ST. ALOYSIUS COLLEGE(AUTONOMOUS), JABALPUR

Reaccredited 'A++ 'Grade by NAAC(CGPA:3.58/4.00)
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. II Semester
Paper-Major 2
MECHANICS AND GENERAL PROPERTIES OF MATTER
Course Outcomes

	Course Outcomes	Cognitive Level
CO-I	Learner will understand the contributions of Varahmihir and Vikram Sarabhai to science and the development of Mechanics in India.	U
CO-II	Learner will be able to analyze Kanad's law of motion, rigid body dynamics, center of mass, and conservation of linear and angular momentum.	R,An, E
CO-III	Learner will be able to investigate surface tension concepts, intermolecular forces, and apply methods to measure surface tension	Ap, E
CO-IV	Learner will be able to understand the concept of rotational irrotational flow and apply Bernoulli's theorem to fluid flow under different conditions	R, U, Ap
CO-V	Learner will be able to understand gravitational potential, central forces, and apply Kepler's law of planetary motion and predict about stability of Satellites orbits	U, Ap, C

R-Recall, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

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Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	30	70	100
Practical	2	30	70	100
Total	6	100		

Evaluation Scheme

	Marks	
	Internal	External
Theory	3 Internal Exams of 15 Marks (During the Semester, best 2 will be taken)	1 External Exam (At the End of Semester)
Practical	Question Answer /any given Task during class (Oral):10 Marks Attendance: 10 Marks Assignment/Presentation/Sessionalviva:10Marks	1 External Exam (At the End of Semester)

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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:** 70

Units	Topics	No. of Lectures
I	**Historical Background** [iii] 1. Historical perspective on the development of mechanics in india and its culture, Varahamihir and Vikram Sarabhai: Life and contribution towards science and society 2. Kanad's law of motion, Vaisheshika's theory of elasticity, concept of surface tension, fluidity and viscosity in ancient Indian text, Bhakaracharya Second's concept of gravitation, Aryabhatta's calculation of planetary distances. 3. Newton's Laws of motion, motion in uniform field, Newton's equation of motion. **Activities:** 1. Explain the concept of laws of motion proposed by Maharishi Kanad and conduct a comparative study with Newton's law of motion. 2. Assign students to research Bhaskaracharya II's idea of gravity from his book Sidddhanta Shiromani. *Keywords:* Kanad's law of motion, Vaisheshika's theory of elasticity.	12
II	**Rigid and deformable body** [vii] 1. System of particles and concept of Rigid body, Torque, Center of mass: position and motion of center of mass, Conservation of linear and angular momentum with examples, Single stage rocket. 2. Rotatory motion and concept of moment of inertia, Theorems of moment of inertia: theorem of addition, theorem of perpendicular axis, theorem of parallel axis, Calculation of moment of inertia of rectangular lamina, disc, solid cylinder and solid sphere. 3. Hook's law, Young's modulus, Bulk modulus, Modulus of rigidity and Poisson's ratio, Relationship between various elastic moduli, Possible values of Poisson's ratio, Poisson's ratio of rubber in Laboratory, Torsion of a cylinder and it's strain energy.	12

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	4. Determining modulus of rigidity of a wire using Torsional pendulum and Maxwell's needle, Searl's method to find Y, η and σ of the material of a wire, theory of bending beam, Cantilever, Young's Modulus of a beam supported at its ends and loaded in the middle. **Activities:** 1. Take a rubber strip and stretch it. Observe how its width decreases as the length increases. Use a vernier caliper to measure width reduction and calculate Poisson's ratio. 2. Take a thin wire and suspend weights at one end. Measure elongation using vernier calipers. Apply the Young's modulus formula to determine its value. *Keywords:* Young's modulus, Bulk modulus, Modulus of rigidity, Poisson's ratio	
III	**Surface Tension** [vii] 1. Inter-molecular forces and potential energy curve, force of cohesion and adhesion, 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. 2. Angle of contact, Expression for 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 and Jaegar's method. **Activities:** 1. Conduct an analytical study on the usefulness of capillarity and surface tension in daily life 2. Presentation: Importance of surface tension in daily life with examples. *Keywords:* Inter-molecular force, Surface tension, Angle of contact, Capillarity.	**12**
IV	**Viscosity** [vii] 1. Ideal and Viscous fluid, Streamline and turbulent flow, Equation of continuity, Rotational and irrotational flow, Energy of a flowing fluid, Euler's equation of motion of non-viscous fluid and its physical significance.	12

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	2. Bernoulli's theorem and its application s (Velocity of efflux, Venturimeter, shapes of wings of airplane, Magnus effect, Filter pump, Bunsen's Burner). 3. Viscous flow of a fluid and coefficient of viscosity, flow of a 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. **Activities:** 1. Gently place a dry sewing needle on water without breaking the surface. Observe how it floats due to surface tension. Add a drop of soap and watch the effect of impurities on surface tension. 2. Presentation: Importance of Viscosity and its importance in daily life with examples. *Keywords:* Viscosity, Euler's equation, Poiseuille's formula.	
V	**Gravitational potential and Central force** [vii] 1. Conservative and non-conservative force field, Conservation of energy in motion under the conservative and non-conservative forces. 2. Gravitational potential, intensity of gravitational field, gravitational potential energy, and gravitational self-energy, gravitational potential and intensity of gravitational field due to a solid sphere. 3. Motion under central forces, Conservative characteristics of central forces, The motion of two particle system in central force, Concept of reduced mass, Reduced mass of positronium and hydrogen, Motion of celestial bodies and derivation of Kepler's laws. **Activities:** 1. Tie a ball to a string and swing it in a circular motion. Observe that the force is always is always directed towards center (central force). Release the string and see how the ball moves tangentially. 2. Ask students to draw gravitational filed intensity diagrams for different mass distributions (such as a point mass and a solid sphere), and to plot the variation of gravitational potential and gravitational field with distance. *Keywords:* Conservative force field, Gravitational potential, Gravitational self-energy, Central force, reduced mass.	12

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Code Details: Gender – [i], Environment & Sustainability – [ii], Human Values – [iii],

Professional Ethics – [iv], Employability – [v], Entrepreneurship - [vi], Skill Development -[vii]

References

Suggested Readings:

1. Pandey R. C., "Surya siddhanta", Chaukhamba Surabharati Prakashan, Varanasi.
2. History of Science in Sanskrit Sentences, NCERT, 2018.
3. Bhaskara II, "Siddhanta Shiromani", (1150 CE).
4. Dongre N. G., Nene S. G., "Physics in Ancient India", National Book Trust, India.
5. Chakrabarty Debasish, "Vaisesika Sutra of Canada", D.K. Printworld P. Ltd., New Delhi.
6. Mathur D. S., "Mechanics", S. Chand, 2012.
7. Mathur D. S., "Properties of Matter", Shyamlal Charitable Trust, New Delhi.
8. Sears and Zeemansky, "University Physics", Pearson Education.
9. Books published by Madhya Pradesh Hindi Granth Academy, Bhopal.
10. Hans and Puri, "Mechanics "Tata McGraw Hill
11. Kleppner and Kolenkov ," An Introduction to Mechanics" Tata McGraw Hill.
12. Resnick and Halliday "Fundamentals of Physics", 1966.

Web Links:
Suggested equivalent online courses:

1. https://www.eshiksha.mp.gov.in/mpdhe/ Learning Management System, Department of higher education, Government of Madhya Pradesh (M.P.).
2. https://nptel.ac.in/courses /115/106/1151106090/ Mechanics, Heat, Oscillations and Waves by prof. V. Balakrishnan, Department of Physics of Physics, Indian Institute of Technology, Madras.

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List of Experiments [iv,] [vii]

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.

Other experiments of the same difficulty level may be added.
Student needs to perform at least 7 experiments.

REFERENCES

1. Arora C.L., "B.Sc. Practical Physics", S.Chand, New Delhi (2021).

2. Ghosh & Majumdar., "Advanced Practical Physics, Vol.1&Vol.2", Shridhar Publishers, Kolkata (2019)

3. Indu Prakash, "Textbook of Practical Physics, Vol.1&Vol.2, Kitab Mahal, New Delhi (2012)

4. B.L. Worsnop & H. T. Flint, "Advanced Practical Physics" Khosla Publishing House

5. Squires G.L., "Practical Physics", Cambridge University Press, (2001)