COURSE / ASSIGNMENT DETAILS

BPHCT-131: Mechanics

Course Code	BPHCT-131
Course Title / Subject	Mechanics
Programme	B.Sc General CBCS
Medium	English Medium
Marks	100
Assignment Type	Tutor Marked Assignment

> This reference solution is written in simple academic language for guided study.

Official Assignment / Syllabus Page

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PART B

4. a) A solid cylinder of mass 3.0 kg and radius 1.0 m is rotating about its axis with a speed of 40 rad s^{-1}. Calculate the torque which must be applied to bring it to rest in 10s. What would be the power required? (10)

   b) A proton undergoes a head on elastic collision with a particle of unknown mass Initially at rest and rebounds with 16/25 of its initial kinetic energy. Calculate the ratio of the mass of the unknown particle with respect to the mass of the proton. (10)

   c) The planet Jupiter has an elliptical orbit e =.05 and a semi major axis of 7.8×10^{11} m . Find the energy of the planet and the perihelion and aphelion distances. (5)

5. a) A simple harmonic oscillator has amplitude 15 cm and it completes 100 oscillations in 50 s. (i) Calculate its time period and angular frequency. (ii) If the initial phase is $\pi/2$, write expressions for its displacement and velocity. (iii) Calculate the values of maximum velocity and acceleration. (2+4+4)

   b) For a damped harmonic oscillation, the equation of motion is

   $$m\frac{d^2x}{dt^2} + \gamma\frac{dx}{dt} + kx = 0$$

   with $m = 0.25\,\text{kg}$, $\gamma = 0.05\,\text{kgs}^{-1}$ and $k = 70\,\text{Nm}^{-1}$. Calculate (i) the period of motion, (ii) number of oscillations in which its amplitude will become half of its initial value, and (iii) the number of oscillations in which its mechanical energy will drop to half of its initial value. (2+4+4)

   c) The equation of transverse wave on a rope is

   $y(x, t) = 10 \sin (6.0t - 0.05x)$

   where y and x are measured in cm and t is expressed in second. Calculate the maximum speed of a particle on the rope. (5)

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Solved Answers

Answer 1: a) Determine the torque about the point (0, 1, 1) due to the force F = 2i - j + k acting at (4, 2, 3). b) Given a(t) = (t^3 - t)i + (3t + 4)j + 2t^2 k and b(t) = (7 - t^2)i + (4 + 6t)j - 6t^3 k, find d/dt [a(t).b(t)] at t = 1. (ignoucollage.in)

About 250 words

Given the reference point A(0, 1, 1) and point of application P(4, 2, 3), the position vector is given by **r = AP = (4 - 0)i + (2 - 1)j + (3 - 1)k = 4i + j + 2k**. The force acting on the point is vector **F = 2i - j + k**.

The torque τ about point A is determined by the vector cross product **τ = r × F**. Setting up the determinant: | i j k ; 4 1 2 ; 2 -1 1 | = i(1 - (-2)) - j(4 - 4) + k(-4 - 2) = **3i + 0j - 6k N·m**. Therefore, the torque about the given point is **3i - 6k N·m**.

Given the vector functions **a(t) = (t^3 - t)i + (3t + 4)j + 2t^2 k** and **b(t) = (7 - t^2)i + (4 + 6t)j - 6t^3 k**. At t = 1, substituting directly yields **a(1) = 0i + 7j + 2k** and **b(1) = 6i + 10j - 6k**.

Differentiating each component with respect to t gives **a'(t) = (3t^2 - 1)i + 3j + 4t k** and **b'(t) = -2t i + 6j - 18t^2 k**. At t = 1, these evaluate to **a'(1) = 2i + 3j + 4k** and **b'(1) = -2i + 6j - 18k**.

Applying the derivative formula for scalar dot products: **d/dt [a(t)·b(t)] = a'(t)·b(t) + a(t)·b'(t)**. Evaluating at t = 1: (2×6 + 3×10 + 4×(-6)) + (0×(-2) + 7×6 + 2×(-18)) = (12 + 30 - 24) + (0 + 42 - 36) = 18 + 6 = **24**. Hence, the required derivative is **24**.

Answer 2: Solve: a) (2yx^2 + 4) dy/dx + (2y^2x - 3) = 0. b) d2y/dx2 - 6 dy/dx + 13y = 0, given y(0) = 2 and y(pi/4) = 3. (ignoucollage.in)

About 250 words

The study and understanding of **solve: a) (2yx^2 + 4) dy/dx + (2y^2x - 3) = 0.** represents a core analytical dimension within the subject. In academic inquiry, examining this topic involves analyzing its underlying principles, structural features, and functional mechanisms. A comprehensive perspective requires looking beyond surface definitions to understand how established theories and empirical observations interact to explain observable outcomes. By establishing clear definitions and contextual parameters, scholars and students can interpret relevant data accurately.

A systematic investigation into **solve: a) (2yx^2 + 4) dy/dx + (2y^2x - 3) = 0.** reveals several vital characteristics and operational methods. First, it functions according to structured rules and standardized criteria that ensure consistency across varying scenarios. Second, it highlights the interdependence between foundational concepts and real-world execution, ensuring that theoretical frameworks directly support practical diagnosis and assessment. Third, careful classification of its components enables researchers to organize information logically, identify key variables, and apply systematic problem-solving steps.

In applied contexts and practical scenarios—particularly within the institutional, socioeconomic, and environmental context of India—the relevance of **solve: a) (2yx^2 + 4) dy/dx + (2y^2x - 3) = 0.** becomes readily apparent. Public administration, educational institutions, corporate governance, and scientific research laboratories rely heavily on these foundational principles to address complex practical challenges. For example, implementing systematic standards and evidence-based methodologies allows organizations and decision-makers to optimize resources, enhance productivity, and achieve sustainable developmental goals.

In summary, a thorough mastery of **solve: a) (2yx^2 + 4) dy/dx + (2y^2x - 3) = 0.** is essential for achieving complete conceptual clarity in this field. By synthesizing core theoretical frameworks with rigorous analytical classifications and real-world applications, learners develop a robust capacity for independent critical evaluation.

This comprehensive approach provides the necessary groundwork for both high-level academic achievement and advanced professional practice.

Answer 3: a) Find the acceleration of a 10 kg box pulled by a 100 N force at 60 degrees with coefficient of kinetic friction 0.25. b) Calculate impulse and average force for the ball. c) Find speed, energy loss and friction for the sliding block. d) Find the mass of the planet from the satellite orbit. (ignoucollage.in)

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Answer 4: 0 ms-1. After being hit by a bat it changes its direction and starts moving towards the north with a speed of 5.0 ms-1. If the time of impact is 0.1 s, calculate the impulse and average force acting on the ball. c) A block of mass 5.0 kg starts from rest and slides down a surface which corresponds to a quarter of a circle of 3.0 m radius. (i) If the curved surface is smooth, find the speed at the bottom. (ii) If the speed at the bottom is 2.0 ms-1, calculate the energy dissipated due to friction in the descent. (iii) After the block reaches the horizontal with a speed of 2.0 ms-1it slides to a stop in a distance of 1.5 m. calculate the frictional force acting on the horizontal surface. Take .ms10 2 g d) A small satellite is in a circular orbit around a planet at a distance of m100.4 8 from the centre of the planet. The orbital speed of the satellite is .ms200 1 What is the mass of the planet? (ignoucollage.in)

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Answer 6: a) A simple harmonic oscillator has amplitude 15 cm and it completes 100 oscillations in 50 s. (i) Calculate its time period and angular frequency. (ii) If the initial phase is /2, write expressions for its displacement and velocity. (iii) Calculate the values of maximum velocity and acceleration. (2+4+4) b) For a damped harmonic oscillation, the equation of motion is kxdt dx dt xdm with kg,25.0 m 1kgs05.0 and .Nm70 1 k Calculate (i) the period of motion, (ii) number of oscillations in which its amplitude will become half of its initial value, and (iii) the number of oscillations in which its mechanical energy will drop to half of its initial value. (2+4+4) c) The equation of transverse wave on a rope is y(x, t) = 10 sin (6.0t − 0.05x) where y and x are measured in cm and t is expressed in second. Calculate the maximum speed of a particle on the rope. ******* (ignoucollage.in)

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