorem, Green's and Stokes Theorems and their applications in terms of different mathematical problems.

CO6: Concept of orthogonal curvilinear coordinates as well as mathematical derivation of gradient, divergence, curl and Laplacian

CO7: Description of Cartesian, spherical polar and cylindrical polar coordinate systems.

CO8: Definition of Analytic Function and illustration of Taylor's series and Maclaurin's series for functions of single variables.

CO9: Classification of differential equations with illustrations, solution of problems on first order differential equations with integrating factor.

CO10: Illustration of second order ODEs with constant coefficients and solution with the concept of integrating factor.

CO11: Solution of partial differential equations by the method of separation of variables and Laplace's equation in 2D and 3D.

*Unit-II: Introduction to Thermodynamics*

CO12: Description of matter macroscopically and microscopically, relation between microscopic and macroscopic state variables and ideal gas and van der Wall's equations.

CO13: Thermodynamic description of a system, extensive and intensive thermodynamic variables, thermodynamic equilibrium, zeroth law of thermodynamics and the concept of temperature.

CO14: Concept of work and heat, state functions, first law of thermodynamics and its differential form.

CO15: Idea of internal energy and examples of various thermodynamic processes involving the first law.

CO16: Applications of first law of thermodynamics, general relation between $C_P$ and $C_V$, calculations of work done during isothermal and adiabatic processes, compressibility and expansion coefficient.

CO17: Concept of reversible and irreversible processes with examples, conversion of work into heat and heat into work, heat engines, Carnot's cycle, Carnot's engine and its efficiency, idea of refrigerator and coefficient of performance.

CO18: Statement of second law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence,

CO19: Concept of Carnot's theorem, and the study of applications of second law of thermodynamics, thermodynamic scale of temperature and its equivalence to perfect gas scale.

CO20: Concept of entropy, Clausius theorem, Clausius inequality, second law of thermodynamics in terms of entropy, entropy of a perfect gas and principle of increase of entropy.

CO21: Study of entropy change in reversible and irreversible processes, entropy-temperature diagrams, third law of thermodynamics and the unattainability of absolute zero.

CO22: Theory of blackbody radiation and its spectral distribution and the concept of energy density.

CO23: Derivation of Planck's law of blackbody radiation and the deduction of Wein's distribution law, Rayleigh Jeans law, Stefan-Boltzmann law and Wein's distribution law from Planck's law.

| Semester | I |
|---|---|
| Title of Course | Introduction to Python Programming and Graph Plotting (SEC-1) |
| Paper Code | SEC-1P (Lab) |
| Credits | 03 |
| Hours | 06 hours/week |

*The students of Physics (H) of Semester-I will acquire the practical knowledge about Introduction to Programming in Python (Version-3), Problems and Applications, Introduction of Graph Plotting by hands on computer programming.*

***The lab paper (SEC-1P) of this course (SEC-1) provides the student with-***

CO1: Basics of scientific computing such as types of variables and data, mathematical operations, and the use of Python interpreter as a calculator.

CO2: Use of compound statements such as logical conditions, loops and user defined functions (def:) in Python.

CO3: Importance and method of importing different modules or libraries like math, cmath, numpy etc. and the use of "help" and "dir" command to know the inbuilt manuals.

CO4: Basic concepts of name spaces – local and global, Python sciprts and I/O operations like opening and writing to files.

CO5: Concepts and uses of different data types, e.g. List, Tuples, Sets, Strings and the built in functions involving these data types.

CO6: Computation of basic mathematical problems such as finding odd, even numbers, factors of an integer, roots of a quadratic equation, area of triangle by Heron's formula using Python programming.

CO7: Computation of mean, variance, and standard deviation of list of various random numbers using Python.

CO8: Computation of all prime numbers within a given range, sorting of lists using Bubble, Insertion and Selection sort, sum of series correct up to a given decimal place using Python.

CO9: Studying the motion of a particles under a given force F(x,t,v) with given initial condition using Euler's method and plotting (t,x), (x,v) and (t,v) using Matplotlib library.

CO10: Computation of matrix addition, multiplication and transpose directly and using List comprehension.

CO11: Concept of curve fitting, least square fit, goodness of fit and standard deviation using Python.

CO12: Introduction to graph plotting using Matplotlib as a plotting module, basics of XY-plotting of functions such as power laws and exponential functions, trigonometric functions, hyperbolic functions, and user defined functions.

CO13: Use of Matplotlib to plot Bar charts, histograms, polar plots, pie plots and data from a file, subplots and multiple plots.

| Semester | I |
|---|---|
| Title of Course | Mathematical Physics and Mechanics (MI-1) |
| Paper Code | MI-1T (Theory) |
| Credits | 03 |
| Hours | 03 hours/week |

*The students of other science subjects (H) of Semester-I will acquire the knowledge about Differential Equations, Vector Calculus, Fundamentals of Dynamics, Gravitation and Central Force Motion, Rotational Dynamics, Motion under Central Forces, General Properties of Matter by studying this course.*

***The theory paper (MI-1T) of this course (MI-1) provides the student with-***

CO1: Solution of problems on partial derivatives, exact and inexact differentials, first order linear differential equations (LDEs) with integrating factor.

CO2: Solution of second order linear differential equations (LDEs) with constant coefficients, concept of particular integral.

CO3: Theory of the properties of vector under rotation, scalar product, the invariance of scalar product under rotation, scalar triple product and their interpretation in terms of area and volume respectively, scalar and vector fields as well as solution of different mathematical problems on these topics.

CO4: Theory of directional derivatives and normal derivative of a vector, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field along with solution of different mathematical problems on these topics.

CO5: Statements of Gauss' divergence theorem, Green's and Stokes Theorems and their applications in terms of different mathematical problems.

CO6: Idea of reference frames and inertial frames, concept of Galilean transformations and Galilean invariance.

CO7: Understanding the basics of Newton's laws of motion and their application to various dynamical situations.

CO8: Basic concept of dynamics of a system of particles and centre of mass, procedure to evaluate centre of mass in different bodies, concept of centre of mass frame.

CO9: Description of non-inertial frames and fictitious forces arising in a non-inertial frame.

CO10: Understanding the basics of laws of gravitation, inertial and gravitational mass, potential and field due to spherical shell and solid sphere.

CO11: Ideas of central force field, basic features of the motion under a central force, e.g. planar motion, conservation of angular momentum and constant areal velocity.

CO12: Understanding perpendicular and parallel axes theorems, ideas of radius of gyration.

CO13: Basic concept for the moment of inertia about the given axis of symmetry for different uniform mass distributions, particularly rectangular, cylindrical and spherical bodies, idea of pure rolling of a body on an inclined plane.

CO14: Illustration of central force field as a two-body problem and reduction of it into one-body problem, concept of reduced mass, its definition and nature.

CO15: Basic features of motion under central force field, setting up differential equations of orbit and the corresponding energy expression, simple derivations of nature of force from the equations of orbit.

CO16: Understanding the principles of elasticity through the study of a few elastic constants and the relation between those e.g. Young's modulus and modulus of rigidity, twisting torque on a cylinder or wire.

CO17: Concept of surface tension and surface energy, angle of contact, capillarity and Jurin's law and its applications, concept of molecular theory of surface tension, ripple method.

CO18: Basic idea of viscosity and Reynold's number, ideas on simple principles of fluid flow and the equations governing fluid dynamics.

CO19: Understanding Poiseuille's equation for flow of a liquid through a capillary tube, Stokes las and its application to highly viscous liquid.

| Semester | I |
|---|---|
| Title of Course | Mathematical Physics and Mechanics (MI-1) |
| Paper Code | MI-1P (Lab) |
| Credits | 01 |
| Hours | 02 hours/week |

*The students of other science subjects (H) of Semester-I will acquire the practical knowledge about the Slide Callipers, Screw Gauge and Travelling Microscope, Motion of a Spring and Calculation of Spring Constant and g, Digital Timing Technique, Bar Pendulum, Kater's Pendulum, Moment of Inertia of a Flywheel, Elastic Constants by Searle's Method, Maxwell's Needle Method by hands on practical experiments.*

***The lab paper (MI-1P) of this course (MI-1) provides the student with-***

CO1: Study of necessary theory, working formula and experimental measurement of length (or diameter) using slide callipers, screw gauge and travelling microscope.

CO2: Study of necessary theory, working formula and experimental determination of acceleration due to gravity (g) and velocity for a freely falling body using digital timing technique.

CO3: Study of necessary theory, working formula and experimental observation for the motion of a spring and calculation of its spring constant, and acceleration due to gravity (g).

CO4: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Bar Pendulum.

CO5: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Kater's Pendulum.

CO6: Study of necessary theory, working formula and experimental determination the moment of inertia of a flywheel.

CO7: Study of necessary theory, working formula and experimental determination of the modulus of rigidity of a wire by Maxwell's needle.

CO8: Study of necessary theory, working formula and experimental determination of the elastic constants of a wire by Searle's method.

| Semester | II |
|---|---|
| Title of Course | Foundation of Physics – 2 (MJ-2) |
| Paper Code | MJ-2T (Theory) |
| Credits | 04 |
| Hours | 04 hours/week |

*The students of Physics (H) of Semester-II will acquire the knowledge about Unit – I: Preliminary Classical Mechanics and Unit – II: Basic Electricity & Magnetism by studying this course. Unit – I: Preliminary Classical Mechanics contains Introduction, Dynamics of a System of Particles, Rotating Frame of Reference, Motion under Central Forces, Scattering, Mechanics of Continuum as course modules and Unit – II: Basic Electricity & Magnetism contains Electric Field and Electric Potential, Electrostatic Energy & Capacitor, Method of Images, Dielectric Properties of Matter, Lorentz Force, Magnetic Field, Magnetic Properties of Matter as course modules.*

***The theory paper (MJ-2T) of this course (MJ-2) provides the student with-***

*Unit – I: Preliminary Classical Mechanics*

CO1: Understanding the historical growth of Newtonian classical mechanics.

CO2: Idea of reference frames and inertial frames, concept of Galilean transformations and Galilean invariance.

CO3: Understanding the basics of Newton's laws of motion and their application to various dynamical situations.

CO4: Differentiation between conservative and non-conservative forces, kinetic energy and potential energy, Familiarization with elastic potential energy, conceptual

background of force as gradient of potential energy, methods to calculate the work done by and against a force field.

CO5: Learning the concept of conservation of energy, linear momentum, angular momentum and their applications to basic problems.

CO6: Basic concept of dynamics of a system of particles and centre of mass, procedure to evaluate centre of mass in different bodies, concept of centre of mass frame.

CO7: Understanding the motion of centre of mass under external force, calculation of kinetic energy and angular momentum about centre of mass and laboratory frames, idea of conservation of mechanical energy.

CO8: Description of non-inertial frames and fictitious forces arising in a non-inertial frame.

CO9: Concept of centrifugal force, Coriolis force and their applications, ideas on the effect of Coriolis force on nature.

CO10: Ideas of central force field, basic features of the motion under a central force, e.g. planar motion, conservation of angular momentum and constant areal velocity.

CO11: Illustration of central force field as a two-body problem and reduction of it into one-body problem, concept of reduced mass, its definition and nature.

CO12: Basic features of motion under central force field, setting up differential equations of orbit and the corresponding energy expression, simple derivations of nature of force from the equations of orbit.

CO13: Understanding polar equation of conics, basics of Kepler's laws and derivation, concept of Laplace-Runge-Lenz vector and nature of orbit under inverse square repulsive force and along with the stability.

CO14: Understanding two-body collision, concept of scattering.

CO15: Basic idea of kinematics for moving fluids, idea of viscosity, streamline flow, turbulent flow and Reynold's number, ideas on simple principles of fluid flow and the equations governing fluid dynamics, concept of equation of continuity.

CO16: Understanding Poiseuille's equation for flow of a liquid through a capillary tube, Stokes law and its application to highly viscous liquid.

CO17: Idea of fluid dynamics, understanding Euler equation and simple examples of fluid statics e.g. Archimedes Principles, idea of Bernoulli's theorem.

*Unit – II: Basic Electricity & Magnetism*

CO18: Concept of electric field and electric potential from Coulomb's law, calculation of electric field, basic idea of electric dipole and its calculation related to force and torque.

CO19: Demonstration of Gauss' law for the electric field and application to systems of point charges as well as line, surface and volume distributions of charges.

CO20: Explanation and differentiation of the vector (electric fields from Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics, ideas of Poisson and Laplace equations.

CO21: Application of Gauss' Law of electrostatics to solve a variety of problems.

CO22: Ideas about electrostatic energy and calculation of electrostatic energy for charged spheres, conductors and dielectric materials, concept of surface charge.

CO23: Demonstration of working and understanding of capacitors of various shapes filled with dielectrics.

CO24: Concept of Method of Images and its application for a few examples.

CO25: Concept of electric fields in matter, polarization and polarization charges, dielectric materials.

CO26: Ideas of electric susceptibility and dielectric constant, concept of displacement vector, applications of Gauss' law in dielectric materials.

CO27: Concept of Lorentz force, ideas of force on a current carrying conductor inside a magnetic field.

CO28: Basic idea of the trajectory of charged particles in uniform electric field and crossed uniform electric and magnetic fields, ideas and basic principles of a Cyclotron.

CO29: Ideas of magnetic force in current carrying elements, demonstration of Biot Savart Law for current carrying elements and its application to systems of straight wire and circular current loops.

CO30: Concept of Ampere's Circuital Law and its application to infinite straight wire, infinite planar surface current and solenoids, ideas of axial vector e.g. magnetic field and its properties.

CO31: Concept of current loop as magnetic dipoles, magnetic dipole moment and its analogy with electric dipole moment, concept of magnetic vector potential and magnetic forces, application of magnetic forces on point charges and current carrying elements.

CO32: Understanding the magnetic properties of materials and magnetic susceptibility, magnetic permeability, qualitative ideas of paramagnetism, diamagnetism and ferromagnetism, B-H loop, magnetic hysteresis.

| Semester | II |
|---|---|
| Title of Course | Basic Instrumentation (SEC-2) |
| Paper Code | SEC-2P (Lab) |
| Credits | 03 |
| Hours | 06 hours/week |

*The students of Physics (H) of Semester-II will acquire the practical knowledge about the Basic Ideas of Measurements, Resistances, Analog and Digital Voltmeter and Ammeter, Digital Multimeter, Introduction to Electrical Household Wiring by hands on practical experiments.*

***The lab paper (SEC-2P) of this course (SEC-2) provides the student with-***

CO1: Basic concept of accuracy and precision of data sensitivity and range of resolution of instruments.

CO2: Calculate the uncertainties or errors in measurements and loading effect of some basic instruments.

CO3: Study of necessary theory, working formula and experimental measurement of unknown Resistance using Carbon resistance, electronic rheostats.

CO4: Study of necessary theory, working formula and experimental measurement of unknown Resistance using electronic potentiometer.

CO5: Study and experimental demonstration of basic block diagram of analog and digital voltmeter and ammeter.

CO6: Study the principles of voltage and current measurements and ideas of resistance of voltmeters and ammeters in different ranges.

CO7: Study the working principles of digital meters (voltmeters and ammeters), and understand the various specification of an electronic meter.

CO8: Computation on advantages of digital meter over an analog meter and study the basic ideas on range change of meter.

CO9: Study of block diagram and working principle of a digital multimeter to measurement of resistance, current (dc & ac), voltage (dc & ac), inductance, diode and transistor checking.

CO10: Study the concept of basic electricity as like power rating, idea on transformer action, measurement of electrical quantities like Voltage, Currents, Resistance, Impedance, power factor and energy.

CO11: Computation of familiarisation with PVC wires with SWG, PVC conduit pipes, sockets and plugs, clips, switches, fuse, holder, ceiling rose, Miniature Circuit Breaker (MCB), Residual Current Circuit Breaker (RCCB).

CO12: Study the Earth Leakage Circuit Breaker (ELCB), Double Pole (DP) or Single Pole and Neutral Miniature Circuit Board (SPN MCB), DP Isolator, live line, neutral and earth connections, consequences of faulty earth connection.

CO13: Study the Two-way switching in stairs, bed switch connection, fluorescent / LED tube circuit, connection from lamp post on road to main distribution board (home).

CO14: Study the assessment of total load with circuit, sub-circuits, and components with specifications, connections for refrigerator / microwave oven, concept of Single phase and three phase circuits.

CO15: Observations of the Fires in electrical Circuits & Precautions, safely handling Tools & Equipment /Fire Fighting and use of fire extinguishers.

CO16: Submission of a plan and estimation of power, points with circuit connection in real case as a short project.

| Semester | II |
|---|---|
| Title of Course | Thermal Physics and Statistical Mechanics (MI-2) |
| Paper Code | MI-2T (Theory) |
| Credits | 03 |
| Hours | 03 hours/week |

*The students of other science subjects (H) of Semester-II will acquire the knowledge about the Laws of Thermodynamics and their Applications, Various Thermodynamic Processes, Thermodynamic Potentials, Kinetic Theory of Gases, Blackbody Radiations, Different Distribution Laws for Blackbody Radiations, Classical and Quantum Statistical Mechanics and their Applications by studying this course.*

***The theory paper (MI-2T) of this course (MI-2) provides the student with-***

CO1:General thermodynamic description of a system, zeroth law of thermodynamics and the concept of temperature.

CO2: Statement and understanding of first law of thermodynamics, idea of internal energy and the conversion of heat into work, examples of various thermodynamic processes.

CO3: Study of the applications of first law of thermodynamics, general relation between $C_P$ and $C_V$, calculations of work done during isothermal and adiabatic processes, compressibility and expansion coefficient.

CO4: Concept of reversible and irreversible processes, statement of second law of thermodynamics and the idea of entropy.

CO5: Study of Carnot's cycle and Carnot's theorem, entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, third law of thermodynamics and the unattainability of absolute zero.

CO6: Theoretical and mathematical understanding of the thermodynamic potentials e.g. enthalpy, Gibbs free energy, Helmholtz free energy and internal energy functions.

CO7: Study of Maxwell's relations and applications in Joule-Thompson effect, Clausius- Clapeyron equation, expression for ($C_P - C_V$), $C_P/C_V$ and TdS equations.

CO8: Derivation of Maxwell's law of distribution of velocities and its experimental verification, mean free path (zeroth order).

CO9: Study of transport phenomena, viscosity, conduction and diffusion (for vertical case), law of equipartition of energy and its applications to specific heat of gases, mono-atomic and diatomic gases.

CO10: Theoretical concept of blackbody radiation, its spectral distribution, concept of energy density of radiations.

CO11: Fundamental postulates and mathematical derivation of Planck's law of blackbody radiation.

CO12: Deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan Boltzmann law and Wien's displacement law from Planck's law of blackbody radiations.

CO13: Theoretical concept of phase space, macrostate and microstate, entropy and thermodynamic probability.

CO14: Study of Maxwell-Boltzmann distribution law and its applications to the distribution of velocity of the atoms/molecules of an ideal gas.

CO15: Fundamental postulates of quantum statistics - Fermi-Dirac distribution law and its application to a system of electron gas, Bose-Einstein distribution law and its application to a photon gas, comparison of three statistics.

| Semester | II |
|---|---|
| Title of Course | Thermal Physics and Statistical Mechanics (MI-2) |
| Paper Code | MI-2P (Lab) |
| Credits | 01 |
| Hours | 02 hours/week |

*The students of other science subjects (H) of Semester-II will acquire the practical knowledge about the Mechanical Equivalent of Heat, Measurement of Planck's Constant using Blackbody Radiation, Determination of Stefan's Constant, Coefficient of Thermal Conductivity, Temperature Coefficient of Resistance, Variations of Thermo EMF across Junctions of a Thermocouple and Calibration Resistance Temperature Device (RTD) by hands on practical experiments.*

***The lab paper (MI-2P) of this course (MI-2) provides the student with-***

CO1: Study of necessary theory, working formula and experimental method to measure Planck's constant using black body radiation.

CO2: Study of necessary theory, working formula and experimental method to determine Stefan's constant.

CO3: Study of necessary theory, working formula and experimental method to study the variation of thermo EMF across two junctions of a thermocouple with temperature.

CO4: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Searle's apparatus.

CO5: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.

CO6: Study of necessary theory, working formula and experimental method to determine mechanical equivalent of heat J, by Callender and Barne's constant flow method.

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# Course Outcome

# Physics (Gen.)

| Semester | I |
|---|---|
| Title of Course | Mathematical Methods and Mechanics (including STR) (MJ-A1) |
| Paper Code | MJ-A1T (Theory) |
| Credits | 03 |
| Hours | 03 hours/week |

*The students of Physics (Gen or MDC) of Semester-I will acquire the knowledge about Differential Equations, Vector Calculus, Fundamentals of Dynamics, Gravitation and Central Force Motion, Rotational Dynamics, Motion under Central Forces, General Properties of Matter, Special Theory of Relativity by studying this course.*

***The theory paper (MJ-A1T) of this course (MJ-A1) provides the student with-***

CO1: Solution of problems on partial derivatives, exact and inexact differentials, first order linear differential equations (LDEs) with integrating factor.

CO2: Solution of second order linear differential equations (LDEs) with constant coefficients, concept of particular integral.

CO3: Theory of the properties of vector under rotation, scalar product, the invariance of scalar product under rotation, scalar triple product and their interpretation in terms of area and volume respectively, scalar and vector fields as well as solution of different mathematical problems on these topics.

CO4: Theory of directional derivatives and normal derivative of a vector, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field along with solution of different mathematical problems on these topics.

CO5: Statements of Gauss' divergence theorem, Green's and Stokes Theorems and their applications in terms of different mathematical problems.

CO6: Idea of reference frames and inertial frames, concept of Galilean transformations and Galilean invariance.

CO7: Understanding the basics of Newton's laws of motion and their application to various dynamical situations.

CO8: Basic concept of dynamics of a system of particles and centre of mass, procedure to evaluate centre of mass in different bodies, concept of centre of mass frame.

CO9: Description of non-inertial frames and fictitious forces arising in a non-inertial frame.

CO10: Understanding the basics of laws of gravitation, inertial and gravitational mass, potential and field due to spherical shell and solid sphere.

CO11: Ideas of central force field, basic features of the motion under a central force, e.g. planar motion, conservation of angular momentum and constant areal velocity.

CO12: Understanding perpendicular and parallel axes theorems, ideas of radius of gyration.

CO13: Basic concept for the moment of inertia about the given axis of symmetry for different uniform mass distributions, particularly rectangular, cylindrical and spherical bodies, idea of pure rolling of a body on an inclined plane.

CO14: Illustration of central force field as a two-body problem and reduction of it into one-body problem, concept of reduced mass, its definition and nature.

CO15: Basic features of motion under central force field, setting up differential equations of orbit and the corresponding energy expression, simple derivations of nature of force from the equations of orbit.

CO16: Understanding the principles of elasticity through the study of a few elastic constants and the relation between those e.g. Young's modulus and modulus of rigidity, twisting torque on a cylinder or wire.

CO17: Concept of surface tension and surface energy, angle of contact, capillarity and Jurin's law and its applications, concept of molecular theory of surface tension, ripple method.

CO18: Basic idea of viscosity and Reynold's number, ideas on simple principles of fluid flow and the equations governing fluid dynamics.

CO19: Understanding Poiseuille's equation for flow of a liquid through a capillary tube, Stokes las and its application to highly viscous liquid.

CO20: Demonstration of special theory of relativity (STR) through Michelson-Morley experiment and postulates of STR, constancy of speed of light.

CO21: Understanding Lorentz Transformation, ideas of length contraction, time dilation, relativistic addition of velocities.

| Semester | I |
|---|---|
| Title of Course | Mathematical Methods and Mechanics (including STR) (MJ-A1) |
| Paper Code | MJ-A1P (Lab) |
| Credits | 01 |
| Hours | 02 hours/week |

*The students of Physics (Gen or MDC) of Semester-I will acquire the practical knowledge about the Slide Callipers, Screw Gauge and Travelling Microscope, Motion of a Spring and Calculation of Spring Constant and g, Digital Timing Technique, Bar Pendulum, Kater's Pendulum, Moment of Inertia of a Flywheel, Elastic Constants by Searle's Method, Maxwell's Needle Method by hands on practical experiments.*

***The lab paper (MJ-A1P) of this course (MJ-A1) provides the student with-***

CO1: Study of necessary theory, working formula and experimental measurement of length (or diameter) using slide callipers, screw gauge and travelling microscope.

CO2: Study of necessary theory, working formula and experimental determination of acceleration due to gravity (g) and velocity for a freely falling body using digital timing technique.

CO3: Study of necessary theory, working formula and experimental observation for the motion of a spring and calculation of its spring constant, and acceleration due to gravity (g).

CO4: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Bar Pendulum.

CO5: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Kater's Pendulum.

CO6: Study of necessary theory, working formula and experimental determination the moment of inertia of a flywheel.

CO7: Study of necessary theory, working formula and experimental determination of the modulus of rigidity of a wire by Maxwell's needle.

CO8: Study of necessary theory, working formula and experimental determination of the elastic constants of a wire by Searle's method.

| Semester | I |
|---|---|
| Title of Course | Introduction to Python Programming and Graph Plotting (SEC-1) |
| Paper Code | SEC-1P (Lab) |
| Credits | 03 |
| Hours | 06 hours/week |

*The students of Physics (Gen or MDC) of Semester-I will acquire the practical knowledge about Introduction to Programming in Python (Version-3), Problems and Applications, Introduction of Graph Plotting by hands on computer programming.*

***The lab paper (SEC-1P) of this course (SEC-1) provides the student with-***

CO1: Basics of scientific computing such as types of variables and data, mathematical operations, and the use of Python interpreter as a calculator.

CO2: Use of compound statements such as logical conditions, loops and user defined functions (def:) in Python.

CO3: Importance and method of importing different modules or libraries like math, cmath, numpy etc. and the use of "help" and "dir" command to know the inbuilt manuals.

CO4: Basic concepts of name spaces – local and global, Python sciprts and I/O operations like opening and writing to files.

CO5: Concepts and uses of different data types, e.g. List, Tuples, Sets, Strings and the built in functions involving these data types.

CO6: Computation of basic mathematical problems such as finding odd, even numbers, factors of an integer, roots of a quadratic equation, area of triangle by Heron's formula using Python programming.

CO7: Computation of mean, variance, and standard deviation of list of various random numbers using Python.

CO8: Computation of all prime numbers within a given range, sorting of lists using Bubble, Insertion and Selection sort, sum of series correct up to a given decimal place using Python.

CO9: Studying the motion of a particles under a given force F(x,t,v) with given initial condition using Euler's method and plotting (t,x), (x,v) and (t,v) using Matplotlib library.

CO10: Computation of matrix addition, multiplication and transpose directly and using List comprehension.

CO11: Concept of curve fitting, least square fit, goodness of fit and standard deviation using Python.

CO12: Introduction to graph plotting using Matplotlib as a plotting module, basics of XY-plotting of functions such as power laws and exponential functions, trigonometric functions, hyperbolic functions, and user defined functions.

CO13: Use of Matplotlib to plot Bar charts, histograms, polar plots, pie plots and data from a file, subplots and multiple plots.

| Semester | I |
|---|---|
| Title of Course | Mathematical Physics and Mechanics (MI-C1) |
| Paper Code | MI-C1T (Theory) |
| Credits | 03 |
| Hours | 03 hours/week |

*The students of other science subjects (Gen or MDC) of Semester-I will acquire the knowledge about Differential Equations, Vector Calculus, Fundamentals of Dynamics, Gravitation and Central Force Motion, Rotational Dynamics, Motion under Central Forces, General Properties of Matter by studying this course.*

***The theory paper (MI-C1T) of this course (MI-C1) provides the student with-***

CO1: Solution of problems on partial derivatives, exact and inexact differentials, first order linear differential equations (LDEs) with integrating factor.

CO2: Solution of second order linear differential equations (LDEs) with constant coefficients, concept of particular integral.

CO3: Theory of the properties of vector under rotation, scalar product, the invariance of scalar product under rotation, scalar triple product and their interpretation in terms of area and volume respectively, scalar and vector fields as well as solution of different mathematical problems on these topics.

CO4: Theory of directional derivatives and normal derivative of a vector, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field along with solution of different mathematical problems on these topics.

CO5: Statements of Gauss' divergence theorem, Green's and Stokes Theorems and their applications in terms of different mathematical problems.

CO6: Idea of reference frames and inertial frames, concept of Galilean transformations and Galilean invariance.

CO7: Understanding the basics of Newton's laws of motion and their application to various dynamical situations.

CO8: Basic concept of dynamics of a system of particles and centre of mass, procedure to evaluate centre of mass in different bodies, concept of centre of mass frame.

CO9: Description of non-inertial frames and fictitious forces arising in a non-inertial frame.

CO10: Understanding the basics of laws of gravitation, inertial and gravitational mass, potential and field due to spherical shell and solid sphere.

CO11: Ideas of central force field, basic features of the motion under a central force, e.g. planar motion, conservation of angular momentum and constant areal velocity.

CO12: Understanding perpendicular and parallel axes theorems, ideas of radius of gyration.

CO13: Basic concept for the moment of inertia about the given axis of symmetry for different uniform mass distributions, particularly rectangular, cylindrical and spherical bodies, idea of pure rolling of a body on an inclined plane.

CO14: Illustration of central force field as a two-body problem and reduction of it into one-body problem, concept of reduced mass, its definition and nature.

CO15: Basic features of motion under central force field, setting up differential equations of orbit and the corresponding energy expression, simple derivations of nature of force from the equations of orbit.

CO16: Understanding the principles of elasticity through the study of a few elastic constants and the relation between those e.g. Young's modulus and modulus of rigidity, twisting torque on a cylinder or wire.

CO17: Concept of surface tension and surface energy, angle of contact, capillarity and Jurin's law and its applications, concept of molecular theory of surface tension, ripple method.

CO18: Basic idea of viscosity and Reynold's number, ideas on simple principles of fluid flow and the equations governing fluid dynamics.

CO19: Understanding Poiseuille's equation for flow of a liquid through a capillary tube, Stokes las and its application to highly viscous liquid.

| Semester | I |
|---|---|
| Title of Course | Mathematical Physics and Mechanics (MI-C1) |
| Paper Code | MI-C1P (Lab) |
| Credits | 01 |
| Hours | 02 hours/week |

*The students of other science subjects (Gen or MDC) of Semester-I will acquire the practical knowledge about the Slide Callipers, Screw Gauge and Travelling Microscope, Motion of a Spring and Calculation of Spring Constant and g, Digital Timing Technique, Bar Pendulum, Kater's Pendulum, Moment of Inertia of a Flywheel, Elastic Constants by Searle's Method, Maxwell's Needle Method by hands on practical experiments.*

***The lab paper (MI-C1P) of this course (MI-C1) provides the student with-***

CO1: Study of necessary theory, working formula and experimental measurement of length (or diameter) using slide callipers, screw gauge and travelling microscope.

CO2: Study of necessary theory, working formula and experimental determination of acceleration due to gravity (g) and velocity for a freely falling body using digital timing technique.

CO3: Study of necessary theory, working formula and experimental observation for the motion of a spring and calculation of its spring constant, and acceleration due to gravity (g).

CO4: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Bar Pendulum.

CO5: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Kater's Pendulum.

CO6: Study of necessary theory, working formula and experimental determination the moment of inertia of a flywheel.

CO7: Study of necessary theory, working formula and experimental determination of the modulus of rigidity of a wire by Maxwell's needle.

CO8: Study of necessary theory, working formula and experimental determination of the elastic constants of a wire by Searle's method.

| Semester | II |
|---|---|
| Title of Course | Mathematical Methods and Mechanics (including STR) (MJ-B1) |
| Paper Code | MJ-B1T (Theory) |
| Credits | 03 |
| Hours | 03 hours/week |

*The students of Physics (Gen or MDC) of Semester-II will acquire the knowledge about Differential Equations, Vector Calculus, Fundamentals of Dynamics, Gravitation and Central Force Motion, Rotational Dynamics, Motion under Central Forces, General Properties of Matter, Special Theory of Relativity by studying this course.*

***The theory paper (MJ-B1T) of this course (MJ-B1) provides the student with-***

CO1: Solution of problems on partial derivatives, exact and inexact differentials, first order linear differential equations (LDEs) with integrating factor.

CO2: Solution of second order linear differential equations (LDEs) with constant coefficients, concept of particular integral.

CO3: Theory of the properties of vector under rotation, scalar product, the invariance of scalar product under rotation, scalar triple product and their interpretation in terms of area and volume respectively, scalar and vector fields as well as solution of different mathematical problems on these topics.

CO4: Theory of directional derivatives and normal derivative of a vector, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field along with solution of different mathematical problems on these topics.

CO5: Statements of Gauss' divergence theorem, Green's and Stokes Theorems and their applications in terms of different mathematical problems.

CO6: Idea of reference frames and inertial frames, concept of Galilean transformations and Galilean invariance.

CO7: Understanding the basics of Newton's laws of motion and their application to various dynamical situations.

CO8: Basic concept of dynamics of a system of particles and centre of mass, procedure to evaluate centre of mass in different bodies, concept of centre of mass frame.

CO9: Description of non-inertial frames and fictitious forces arising in a non-inertial frame.

CO10: Understanding the basics of laws of gravitation, inertial and gravitational mass, potential and field due to spherical shell and solid sphere.

CO11: Ideas of central force field, basic features of the motion under a central force, e.g. planar motion, conservation of angular momentum and constant areal velocity.

CO12: Understanding perpendicular and parallel axes theorems, ideas of radius of gyration.

CO13: Basic concept for the moment of inertia about the given axis of symmetry for different uniform mass distributions, particularly rectangular, cylindrical and spherical bodies, idea of pure rolling of a body on an inclined plane.

CO14: Illustration of central force field as a two-body problem and reduction of it into one-body problem, concept of reduced mass, its definition and nature.

CO15: Basic features of motion under central force field, setting up differential equations of orbit and the corresponding energy expression, simple derivations of nature of force from the equations of orbit.

CO16: Understanding the principles of elasticity through the study of a few elastic constants and the relation between those e.g. Young's modulus and modulus of rigidity, twisting torque on a cylinder or wire.

CO17: Concept of surface tension and surface energy, angle of contact, capillarity and Jurin's law and its applications, concept of molecular theory of surface tension, ripple method.

CO18: Basic idea of viscosity and Reynold's number, ideas on simple principles of fluid flow and the equations governing fluid dynamics.

CO19: Understanding Poiseuille's equation for flow of a liquid through a capillary tube, Stokes las and its application to highly viscous liquid.

CO20: Demonstration of special theory of relativity (STR) through Michelson-Morley experiment and postulates of STR, constancy of speed of light.

CO21: Understanding Lorentz Transformation, ideas of length contraction, time dilation, relativistic addition of velocities.

| Semester | II |
|---|---|
| Title of Course | Mathematical Methods and Mechanics (including STR) (MJ-B1) |
| Paper Code | MJ-B1P (Lab) |
| Credits | 01 |

| | |
|---|---|
| Hours | 02 hours/week |

*The students of Physics (Gen or MDC) of Semester-II will acquire the practical knowledge about the Slide Callipers, Screw Gauge and Travelling Microscope, Motion of a Spring and Calculation of Spring Constant and g, Digital Timing Technique, Bar Pendulum, Kater's Pendulum, Moment of Inertia of a Flywheel, Elastic Constants by Searle's Method, Maxwell's Needle Method by hands on practical experiments.*

***The lab paper (MJ-B1P) of this course (MJ-B1) provides the student with-***

CO1: Study of necessary theory, working formula and experimental measurement of length (or diameter) using slide callipers, screw gauge and travelling microscope.

CO2: Study of necessary theory, working formula and experimental determination of acceleration due to gravity (g) and velocity for a freely falling body using digital timing technique.

CO3: Study of necessary theory, working formula and experimental observation for the motion of a spring and calculation of its spring constant, and acceleration due to gravity (g).

CO4: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Bar Pendulum.

CO5: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Kater's Pendulum.

CO6: Study of necessary theory, working formula and experimental determination the moment of inertia of a flywheel.

CO7: Study of necessary theory, working formula and experimental determination of the modulus of rigidity of a wire by Maxwell's needle.

CO8: Study of necessary theory, working formula and experimental determination of the elastic constants of a wire by Searle's method.

| Semester | II |
|---|---|
| Title of Course | Basic Instrumentation (SEC-2) |
| Paper Code | SEC-2P (Lab) |
| Credits | 03 |
| Hours | 06 hours/week |

*The students of Physics (Gen or MDC) of Semester-II will acquire the practical knowledge about the Basic Ideas of Measurements, Resistances, Analog and Digital Voltmeter and Ammeter, Digital Multimeter, Introduction to Electrical Household Wiring by hands on practical experiments.*

***The lab paper (SEC-2P) of this course (SEC-2) provides the student with-***

CO1: Basic concept of accuracy and precision of data sensitivity and range of resolution of instruments.

CO2: Calculate the uncertainties or errors in measurements and loading effect of some basic instruments.

CO3: Study of necessary theory, working formula and experimental measurement of unknown Resistance using Carbon resistance, electronic rheostats.

CO4: Study of necessary theory, working formula and experimental measurement of unknown Resistance using electronic potentiometer.

CO5: Study and experimental demonstration of basic block diagram of analog and digital voltmeter and ammeter.

CO6: Study the principles of voltage and current measurements and ideas of resistance of voltmeters and ammeters in different ranges.

CO7: Study the working principles of digital meters (voltmeters and ammeters), and understand the various specification of an electronic meter.

CO8: Computation on advantages of digital meter over an analog meter and study the basic ideas on range change of meter.

CO9: Study of block diagram and working principle of a digital multimeter to measurement of resistance, current (dc & ac), voltage (dc & ac), inductance, diode and transistor checking.

CO10: Study the concept of basic electricity as like power rating, idea on transformer action, measurement of electrical quantities like Voltage, Currents, Resistance, Impedance, power factor and energy.

CO11: Computation of familiarisation with PVC wires with SWG, PVC conduit pipes, sockets and plugs, clips, switches, fuse, holder, ceiling rose, Miniature Circuit Breaker (MCB), Residual Current Circuit Breaker (RCCB).

CO12: Study the Earth Leakage Circuit Breaker (ELCB), Double Pole (DP) or Single Pole and Neutral Miniature Circuit Board (SPN MCB), DP Isolator, live line, neutral and earth connections, consequences of faulty earth connection.

CO13: Study the Two-way switching in stairs, bed switch connection, fluorescent / LED tube circuit, connection from lamp post on road to main distribution board (home).

CO14: Study the assessment of total load with circuit, sub-circuits, and components with specifications, connections for refrigerator / microwave oven, concept of Single phase and three phase circuits.

CO15: Observations of the Fires in electrical Circuits & Precautions, safely handling Tools & Equipment /Fire Fighting and use of fire extinguishers.

CO16: Submission of a plan and estimation of power, points with circuit connection in real case as a short project.

| Semester | II |
|---|---|
| Title of Course | Thermal Physics and Statistical Mechanics (MI-C2) |
| Paper Code | MI-C2T (Theory) |
| Credits | 03 |
| Hours | 03 hours/week |

*The students of other science subjects (Gen or MDC) of Semester-II will acquire the knowledge about the Laws of Thermodynamics and their Applications, Various Thermodynamic Processes, Thermodynamic Potentials, Kinetic Theory of Gases, Blackbody Radiations, Different Distribution Laws for Blackbody Radiations, Classical and Quantum Statistical Mechanics and their Applications by studying this course.*

***The theory paper (MI-C2T) of this course (MI-C2) provides the student with-***

CO1:General thermodynamic description of a system, zeroth law of thermodynamics and the concept of temperature.

CO2: Statement and understanding of first law of thermodynamics, idea of internal energy and the conversion of heat into work, examples of various thermodynamic processes.

CO3: Study of the applications of first law of thermodynamics, general relation between $C_P$ and $C_V$, calculations of work done during isothermal and adiabatic processes, compressibility and expansion coefficient.

CO4: Concept of reversible and irreversible processes, statement of second law of thermodynamics and the idea of entropy.

CO5: Study of Carnot's cycle and Carnot's theorem, entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, third law of thermodynamics and the unattainability of absolute zero.

CO6: Theoretical and mathematical understanding of the thermodynamic potentials e.g. enthalpy, Gibbs free energy, Helmholtz free energy and internal energy functions.

CO7: Study of Maxwell's relations and applications in Joule-Thompson effect, Clausius- Clapeyron equation, expression for ($C_P - C_V$), $C_P/C_V$ and TdS equations.

CO8: Derivation of Maxwell's law of distribution of velocities and its experimental verification, mean free path (zeroth order).

CO9: Study of transport phenomena, viscosity, conduction and diffusion (for vertical case), law of equipartition of energy and its applications to specific heat of gases, mono-atomic and diatomic gases.

CO10: Theoretical concept of blackbody radiation, its spectral distribution, concept of energy density of radiations.

CO11: Fundamental postulates and mathematical derivation of Planck's law of blackbody radiation.

CO12: Deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan Boltzmann law and Wien's displacement law from Planck's law of blackbody radiations.

CO13: Theoretical concept of phase space, macrostate and microstate, entropy and thermodynamic probability.

CO14: Study of Maxwell-Boltzmann distribution law and its applications to the distribution of velocity of the atoms/molecules of an ideal gas.

CO15: Fundamental postulates of quantum statistics - Fermi-Dirac distribution law and its application to a system of electron gas, Bose-Einstein distribution law and its application to a photon gas, comparison of three statistics.

| Semester | II |
|---|---|
| Title of Course | Thermal Physics and Statistical Mechanics (MI-C2) |
| Paper Code | MI-C2P (Lab) |
| Credits | 01 |
| Hours | 02 hours/week |

*The students of other science subjects (Gen or MDC) of Semester-II will acquire the practical knowledge about the Mechanical Equivalent of Heat, Measurement of Planck's Constant using Blackbody Radiation, Determination of Stefan's Constant, Coefficient of Thermal Conductivity, Temperature Coefficient of Resistance, Variations of Thermo EMF across Junctions of a Thermocouple and Calibration Resistance Temperature Device (RTD) by hands on practical experiments.*

***The lab paper (MI-C2P) of this course (MI-C2) provides the student with-***

CO1: Study of necessary theory, working formula and experimental method to measure Planck's constant using black body radiation.

CO2: Study of necessary theory, working formula and experimental method to determine Stefan's constant.

CO3: Study of necessary theory, working formula and experimental method to study the variation of thermo EMF across two junctions of a thermocouple with temperature.

CO4: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Searle's apparatus.

CO5: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.

CO6: Study of necessary theory, working formula and experimental method to determine mechanical equivalent of heat J, by Callender and Barne's constant flow method.