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. I Semester
Paper-Minor 1
Fundamentals of Mechanics and Matter

Course Outcomes

	Course Outcomes	Cognitive Level
CO-I	The learner will understand the contributions of Varahmihir and Vikram Sarabhai to science and analyze Kanad's law of motion	U,An
CO-II	Learner will be able to apply moment of inertia theorems and perform calculation of moment of inertia for different bodies and modulus of elasticity	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	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	3	30	70	100
Practical	1	30	70	100
Total	4	200		

Evaluation Scheme

	Marks	
	Internal	External
Theory	3 Internal Exams of 15 Marks (During the Semester, best 2 will be taken)	1 External Exams (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 Exams (At the End of Semester)

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Content of the Course
Theory

No. of Lectures (in hours per week): 3 Hrs. per week

Total No. of Lectures: 45 Hrs.   **Maximum Marks:** 70

Units	Topics	No. of Lectures
I	**Historical Background** [iii] 1. Varahamihir and Vikram Sarabhai: Life and contribution towards science and society 2. Kanad's three laws of motion, Vaisheshika's theory of elasticity, concept of surface tension, fluidity and viscosity in ancient Indian text, Bhakarachary's concept of gravitation, aryabhatta's calculation of planetary distances. **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's idea of gravity from his book Sidddhanta Shiromani. *Keywords:* Kanad's law of motion, Vaisheshika's theory of elasticity.	9
II	**Rigid and deformable body** [vii] 1. System of particles and concept of Rigid body, Torque, Center of mass: position of centre of mass, motion of center of mass, Conservation of linear and angular momentum with examples, Single stage rocket, Rotatory motion and concept of moment of inertia, Theorems on moment of inertia 2. Hook's law, Young's modulus, Bulk modulus, Modulus of rigidity and Poisson's ratio, Possible values of Poisson's ratio, Poisson's ratio of rubber in Laboratory, Torsion of a cylinder, strain energy of twisted cylinder. **3.** 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, bending of beam, Cantilever. **Activities:** 1. Take a rubber strip and stretch it. Observe how its width decreases as the length increases. Use a vernier caliper to	9

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	measure width reduction and calculate Poisson's ratio. 2. Take a thin wire and suspend weights at one end. Measure elongation using vernier callipers. 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, 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.	**9**
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. 2. Bernoulli's theorem and its applications (Velocity of efflux, shapes of wings of airplanes). 3. Viscous flow of a fluid and coefficient of viscosity, flow of a liquid through a capillary tube, Poiseuille's formula and Stoke's formula **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 in daily life with examples.	9

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	Keywords: Viscosity, Euler's equation, Poiseuille's formula.	
V	**Gravitational and Central force** [vii] 1. Conservative and non-conservative force field, Conservation of energy in motion under the conservative and non-conservative forces. Motion under central forces, Conservative characteristics of central forces 2. 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 directed towards center (central force). Release the string and see how the ball moves tangentially. **2.** Ask students to calculate reduced mass of Hydrogen atom and positronium *Keywords:* Conservative force field, Central force, reduced mass.	9

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. Hans and Puri , "Mechanics " Tata McGraw Hill
9. Kleppner and Kolenkov ," An Introduction to Mechanics" Tata McGraw Hill.
10. Resnick and Halliday "Fundamentals of Physics", 1966.
11. Sears and Zeemansky, "University Physics", Pearson Education.
12. Books published by Madhya Pradesh Hindi Granth Academy, Bhopal.

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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.

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.

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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)