ST. ALOYSIUS COLLEGE(AUTONOMOUS), JABALPUR

Reaccredited 'A+ 'Grade by NAAC(CGPA:3.68/4.00)
College with Potential for Excellence by UGC
DST-FIST Supported & STAR College Scheme by DBT

Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. I Semester

Paper-Major& Minor

MECHANICS AND GENERAL PROPERTIES OF MATTER

Course Outcomes

	Course Outcomes	Cognitive Level
CO-I	The learner will use second order linear differential equations to study and solve problems in Harmonicoscillations	U, R, Ap,E
CO-II	Learner will be able to understand / recall Rigid body, Centre of mass, the connection between Rotational Dynamics and moment of inertia. Learner will be able todetermine the Moment of inertia about a given axis of symmetry for different uniform mass distributions.	R, ,U, Ap, An, R, E
CO-III	Learner will be able to understand and apply the law of conservation of linear momentum and understand the concept of center of mass, Elasticity and various elastic moduli	R, U, An, Ap, E
CO-IV	Learner will be able to understand Principles of fluid flow and the equations governing fluid dynamics such as equation of continuity, Bernoulli's Theorem etc.	R , U , Ap, An, E
CO-V	Learner will be able to understand / recall Conservative force field, Gravitational potential, Gravitational self-energy, Central force, reduced mass, Kepler's law, Scattering.	U,R,Ap,An
CO-VI	Learner will be able to understand the concept of AstroPhysics, special theory of relativity.	U,Ap, E,C

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	40	60	**100**
Practical	2	40	60	**100**
Total	**6**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week

Total No. of Lectures: 60 Hrs. **Maximum Marks:** 60

Units	Topics	No. of Lectures
I	**Historical background and Oscillations** **1.1 Historical background** 1.1.1 A brief historical background of mathematics and mechanics in the context of India andIndian culture. 1.1.2 A brief biography of Varahamihira and Vikram Sarabhai with their major contribution toscience and society. **1.2 Oscillations** 1.2.1 SHM: Simple Harmonic Oscillations. 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; Powerdissipation and Quality factor. Keywords: SHM, Gravitation, Oscillation, Quality factor.	12
II	**Mechanics of Rigid and deformable bodies** **2.1 Rigid body mechanics** 2.1.1 System of particles and concept of Rigid body, Torque, Centre of mass: position of the centre of mass, Motion of the centre of mass, Conservation of linear & angular momentum with examples, Systems of variable mass: Single stage and multistage rocket, Conveyor 2.1.2 Rotatory motion and concept of moment of inertia, Theorems on moment of inertia: theorem of addition, theorem of perpendicular axis, theorem of parallel axis, Calculationof moment of inertia of rectangular lamina, disc, solid cylinder, solid sphere. **2.2 Mechanics of deformable bodies:**	12

	2.2.1 Hook's law, Young's modulus, Bulk modulus, Modulus of rigidity and Poisson's ratio,Relationship between various elastic moduli. 2.2.2 Possible values of Poisson's ratio, Finding Poisson's ratio of rubber in the laboratory,Torsion of a cylinder, Strain energy of twisted cylinder. 2.2.3 Finding the modulus of rigidity of the material of a wire by Barton's method, Torsional pendulum and Maxwell's needle, Searle's method to find Y,η and σ of the material of wire, Bending of beam, Cantilever, Beam supported at its ends and loaded in the middle. **Keywords/Tags:** Rigid body, Centre of mass, Moment of inertia, Poisson's ratio.	
III	**Fluid mechanics** **3.1 Surface Tension** 3.1.1 Inter- molecular forces and potential energy curve, force of cohesion and adhesion. 3.1.2 Surface tension, Explanation of surface tension on the basis of intermolecular forces,Surface energy, Effect of temperature and impurities on surface tension, Daily life application of surface tension. 3.1.3 Angle of contact, The pressure difference between the two sides of a curved liquid surface, Excess pressure inside a soap bubble, Capillarity, determination of surface tension of a liquid –capillary rise method, Jaeger's method. **3.2 Viscosity** 3.2.1 Ideal and viscous fluid, Streamline and turbulent flow, Equation of continuity, Rotational and irrotational flow, Energy of a flowing fluid,	**12**

	Euler's equation ofmotion of a non-viscous fluid and its physical significance. 3.2.2 Bernoulli's theorem and its applications (Velocity of efflux, shapes of wings of airplane, Magnus effect, Filter pump, Bunsen's burner) 3.2.3 Viscous flow of a fluid, Flow of liquid through a capillary tube, Derivation of Poiseuille's formula and limitations, Stoke's formula, Motion of a spherical body fallingin a viscous fluid. **Keywords/Tags:** Inter-molecular force, Surface tension, Angle of contact, Capillarity, Viscosity,Euler's equation, Poiseuille's formula.	
IV	**Gravitational potential and central forces** **4.1.1** Gravitationalpotential [Conservative and non-conservative force field, Conservation of energy in motion under the conservative and non-conservative forces, Potential energy. **4.1.2** Conservative force, Conservation of energy, Gravitational potential and gravitational potential energy, Gravitational potential and intensity of gravitational field due to auniform spherical shell and a uniform solid sphere. **4.1.3** Gravitational self-energy, Gravitational self-energy of a uniform spherical shell and a uniform solid sphere. **4.2 Central forces** **4.2.1** Motion under Central forces, Conservative characteristics of central forces. **4.2.2** The motion of a two particles system in central force, Concept of reduced mass, Reducedmass of positronium and hydrogen.	12

	4.2.3 Motion of particle in an inverse-square central force, Motion of celestial bodies andderivation of Kepler's laws **4.2.4** Elastic and inelastic scattering (elementary idea). **Keywords/Tags:** Conservative force field, Gravitational potential, Gravitational self-energy,Central force, reduced mass, Scattering.	
V	**Relativistic Mechanics and Astrophysics** **5.1 Relativistic Mechanics:** **5.1.1** Frame of references, Galilean transformation, and Michelson-Morley experiment. **5.1.2** Postulates of special theory of relativity, Lorentz Transformation, Simultaneity and orderof events, Length contraction, Time dilation, Relativistic transformation of velocities, Variation of mass with velocity. **5.1.3** Mass-energy equivalence and its experimental verification. **5.2 Astrophysics** **5.2.1** Introduction to the universe, Properties of the Sun, Concept of Astronomical Distance. **5.2.2** Life cycle of stars, Chandrasekhar Limit, H-R diagram, Red giant star, White dwarf star,Neutron star, Black hole. **5.2.3** Big Bang Theory (elementary idea). **Keywords/Tags:** Transformation, Mass-energy equivalence, Astronomical distance,Chandrasekhar limit, Black hole.	**12**

References

Test/Reference Books:

1) Spiegel M. R., "Vector Alalysis: Schaum Outline Series ", McGraw Hill Education, 2017.
2) Mathur D. S., "Mechanics ", S.Chand, 2012.
3) Mathur D. S., "Properties of Matter ", Shyamlal Charitable trust, New Delhi.
4) Ghatak A. K., Goyal I. C., and Chua S. J. "Mathematical Physics", Laxmi Publications Private Limited, 2017.
5) Hans and Puri , "Mechanics " Tata McGraw Hill
6) Sears and Zeemansky, "University Physics", Pearson Education.
7) Kleppner and Kolenkov ," An Introduction to Mechanics" Tata McGraw Hill.
8) Resnick and Halliday "Fundamentals of Physics", 1966.

Web Links:
Suggested equivalent online courses:

1. **https://nptel.ac.in/courses/115/103/115103036/** Mathematical Physics by Dr. Saurabh Basu, IIT, Guwahati.
2. **https://nptel.ac.in/courses/115/106/115106090/** Mechanics, Heat, Oscillations and Waves by Prof. V. Balakrishanan, IIT, Chennai.

List of Experiments

1. Determination of Young's modulus, modulus of rigidity and Poisson's ratio of material of wire using Searle's method.

2. Determination of Young's modulus of material of a metallic bar by bending of beam method.

3. Determination of acceleration due to gravity (g) using bar pendulum.

4. Determination of acceleration due to gravity (g) using Kater's reversible pendulum.

5. Determination of modulus of rigidity of a rod with the help of Barton's apparatus.

6. Determination of coefficient of viscosity of liquid using Poiseuille's method.

7. Determination of moment of inertia of a fly wheel about its axis of rotation.

8. Determination of the moment of inertia of a given body (irregular body) with the help of inertia table.

9. Verification of the theorem of parallel/perpendicular axes of moment of inertia.

10. Determination of modulus of rigidity of material of wire with the help of Maxwell's needle.

11. Determination of Young's modulus of a rod using Cantilever method.

12. Determination of modulus of rigidity of material of wire with the help of torsional pendulum.

13. Determination of force constant of a spring.

14. Determination of Poisson's ratio of rubber.

15. Determination of surface tension of a liquid by Jaeger's method.

B.Sc. I Semester
Paper-Elective
MECHANICS AND GENERAL PROPERTIES OF MATTER

COURSE OUTCOME

	Course Outcomes	Cognitive Level
CO-I	The learner will use second order linear differentialequations to study and solve problems in Harmonic	U, R, E,C
CO-II	Learner will be able to understand / recall Rigid body,Centre of mass, the connection between Rotational Dynamics and moment of inertia. Learner will be able to determine the Moment of inertia about a given axis ofsymmetry for different uniform mass distributions.	R, ,U, Ap, An,R, E
CO-III	Learner will be able to understand and apply the law of conservation of linear momentum and understand the concept of center of mass, Elasticity and various elastic moduli	R, U, An, Ap,E
CO-IV	Learner will be able to understand Principles of fluid flow and the equations governing fluid dynamics such as equation of continuity, Bernoulli's Theorem etc.	R , U , Ap, An,E
CO-V	Learner will be able to understand / recall Conservative force field, Gravitational potential, Gravitational self- energy, Central force, reduced mass, Kepler's law, Scattering.	U,R,Ap, An

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	3	40	60	**100**
Practical	1	40	60	**100**
Total	**4**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 3.5 Hrs. per week

Total No. of Lectures: 45 Hrs. **Maximum Marks:** 60

Units	Topics	No. of Lectures
I	**Oscillations and Introduction to Astrophysics** **1.1 Oscillations** 1.1.1 SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Dampedoscillation. Forced oscillations: Transient and steady states; Resonance, sharpness ofresonance; Power dissipation and Quality factor. **1.2 Astrophysics** 1.2.1 Introduction to the universe, Properties of the Sun, Concept of Astronomical Distance. 1.2.2 Life cycle of stars, Chandrasekhar Limit, H-R diagram, Red giant star, White dwarf star,Neutron star, Black hole. 1.2.3 Big Bang Theory (elementary idea). Keywords: SHM, Gravitation, Oscillation, Quality factor, Astronomical distance, Chandrasekharlimit, Black hole.	12
II	**Mechanics of Rigid and deformable bodies** **2.1 Rigid body mechanics:** **2.1.1** System of particles and concept of rigid body, Torque, Centre of mass: position of the centre of mass, Motion of the centre of mass, Conservation of linear & angular momentum withexamples, Systems of variable mass: Single stage and multistage rocket, Conveyor **2.1.2** Rotatory motion and concept of moment of inertia, Theorems on moment of inertia: theorem of addition, theorem of perpendicular axis, theorem of parallel axis, Calculation of moment of inertia of	12

	rectangular lamina, disc, solid cylinder, solid sphere. **2.2 Mechanics of deformable bodies:** **2.2.1** Hook's law, Young's modulus, Bulk modulus, Modulus of rigidity and Poisson's ratio,Relationship between various elastic moduli. **2.2.2** Possible values of Poisson's ratio, Finding Poisson's ratio of rubber in the laboratory,Torsion of a cylinder, Strain energy of twisted cylinder. **2.2.3** Finding the modulus of rigidity of the material of a wire by Barton's method, Torsional pendulum and Maxwell's needle, Searle's method to find Y,ηand σ of the material of wire, Bending of beam, Cantilever, Beam supported at its ends and loaded in the middle. **Keywords/Tags:** Rigid body, Centre of mass, Moment of inertia, Poisson's ratio.	
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	viscous fluid and its physical significance 3.2.2 Bernoulli's theorem and its applications (Velocity of efflux, shapes of wings of airplane, Magnus effect, Filter pump, Bunsen's burner) 3.2.3 Viscous flow of a fluid, Flow of liquid through a capillary tube, Derivation of Poiseuille's formula and limitations, Stoke's formula, Motion of a spherical body falling in a viscous fluid. **Keywords/Tags:** Inter-molecular force, Surface tension, Angle of contact, Capillarity, Viscosity,Euler's equation, Poiseuille's formula.	
IV	**Gravitational potential and central forces** **4.1 Gravitational potential:** 4.1.1 Conservative force, Conservation of energy, Gravitational potential and gravitational potential energy, Gravitational potential and intensity of gravitational field due to a uniform spherical shell and a uniform solid sphere. 4.1.2 Gravitational self-energy, Gravitational self-energy of a uniform spherical shell anda uniform solid sphere. **4.2 Central forces:** 4.2.1 Motion under Central forces, Conservative characteristics of central forces. 4.2.2 The motion of a two particles system in central force, Concept of reduced mass,Reduced mass of positronium and hydrogen. 4.2.3 Motion of particle in an inverse-square central force, Motion of celestial bodies andderivation of Kepler's laws 4.2.4 Elastic and inelastic scattering (elementary idea). **Keywords/Tags:** Conservative force field, Gravitational potential, Gravitational self-energy,Central force, reduced mass, Scattering.	**12**

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2. **https://nptel.ac.in/courses/115/106/115106090/** Mechanics, Heat, Oscillations and Waves by Prof. V. Balakrishanan, IIT, Chennai

List of Practical

1. Determination of Young's modulus, modulus of rigidity and Poisson's ratio of material of wire using Searle's method.

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8. Determination of the moment of inertia of a given body (irregular body) with the help ofinertia table.

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11. Determination of Young's modulus of a rod using Cantilever method.

12. Determination of modulus of rigidity of material of wire with the help of torsional pendulum.

13. Determination of force constant of a spring.

14. Determination of Poisson's ratio of rubber.

15. Determination of surface tension of a liquid by Jaeger's method.

16. Determination of Young modulus of brass bar using Flexural Vibration.

Other experiments of the same difficulty level may be added.
Student needs to perform at least 06 experiments.