Syllabus for

Semester I and II

B.Sc in Physics

w.e.f. Academic Session 2023-24

Kazi Nazrul University

Asansol, Paschim Bardhaman
West Bengal 713340

Semester-I:

Mechanics and General properties of Matter

(MJC-1)

Course Type: MJC -1 **(Theory and Practical)**	Course Details: **Mechanics & General Properties of Matter**			L-T-P: 3-0-4	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	20	**35**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1.Understand vector calculus, classical mechanics of single as well as system of particles within the scope the Newtonian formulation.
2. Understand the dynamics of rigid body and concept of moment of inertia. Study of moment of inertia of different bodies and its applications.
3. Examine phenomena of simple harmonic motion and the distinction between undamped, damped and forced oscillations and the concepts of resonance and quality factor in a driven system.
4. Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
5. Study the properties of matter, response of the classical systems to external forces and their elastic deformation and its applications and comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications.

Course Content **MJC-1: Mechanics & General Properties of Matter** **(45 Hrs)**		
Topic	**Contents**	**Class Reqd. (Hrs)**
Vector Calculus	Vector triple product(review); Derivatives of vectors; Gradient, Divergence, Curl of a vector field; Vector integrations-line, surface and volume integration; Gauss' divergence theorem, Stoke's theorem, Green's theorem (statement only with simple applications); Introduction to Orthogonal curvilinear Co-ordinate systems, unit vectors, Jacobian; Special cases: plane, spherical and cylindrical co-ordinate systems; Infinitesimal line segment, area and volume elements in them.	10

Mechanics of Single Particle	Introduction to Inertial & Non-inertial reference frames; Velocity and Acceleration - tangential and normal components, Radial and Cross-radial components; Newton's laws, Inertial frame, Work, Energy, Impulse of a force, Freely falling bodies, Motion in a resistive medium. Projectile motion. Conservative force and concept of potential; Conservation of energy; Dissipative forces; Translation invariance and conservation of inear momentm; Central force & Conservation of angular momentum; Torque; Brief reference to fundamental forces in nature	6
Oscillations	Oscillations: Simple Harmonic Motion and its properties, energy of a simple harmonic oscillator, Damped oscillations: under damped, over-damped, and critically damped motion, Forced Oscillations and Resonance, Q factor and Sharpness; Examples of Oscillators from various branches of physics	8
Gravitation	Kepler's laws, Newton's law of gravitation, Motion of satellites in circular orbit. Geosynchronous orbits.	2
Systems of particles	Degrees of freedom, Centre of mass and Centre of gravity, Momentum, Angular momentum, Torque, Kinetic energy of a system of particles; Conservation of linear momentum, angular momentum, and Energy for a system of particles; Centre of mass motion and Centre of mass coordinate; Examples: two coupled harmonic oscillators, two-body systems with (i) gravitaional, (ii) Coulomb interaction etc.	5
Rigid body Dynamics	Concept of rigid body, Euler's theorem, General motion of rigid bodies: Chasle's theorem, Rotational motion about an axis, Moment of inertia, Radius of gyration, Perpendicular and Parallel Axis Theorems; Moment of inertia of a uniform body-Solid and hollow cylinders, Solid and hollow spheres, Rectangular plane, thin rod; Rotational energy, Conservation of energy, Work and Power, Motion of a flywheel, Theory of compound pendulum- Bar and Kater's pendulum, Foucault Pendulum; determination of "g"; Principal axis and Product of Inertia; Rotating Cordinate & Coriolis force	7
General properties of matter	Elasticity: Relation between different elastic moduli and Poisson's ratio, Torsional pendulum, Bending of beam; Surface Tension: Angle of contact, surface tension and surface energy, pressure difference across curved surface example, excess pressure inside spherical liquid drop; Viscocity: Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poiseulle's method, Stoke's method. Bernoulli's theorem and its applications	7

References/ Suggested Readings

1. *Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill)*
2. *Classical Mechanics – J. C. Upadhyay, (Himalaya Publ.).*
3. *Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).*
4. Theoretical Mechanics - M. R. Spiegel, (Schaum's Outline Series) (McGraw-Hill).
5. Berkeley Physics Course, Vol – I (Mechanics) (Mc Graw Hill).
6. Advanced Accoustics- D. P. Raychaudhury.
7. Waves and Oscillations by N K Bajaj
8. Waves and Oscillations by R. N. Chowdhury
9. An Introduction to Mechanics by Kleppner and Kolenkow
10. Classical Mechanics by Rana Joag
11. Introduction to classical Mechanics with problems and solutions by Davis Morin, Cambridge University Press
12. Feynman Lectures Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
13. Elements of properties of matter by D.S. Mathur
14. A Treatise on general properties of matter by Sengupta and Chatterjee

Students can also explore these sites for additional reading - https://nptel.ac.in/courses https://ocw.mit.edu/search/?q=courses

Experiments to be performed in the first semester (At least 6 experiments have to be performed):

1. To study the Motion of Spring and calculate (a) Spring constant, (b) Acceleration due to gravity.

2. To determine the Moment of Inertia of a Flywheel / regular-shaped body.

3. To determine Coefficient of Viscosity of water by Capillary Flow (Poiseuille‟s) Method.

4. Determination of Young‟s modulus by method of flexure.

5. To determine the Young's Modulus of a Wire by Optical Lever Method.

6. To determine the elastic Constants of a wire by Searle‟s method.

7. To determine the value of acceleration due to gravity using Bar Pendulum.

8. 7. To determine the value of acceleration due to gravity using Kater's Pendulum.

9. Determination of surface tension of a liquid by Jaeger"s method.

10. Determination of surface tension of a liquid by capillary-rise method.

11. Determination of the rigidity modulus of a wire by statical /dynamical method

Reference Books for Laboratory Experiments:

1. Physics through experiments	B. Saraf	Vikas Publications
2. A laboratory manual of Physics for undergraduate classes, 1st Edition,	D P Khandelwal	Vikas Publications.
3. B.Sc. Practical Physics (Revised Edition)	C. L Arora	S.Chand & Co.
4. An advanced course in practical physics.	D. Chatopadhyay, PC Rakshit, B. Saha	New Central Book Agency Pvt Ltd.

Semester-I:

Mechanics and General properties of Matter

(Minor-1)

Course Type: Minor 1 **(Theory and Practical)**	Course Details: **Mechanics & General Properties of Matter**			L-T-P: 3-0-4	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
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their elastic deformation and its applications and comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications.

Course Content MJC-1: Mechanics & General Properties of Matter (45 Hrs)		
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Gravitation	Kepler's laws, Newton's law of gravitation, Motion of satellites in circular orbit. Geosynchronous orbits.	2
Systems of particles	Degrees of freedom, Centre of mass and Centre of gravity, Momentum, Angular momentum, Torque, Kinetic energy of a system of particles; Conservation of linear momentum, angular momentum, and Energy for a system of particles; Centre of mass motion and Centre of mass coordinate; Examples: two coupled harmonic oscillators, two-body systems with (i) gravitaional, (ii) Coulomb interaction etc.	5
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	body-Solid and hollow cylinders, Solid and hollow spheres, Rectangular plane, thin rod; Rotational energy, Conservation of energy, Work and Power, Motion of a flywheel, Theory of compound pendulum- Bar and Kater's pendulum, Foucault Pendulum; determination of "g"; Principal axis and Product of Inertia; Rotating Cordinate & Coriolis force	
General properties of matter	Elasticity: Relation between different elastic moduli and Poisson's ratio, Torsional pendulum, Bending of beam; Surface Tension: Angle of contact, surface tension and surface energy, pressure difference across curved surface example, excess pressure inside spherical liquid drop; Viscocity: Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poiseulle's method, Stoke's method. Bernoulli's theorem and its applications.	7

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4. An advanced course in practical physics.	D. Chatopadhyay, PC Rakshit, B. Saha	New Central Book Agency Pvt Ltd.

COURSE TYPE: MD

COURSE NAME: PHYSICAL SCIENCE

COURSE CODE: BSCCEMMD101

Course Type: **MD (Theoretical)**	Course Details: MDC-1			L-T-P: **3-0-0**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical

			15		**35**

On completion of this course, the students will be able to understand:

Learning objectives:

1. Laws of thermodynamics and concepts of entropy, enthalpy, internal energy, reversible, irreversible processes.

2. Understand the concept of system, variables, heat, work, and their relations.

3. Concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.

4. Familiarization with various states of matter.

5. Physical properties of each state of matter and laws related to describe the states.

6. UnderstandingMaxwell distribution, mean-free path, kinetic energies.

7. Behaviour of real gases, its deviation from ideal behaviour, equation of state, isotherm, andlaw of corresponding states.

8. Liquid state and its physical properties related to temperature and pressure variation.

9. Solids, lattice parameters and different types of solid structures.

10. Understand the basics of chemical kinetics: determination of order, molecularity, theories of reaction rates,determination of rate of opposing/parallel/chain reactions with suitable examples, application of steady statekinetics.

11. To understand the Newton's laws of motion and familiarize with the concept of work, energy and power.

12. Understand the concept of Gravity and also get an idea about the Kepler's laws

13. Students will also familiarize with the motion of airplanes, helicopters; hot air and helium balloons

14. Students will be able to get a grasp of radioactivity and various other concepts involved with it. Also they will be able to get an idea about nuclear fusion and fission.

Syllabus :

1. Thermodynamics Laws (8 Lectures)

Thermal Equilibrium and zeroth law, first law, reversible and irreversible work, criteria of ideal gas, isothermal and adiabatic expansions, Joule-Thomson effect (derivation excluded); Thermochemistry: Hess's law and its application.

Second law and its elementary interpretation, Carnot cycle and theorems, Clausius inequality, concept of free energy and entropy, criteria of spontaneity.

2. States of Matter (10 Lectures)

a) *Gaseous State* - Ideal gas equation, derivation of gas laws, Maxwell's speed and energy distributions (derivation excluded); distribution curves; different types of speeds and their significance, concept of equipartition principle, van der Waals equation. Virial equation, Boyle temperature, critical constants, law of corresponding states, specific heats and their ratios, vapour density, limiting density, abnormal vapour density, frequency of binary collisions; mean free path.

b) *Liquid State* – Viscosity of fluids, temperature and pressure dependence, determination of relative viscosity of liquids. Surface energy and surface tension of liquids, determination of relative surface tension of liquids, temperature dependence.

c) *Solid State* – Unit cell, Bravais lattice, crystal system, Miller indices, Bragg's equation and its application, packing of simple cube, body centred cube and face centred cube.

3. Chemical Kinetics (5 Lectures)

Rate law, order and molecularity of reactions, first and second order reactions, average life period, opposing (first order opposed by first order), consecutive and parallel reactions (first order), concept of steady state and rate determining stepconcept of Arrhenius activation energy. Catalysis, autocatalysis, enzyme catalyst, catalyst poison.

4. Laws of Motion, Energy and Power

Newton's First and Second laws, inertia, vector quantifies, position, velocity, force, acceleration, mass, net force, inertial frames of reference, SI units. Work and energy: Work done and energy, kinetic energy and potential energy, heat and its units; Cost of energy, measuring energy, power, different power sources.

5. Gravity and Space

Force of Gravity: Newton's Third law; weightlessness; elliptical orbits; escape velocity, Kepler's laws, types of satellites; circular acceleration; moment; rockets; airplanes, helicopters; hot air and helium balloons; angular momentum and torque.

6. Nucleus and Radioactivity

Radioactivity: elements and isotopes; radiation and rays, different types of radiation; effects of radiation, the half-life; measuring age from radioactivity; nuclear fission and fusion, chain reactions, nuclear reactors, nuclear waste.

Recommended Books :

1. S. R. Palit, Elementary Physical Chemistry; Book Syndicate Private Limited.

2. P. C. Rakshit, Physical Chemistry; Sarat Book Distributers.
3. Dr. A. K. Mondal, Degree Bhouto O SadharanRasayan; Sarat Book Distributers.
4. A. Ghoshal, Sadharan O BhoutoRasayan;: Books and Allied (P) Ltd.
5. K. L. Kapoor, A Text Book of Physical Chemistry (Vol. 1 & 5), Macmillan India Limited, New Delhi.
6. P. C. Rakshit (Revised by S.C. Rakshit), Physical Chemistry, Sarat Book Distributers, Kolkata.
7. A. Bahl, B.S. Bahl and G.D. Tuli, Essentials of Physical Chemistry, S Chand Publications.
8. Pahari and Pahari, Problems on Physical Chemistry, New Central Book Agency (P) Ltd.
9. A. Ghoshal, Numerical Problems on Physical Chemistry,Books and Allied (P) Ltd.

Semester-II:

Electricity and Magnetism

(**MJC-2)**

Course Type: MJC -2 **(Theory and Practical)**	Course Details: **Electricity and Magnetism**			L-T-P: 3-0-4	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical

		30	**15**	20	**35**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Explain the properties of (i) the electric field produced due to charges at rest; (ii) the magnetic field produced due to steady current, both in free-space and inside matter.*
2. *Develop an understanding on the unification of electric and magnetic fields and Maxwell's eqution governing electromagnetic waves.*
3. *Understand the phenomenon of resonance in LCR AC-circuits, sharpness of resonance, Q-factor, Power factor and the comparative study of series and parallel resonant circuits.*

Course Content MJC-2: Electricity and Magnetism 45 Hours		
Topic	**Contents**	**Class Reqd. (Hrs)**
Electric Field for a point charge	Concept of charge, Conservation and quantization of charge, Coulomb's law, Electric field strength, electric field lines, point charge in an electric field; Electric dipole. work done by a charge (derivation of the expression for potential energy),	2
Electrostatic potential for a point charge	Electric potential, line integral, gradient of a scalar function, relation between field and potential. Potential due to point charge and Constant potential surfaces. Poisson's and Laplace's equations. Uniqueness Theorem.	3
Multipole expansion of potential	Potential and electric field due to a dipole. Multipole expansion – monopole, dipole, quadrupole.	2
Gauss law in Electrostatics	Electric Flux, Gauss's law, Continuous Charge distribution, Calculation of Electric fields of a (i) spherical charge distribution, (ii) line charge and (iii) an infinite flat sheet of charge. Calculation of Potential.	3

Concept of Voltage and current Sources	Concept of Voltage and Current Sources, Kirchhoff's Laws, Network Theorems- Thevenin's, Norton's, Maximum Power Transfer Theorem, Reciprocity Theorem.	4
Electrostatics in Conductors and Dielectrics	Electric field and surface charge density for conductors, Electric Polarisation (atomic view) and bound charge densities for Dielectric materials, Displacement Vector and Gauss's law in dielectrics. Capacitors-parallel plate capacitor with dielectric inside, Electrostatic Energy stored in a capacitor.	5
DC steady currents	Electric currents and current density. Lorentz Force on a moving charge. Electrical conductivity and Ohm's law. Physics of electrical conduction, conduction in metals and semiconductors, circuit elements and circuits: Transient currents in RC, LR and LCR circuits.	4
Magnetostatics	Definition of magnetic field, Ampere's law and Biot-Savart law (magnetic force and magnetic flux), Magnetic force on a current carrying conductor. Magnetic moment of a current-carrying circular loop, electric current in atoms, electron spin and magnetic moment, Hall effect in a conductor.	5
Magnetic materials	Magnetic intensity and magnetic induction, Intensity of magnetization, Susceptibility, Permeability, Types of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials. Magnetization and magnetic susceptibility.	3
Electromagnetic Induction	Electromagnetic induction, conducting rod moving in a magnetic field, Faraday's laws of induction, Lenz's Law, expression for self-inductance and energy stored in a magnetic field. Mutual inductance.	4
AC circuits	RMS and average value of AC, Response of RL, RC, LC, LCR circuits using j-operator method, quality factor, admittance and impedance, power and energy in series and parallel resonance AC circuits. AC bridges- Anderson bridge, Wien bridge,	5

	De'Sauty's bridge.	
Electromagnetic waves	Equation of continuity, Maxwell's equations, Brief reference to Magnetic Monopole; Introduction to Gauges; displacement current, equation for propagation of electromagnetic wave, transverse nature of electromagnetic wave, energy transported by electromagnetic waves. Poynting vector.	5

References/ Suggested Readings

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

2. Electricity and Magnetism, By Rakshit and Chatterjee

3. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

4. Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

5. Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

6. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw-Hill Education

Experiments to be performed in the Second semester (At least 6 experiments has to be performed):

1. To study the characteristics of a series RC Circuit.

2. To determine an unknown low resistance using Potentiometer.

3. To determine an unknown low resistance using Carey Foster's Bridge.

4. To compare capacitances using De' Sauty's bridge.

5. To determine self inductance of a coil by Anderson's bridge.

6. Measurement of magnetic field strength B and its variation in a solenoid (determinination of dB/dx).

7. To verify the Thevenin and Norton theorems in a wheatstone bridge.

8. To verify the superposition, and maximum power transfer theorems in a wheatstone bridge.

9. To study response curve of a Series LCR circuit and determine its (a) Resonant

frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

10. To study the response curve of a parallel LCR circuit and determine its (a) anti-resonant frequency and (b) Quality factor Q.

11. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer

12. Determine a high resistance by leakage method using Ballistic Galvanometer.

13. To determine self-inductance of a coil by Rayleigh's method.

14. To determine temperature co-efficient of resistance of a metal / semiconductor by a meter-bridge.

Semester-II:

Electricity and Magnetism

(**Minor-2)**

Course Type: Minor-2 **(Theory and Practical)**	Course Details: **Electricity and Magnetism**			L-T-P: 3-0-4	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	20	**35**

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Topic	**Contents**	**Class Reqd. (Hrs)**
Electric Field for a point charge	Concept of charge, Conservation and quantization of charge, Coulomb's law, Electric	2

	field strength, electric field lines, point charge in an electric field; Electric dipole. work done by a charge (derivation of the expression for potential energy),	
Electrostatic potential for a point charge	Electric potential, line integral, gradient of a scalar function, relation between field and potential. Potential due to point charge and Constant potential surfaces. Poisson's and Laplace's equations. Uniqueness Theorem.	3
Multipole expansion of potential	Potential and electric field due to a dipole. Multipole expansion – monopole, dipole, quadrupole.	2
Gauss law in Electrostatics	Electric Flux, Gauss's law, Continuous Charge distribution, Calculation of Electric fields of a (i) spherical charge distribution, (ii) line charge and (iii) an infinite flat sheet of charge. Calculation of Potential.	3
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DC steady currents	Electric currents and current density. Lorentz Force on a moving charge. Electrical conductivity and Ohm's law. Physics of electrical conduction, conduction in metals and semiconductors, circuit elements and circuits: Transient currents in RC, LR and LCR circuits.	4
Magnetostatics	Definition of magnetic field, Ampere's law and Biot-Savart law (magnetic force and magnetic flux), Magnetic force on a current carrying conductor. Magnetic moment of a current-carrying circular loop, electric current in atoms, electron spin and magnetic moment, Hall effect	5

	in a conductor.	
Magnetic materials	Magnetic intensity and magnetic induction, Intensity of magnetization, Susceptibility, Permeability, Types of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials. Magnetization and magnetic susceptibility.	3
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