Dr. V.S.KRISHNA GOVERNMENT DEGREE AND PG COLLEGE
(An Autonomous Institution Affiliated to Andhra University
Reaccredited by NAAC with A Grade (3rd Cycle)
District Resource Centre and Centre for Research Studies
Maddilapalem, Visakhapatnam 530013, Andhra Pradesh

Programme: B.Sc. Honours in Physics (Major)

w.e.f. AY 2023-24 **COURSE CODE 23PHYM21**

SEMESTER-II COURSE 3: MECHANICS AND PROPERTIES OF MATTER

Theory Credits: 3 3 hrs/week

Course Objective:

The course on Mechanics and Properties of Matter aims to provide students with a fundamental understanding of the behaviour of physical systems, both in terms of mechanical motion and in terms of the properties of matter

Learning outcomes:

On Completion of the course, the students will be able to		Knowledge level (Bloom's Taxonomy)
CO 1	Understand and apply the concepts of scalar and vector fields, calculate the gradient of a scalar field, determine the divergence and curl of a vector field	Level 2 (Understanding)
CO 2	Apply the laws of motion, solve equations of motion for variable mass systems	Level 3 (Applying)
CO 3	Define a rigid body and comprehend rotational kinematic relations, derive equations of motion for rotating bodies, analyse the precession of a top and gyroscope, understand the precession of the equinoxes	Level 2 (Understanding) Level 4 (Analysing)
CO 4	Define central forces and provide examples, understand the characteristics and conservative nature of central forces, derive equations of motion under central forces.	Level 2 (Understanding) Level 4 (Analysing)
CO 5	Differentiate between Galilean relativity and the concept of absolute frames, comprehend the postulates of the special theory of relativity, apply Lorentz transformations, understand, and solve problems	Level 2 (Understanding) Level 3 (Applying) Level 4 (Analysing)

UNIT-I VECTOR ANALYSIS

Scalar and vector fields, gradient of a scalar field and its physical significance. Divergence and curl of a vector field with derivations and physical interpretation. Vector integration (line, surface, and volume), Statement and proof of Gauss and Stokes theorems

UNIT-II MECHANICS OF PARTICLES

Laws of motion, motion of variable mass system, Equation of motion of a rocket. Conservation of energy and momentum, Collisions in two and three dimensions, Concept of impact parameter, scattering cross-section, Rutherford scattering-derivation.

UNIT-III MECHANICS OF RIGID BODIES AND CONTINUOUS MEDIA

Definition of rigid body, rotational kinematic relations, equation of motion for a rotating body, Precession of a top, Gyroscope, Precession of the equinoxes. Elastic constants of isotropic solids and their relations, Poisson's ratio, and expression for Poisson's ratio. Classification of beams, types of bending, point load, distributed load.

UNIT-IV CENTRAL FORCES

Central forces, definition and examples, characteristics of central forces, conservative nature of central forces, conservative force as a negative gradient of potential energy, equations of motion under a central force. Derivation of Kepler's laws. Motion of satellites. Basic idea of Global Positioning System (GPS)*

UNIT-V SPECIAL THEORY OF RELATIVITY

Galilean relativity, Absolute frames. Michelson-Morley experiment, The negative result. Postulates of special theory of relativity. Lorentz transformation, time dilation, length contraction, addition of velocities, mass-energy relation. Addition of velocities *, four vector formulation*.

(* Added contents of the syllabus)

Course with focus on Employability/ Entrepreneurship /Skill development modules					
Skill development		Employability		Entrepreneurship	

Topics added under Autonomous category

S.No	Title of the topic added	Justification
1	Basic idea of Global Positioning System (GPS)*	Incorporating GPS into the undergraduate syllabus can provide students with a solid foundation in a technology that has transformed the way we navigate and interact with the world
2	Addition of velocities	Learning about relativistic velocity addition helps students appreciate the beauty and elegance of Einstein's theory of special relativity
3	Four vector formulation	Four-vectors provide a unified framework to describe both

		spatial and temporal aspects of physical phenomena, aiding in the simplification and elegance of equations.

REFERENCE BOOKS:

1. BSc Physics -Telugu Akademy, Hyderabad
2. Mechanics - D.S. Mathur, Sulthan Chand & Co, New Delhi
3. Mechanics - J.C. Upadhyaya, Ramprasad & Co., Agra
4. Properties of Matter - D.S. Mathur, S.Chand & Co, New Delhi ,11th Edn., 2000
5. Physics Vol. I - Resnick-Halliday-Krane ,Wiley, 2001
6. Properties of Matter – Brijlal & Subrmanyam, S. Chand &Co. 1982
7. Dynamics of Particles and Rigid bodies– Anil Rao, Cambridge Univ Press, 2006
8. Mechanics-EM Purcell, Mc Graw Hill
9. University Physics-FW Sears, MW Zemansky & HD Young, Narosa Publications, Delhi
10. College Physics-I. T. Bhima sankaram and G. Prasad. Himalaya Publishing House.
11. Mechanics, S. G. Venkata chalapathy, Margham Publication, 2003.

CO-PO Mapping
1- Low, 2- Moderate, 3- High, '-' No Correlation

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1									
CO 2									
CO 3									
CO 4									
CO 5									

CO-PSO Mapping
1- Low, 2- Moderate, 3- High, '-' No Correlation

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1					
CO 2					
CO 3					
CO 4					
CO 5					

STUDENT ACTIVITIES

Unit I: Vector Analysis
Activity: Field Mapping

Students can choose a physical field (e.g., temperature, magnetic field) and create a field map by taking measurements at different points. They can then calculate the gradient of the field and analyse the variations. This activity helps them understand the concept of gradient in a scalar field.

Unit II: Mechanics of Particles
Activity: Collision Experiments

Students can set up simple collision experiments using marbles, carts, or other objects. They can measure the initial and final velocities, masses, and analyze the momentum conservation. By varying the conditions (e.g., masses, initial velocities), they can observe the effects on the collision outcomes.

Unit III: Mechanics of Rigid Bodies and Continuous Media
Activity: Balancing Act

Students can experiment with balancing various objects (e.g., rulers, books) on different points to understand the concept of center of mass and stability. They can analyse the equilibrium conditions and explore how the position of the center of mass affects the stability.

Unit IV: Central Forces
Activity: Pendulum Motion

Students can investigate the motion of a simple pendulum by varying its length and measuring the time period. They can analyze the relationship between the period and the length, and discuss the concept of centripetal force and its role in circular motion.

Unit V: Special Theory of Relativity
Activity: Time Measurement

Students can perform a time measurement experiment using simple devices like water clocks or sand timers. They can compare the measured time between two events at different relative speeds and discuss the concept of time dilation

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Programme: B.Sc. Honours in Physics (Major)
w.e.f. AY 2023-24 **COURSE CODE 23PHYM21P**

SEMESTER II COURSE 3: MECHANICS AND PROPERTIES OF MATTER

Practical | Credits: 1 | 2hrs/week

COURSE OBJECTIVE:

To develop practical skills in the use of laboratory equipment and experimental techniques for measuring properties of matter and analyzing mechanical systems.

Learning outcomes:

On Completion of the course, the students will be able to		Knowledge level (Bloom's Taxonomy)
CO 1	Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques to measure properties of matter and analyze mechanical systems	Level 2 (Understanding) Level 3 (Applying) Level 4 (Analysing)
CO 2	Application of theory to practice: Students should be able to apply theoretical concepts learned in lectures to real-world situations, and understand the limitations of theoretical models.	Level 3 (Applying)
CO 3	Accurate recording and analysis of data: Students should be able to accurately record and analyze experimental data, including understanding the significance of error analysis and statistical methods.	Level 2 (Understanding) Level 3 (Applying) Level 4 (Analysing)
CO 4	Critical thinking and problem solving: Students should be able to identify sources of error, troubleshoot experimental problems, and develop critical thinking skills in experimental design and analysis	Level 2 (Understanding) Level 4 (Analysing) Level 5 (Evaluating)
CO 5	Understanding of physical principles: Students should develop an understanding of the physical principles governing mechanical systems and the properties of matter, including elasticity, viscosity, and thermal expansion.	Level 2 (Understanding) Level 3 (Applying) Level 4 (Analysing)

Minimum of 6 experiments to be done and recorded

1. Viscosity of liquid by the flow method (Poiseuille's method)
2. Young's modulus of the material of a bar (scale) by uniform bending
3. Young's modulus of the material a bar (scale) by non- uniform bending
4. Surface tension of a liquid by capillary rise method
5. Determination of radius of capillary tube by Hg thread method
6. Viscosity of liquid by Searle's viscometer method
7. Bifilar suspension –moment of inertia of a regular rectangular body.
8. Determination of moment of inertia using Fly-wheel
9. Determination of the height of a building using a sextant.
10. Rigidity modulus of material of a wire-dynamic method (torsional pendulum)

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SEMESTER II COURSE 3: MECHANICS AND PROPERTIES OF MATTER

Theory | Credits: 3 | 3 hrs/week

Blue Print for Semester End Theory Examinations

S.No	Type of question	No of questions given			No of questions to be answered		
		No of questions	Marks allotted to each question	Total marks	No of questions	Marks allotted to each question	Total marks
1	Section A Short answer questions	10 (Two questions from each unit)	4	40	5 (Any five out of 10 questions)	4	20
2	Section B Long answer questions	10 (Two questions from each unit with only internal choice)	8	80	5 (Answer one question from each unit)	8	40
Total				120			60

Percentage of choice given $= \frac{(120-60)}{120} \times 100 = 50\%$

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SEMESTER-II COURSE 3: MECHANICS AND PROPERTIES OF MATTER

BLUE PRINT FOR SEMESTER END EXAMINATIONS PAPER SETTING

Learning level wise Weightage

Bloom's Taxonomy level	Weightage	Marks	Essay type	Short answer type
Knowledge/ Remember	33%	20	2(two out of four)	I (one out of two)
Understanding/ Comprehension	27%	16	2(two out of four)	
Application	20%	12	I (one out of two)	I (one out of two)
Analysis	13%	8		2(two out of four)
Synthesis/ Evaluate	7%	4		I (one out of two)
Total	IOO	60	5(each question has internal choice)	5 out of 10 questions

Chapter wise Weightage

Sl. No.	Module/ Chapter	Name of the chapter	8 Marks	4 Marks
1	**I**	VECTOR ANALYSIS	2(one out of two)	2
2	**II**	MECHANICS OF PARTICLES	2(one out of two)	2
3	**III**	MECHANICS OF RIGID BODIES AND CONTINUOUS MEDIA	2(one out of two)	2
4	**IV**	CENTRAL FORCES	2(one out of two)	2
5	**V**	SPECIAL THEORY OF RELATIVITY	2(one out of two)	2
			5(each question has internal choice)	5 out of given 10

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SEMESTER II COURSE 3: MECHANICS AND PROPERTIES OF MATTER

Theory Credits: 3 3 hrs/week

Model Question Paper

Duration: 3Hrs **Max Marks: 60**

Section A

Answer any five questions from the following ($4M \times 5 = 20M$)

1. **Show that curl of a conservative force is zero?**
2. **What is line integral, write its significance?**
3. **Explain conservation of energy and momentum?**
4. **Explain collisions in two dimensions?**
5. **Write a short note on Gyroscope?**
6. **Explain precession of equinoxes?**
7. **Show that central force can be written as negative gradient of potential energy?**
8. **Write a short note on GPS**
9. **Explain length contraction?**
10. **State the postulates of special theory of relativity?**

Section B

Answer all the questions ($8M \times 5 = 40M$)

11. **(a) State and prove Gauss Divergence theorem in vectors**

(OR)

(b) State and prove Stokes's theorem

12. **(a) Define Variable Mass System? Derive an expression for the final velocity of the Rocket?**

(OR)

(b) Define impact parameter and scattering cross section? Derive an expression for Scattering Angle

13. **(a) Write rotational kinematic relations of a rigid body and derive equation of motion of a rigid body?**

(OR)

(b) What are elastic constants of an isotropic solids and obtain their relations?

14. **(a) Define Central Force? Obtain the equation of motion of a body under central force**

(OR)

(b) State Kepler's Laws? Prove Kepler's first law of Planetary Motion

15. **(a) Derive equations of Lorentz Transformations of Space and Time**

(OR)

(b) Derive the Einstein Mass-Energy Relationship

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Programme: B.Sc. Honours in Physics (Major)
w.e.f. AY 2023-24
SEMESTER-II COURSE CODE: 23PHYM22: **WAVES AND OSCILLATIONS**

Theory Credits:3 3hrs/week

COURSEOBJECTIVE:

This course provides students with a broad understanding of the physical principles of the oscillations, to help them develop critical thinking and quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments.

LEARNINGOUTCOMES:

The student should be able

1. To describe the basic characteristics of waves such as frequency, wavelength, amplitude, period, and speed.
2. To utilize mathematical relationships related to wave characteristics.
3. To compare particle motion and wave motion in different types of waves.
4. To distinguish between Longitudinal and Transverse waves.
5. To get the knowledge about how to construct and analysis the square waves, saw tooth waves,etc.fromFourieranalysis.

UNIT-I SimpleHarmonicoscillations

Simple harmonic oscillator and solution of the differential equation-Physical characteristics of SHM, torsion pendulum-measurements of rigidity modulus, compound pendulum-measurement of 'g', Principle of superposition, beats, combination of two mutually perpendicular simple harmonic vibrations of same frequency and different frequencies. Lissajous figures.

UNIT-II Damped and forced oscillations

Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations, comparison with un-damped harmonic oscillator, logarithmic decrement, relaxation time, quality factor, differential equation of forced oscillator and its solution, amplitude resonance and velocity resonance.

UNIT-IIIComplexvibrations

Fourier theorem and evaluation of the Fourier coefficients, analysis of periodic wave functions-squarewave,triangular wave,saw toothwave, simple problemson evolutionof Fourier coefficients.

UNIT-IVVibratingStringsandBars

Transversewavepropagationalongastretchedstring,generalsolutionofwaveequationanditssignificance,modesofvibrationofstretchedstringclampedatends,overtonesandharmonics.Energy transport and transverse impedance. Longitudinal vibrations in bars-wave equation and its general solution. Special cases (i) bar fixed at both ends (ii) bar fixed at the midpoint (iii) bar fixed at one end. Tuning fork.

UNIT-V Ultrasonics:

Ultrasonics, properties of ultrasonic waves, production of ultrasonics by piezoelectric and magnetostrictive methods, detection of ultrasonics, determination of wave length of ultrasonic waves. Applications and uses of ultrasonic waves.

REFERENCE BOOKS:

1. BSc Physics Vol.1,Telugu Academy, Hyderabad.
2. Fundamentals of Physics.Halliday,Resnick&Walker,WileyIndiaEdition2007.
3. Waves&Oscillations.S.Badami,V.BalasubramanianandK.R.Reddy,Orient Longman.
4. CollegePhysics-I.T. Bhimasankaram andG.Prasad.HimalayaPublishingHouse.
5. ScienceandTechnologyofUltrasonics- Baldevraj,Narosa,NewDelhi,2004
6. IntroductiontoPhysicsforScientistsandEngineers.F.J.Buche.McGraw Hill.

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SEMESTER-II COURSE CODE: 23PHYM22: **WAVES AND OSCILLATIONS**

Practical Credits:1 2hrs/week

COURSEOBJECTIVE:

This course provides students with a broad understanding of the physical principles of the oscillations, to help them develop critical thinking and quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments.

LEARNINGOUTCOMES:

1. Students are made to determine the unknown frequency of tuning fork by volume resonator experiment
2. Students are made to determine 'g' by compound bar pendulum
3. Students are made to determine the force constant of a spring by static and dynamic method.
4. Students are made to determine the elastic constants of the material of a flat spiral spring.
5. Students are made to verify the laws of vibrations of stretched string – sonometer
6. Students are made to determine the frequency of a bar– Melde's experiment.
7. Students are made to study the damped oscillation using the torsional pendulum immersed in liquid- decay constant and damping correction of the amplitude.
8. Students are made to form Lissajous figures using CRO.

Minimum of 6 experiments to be done and recorded

Experiments

1. Volume resonator experiment
2. Determination of 'g' by compound bar pendulum
3. Simple pendulum normal distribution of errors-estimation of time period and the error of the mean bystatisticalanalysis
4. Determinationofthe forceconstantof aspringbystatic and dynamicmethod.
5. Determinationofthe elasticconstantsofthematerialofaflatspiralspring.
6. Coupledoscillators
7. Verificationoflawsofvibrations ofstretchedstring sonometer

8. Determinationoffrequencyof abar–Melde'sexperiment.
9. Studyofadampedoscillationusingthetorsionalpendulumimmersedinliquid-decayconstantanddampingcorrection ofthe amplitude.
10. Formationof LissajousfiguresusingCRO.

STUDENTACTIVITIES

Unit-I Simple Harmonic oscillations:

Activity: Measuring the period ofasimplependulumandverifyingtherelationshipbetween the period and the length of the pendulum. Students can use a stopwatch and arulerto measurethe time forafixed numberof oscillations and calculate theperiod.

Unit-IIDamped andforced oscillations:

Activity: Measuring the damping coefficient of a mass-spring system and calculating thequality factor. Students can measure the amplitude of the system as it undergoes dampedoscillationsandusethelogarithmicdecrementformulatocalculatethedampingcoefficient. They can then use the formula for the quality factor to evaluate the quality ofthesystem.

Unit-IIIComplexvibrations:

Activity:ConstructingasquarewaveusingFourierseriesandanalyzingitsFouriercoefficients. Students can use a software tool or a programming language to generate asquare wave and then compute the Fourier coefficients. They can then plot the magnitudespectrumof thewaveform and observethe harmonic components.

Unit-IVVibratingStringsandBars:

Activity: Measuring the speed of sound in a metal rod and comparing it with the theoreticalvalue. Students can use a microphone and an oscilloscope to measure the time delaybetween two reflections of a sound pulse in the rod. They can then use the formula for thespeedofsound inasolidto calculatethespeedandcompareitwith thetheoretical value.

Unit-VUltrasonics:

Activity: Measuring the wavelength of ultrasonic waves using the diffraction of light.Students can use a laser and a diffraction grating to create a diffraction pattern of anultrasonicwave.Theycanthenmeasurethedistancebetweenthediffractionfringesanduse the formula for the diffraction of light to calculate the wavelength of the ultrasonicwave.

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Programme: B.Sc. Honours in Physics (Major)

w.e.f. AY 2023-24

SEMESTER-II COURSE CODE: 23PHYM22: **WAVES AND OSCILLATIONS**

Course :4 Max Marks-60 Time-3Hrs. Credits:3

Learning level wise Weightage				
Bloom's Taxonomy level	Weightage	Marks	Essay type	Short answer type
Knowledge/ Remember	33%	20	2(two out of four)	1(one out of two
Understanding/ Comprehension	27%	16	2(two out of four)	
Application	20%	12	1(one out of two)	1(one out of two
Analysis	13%	8		2(two out of four)
Synthesis/ Evaluate	7%	4		1(one out of two
Total	100	60	5(each question has internal choice)	5 outb of 10 questions

Chapter wise Weightage

S.No	Module/ Chapter	Name of the chapter	8 marks	4 marks
1	I	Simple Harmonic oscillations	2(one out of two)	2
2	II	Damped and forced oscillations	2(one out of two	2
3	III	Complex vibrations	2(one out of two	2
4	IV	Vibrating Strings and Bars	2(one out of two	2
5	V	Ultrasonics	2(one out of two	2
		TOTAL QUESTIONS	5(each question has internal choice)	5 out of given 10

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SEMESTER-II COURSE CODE: 23PHYM22: **WAVES AND OSCILLATIONS**

(MODEL PAPER)

DURATION::3 hrsMAX.MARKS :: 60

SECTION-A

Answer any FIVE questions of the following **(5 X 4 = 20 M)**

1.What are the characteristics of simple harmonic motion.

2. Give the theory of torsional pendulum.

3. Explain the term logarithmic decrement.

4. Explain relaxation time and Q- Factor.

5. State and explain Fourier theorem

6. How do you evaluate Fourier coefficients?

7. Explain fundamental frequency, overtones and harmonics.

8. Explain the energy transport in a stretched string.

9. What are the applications of ultrasonics.

10. Explain various methods used in detection of ultrasonics.

SECTION-A

Answer ALL the questions Of the following **(5 X 8 = 40 M)**

11. (a).What is simple harmonic oscillator? Derive equation of motion of simple harmonic oscillator and find its solution.

[OR]

(b) Discuss the linear combination of two mutually perpendicular simple harmonic vibrations of equal frequency.

12 (a) Describe the equation of motion of damped harmonic oscillator and find the solution. Explain the conditions for under damped motion

[OR]

(b) What are Forced oscillations? Obtain an expression for the amplitude of forced oscillations

13(a) Analize square wave using Fourier theorem.

[OR]

(b)Analize square wave using Fourier theorem

14 (a) Obtain the equation for the velocity of transverse wave in a stretched string and discuss the solution of wave equation.

[OR]

(b) Derive the general solution of a longitudinal wave in a bar. Discuss the modes of vibrations for (a) the bar free at both ends (b) the bar fixed at one end.

15 (a) Explain how ultrasonic waves can be produced using Piezo-electric method.

[OR]

(b) What is Magnetostriction? Explain hoe it is used to produce ultrasonic waves.

Short answer questions

1. What are the characteristics of simple harmonic motion.
2. . Give the theory of torsional pendulum.
3. What are Lissajous figures? Explain.
4. Explain the term logarithmic decrement.
5. Explain relaxation time and Q- Factor.
6. Explain Amplitude resonance.
7. Derive the differential equation of damped oscillator.
8. State and explain Fourier theorem.
9. How do you evaluate Fourier coefficients?
10. Analyse a square wave using Fourier theorem.
11. Explain fundamental frequency, overtones and harmonics.
12. Explain the energy transport in a stretched string.
13. What is transverse impedance?
14. Explain the energy transport in a stretched string.
15. What are the applications of ultrasonics.
16. Explain various methods used in detection of ultrasonics.