Assignment Booklet

BACHELOR'S DEGREE PROGRAMME
(BSCG/BSCM)

MECHANICS

Valid from 1st January, 2025 to 31st December, 2025

ignou
THE PEOPLE'S
UNIVERSITY

School of Sciences
Indira Gandhi National Open University,
Maidan Garhi, New Delhi-110068
(2025)

Dear Student,

Please read the section on assignments in the Programme Guide for B.Sc. that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, **which would consist of one tutor-marked assignment** for this course. The assignment is in this booklet, and it consists of two parts, Part A and B. The total marks of all the parts are 100, of which 35% are needed to pass it.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully:

1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ENROLMENT NO.: …..………………………………………

NAME: ……………………………………………………

ADDRESS: ………………………………………………

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COURSE CODE:…………………………….

COURSE TITLE: ………………………….

ASSIGNMENT CODE: …………………..

STUDY CENTRE: ………………………..   **DATE:** ……………………………………...

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise.

5) Solve Part A and Part B of this assignment, and **submit the complete assignment answer sheets containing Parts A and B within the due date.**

6) The assignment answer sheets are to be submitted to your Study Centre as per the schedule. **Answer sheets received after the due date shall not be accepted.**

   We strongly suggest that you retain a copy of your answer sheets.

7) This assignment is **valid from 1ˢᵗ January, 2025 to 31ˢᵗ December, 2025**. If you have failed in this assignment or fail to submit it by December 31, 2025, then you need to get the assignment for the year 2026, and submit it as per the instructions given in the Programme Guide.

8) **You cannot fill the examination form for this course** until you have submitted this assignment. For any queries, please contact: srjha@ignou.ac.in, slamba@ignou.ac.in

We wish you good luck.

Tutor Marked Assignment
MECHANICS

Note: Attempt all questions. The marks for each question are indicated against it.

PART A

1. a) Determine the torque about the point (0, 1, 1) due to a force $\vec{F} = 2\hat{i} - \hat{j} + \hat{k}$ being exerted at the point (4, 2, 3). (5)

   b) Given two vector functions $\vec{a}(t) = (t^3 - t)\hat{i} + (3t + 4)\hat{j} + 2t^2\hat{k}$ and $\vec{b}(t) = (7 - t^2)\hat{i} + (4 + 6t)\hat{j} - (6t^3)\hat{k}$, determine the derivative of $\vec{a}(t) \cdot \vec{b}(t)$ at $t = 1$. (5)

2. Solve the following ordinary differential equations:

   a) $\left(2yx^2 + 4\right)\dfrac{dy}{dx} + \left(2y^2 x - 3\right) = 0$ (5)

   b) $\dfrac{d^2 y}{dx^2} - 6\dfrac{dy}{dx} + 13y = 0$ for $y(0) = 2$, $y\left(\dfrac{\pi}{4}\right) = 3$. (10)

3. a) A box of mass 10 kg is being pulled on the floor by a mass-less rope with a force of 100 N at an angle of 60° to the horizontal. What is the acceleration of the box if the coefficient of kinetic friction between the floor and the box is $\mu_k = 0.25$? Take $g = 10\,\text{ms}^{-2}$. (5)

   b) A ball having a mass of 0.5 kg is moving towards the east with a speed of velocity 6.0 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. (5)

   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⁻¹ it slides to a stop in a distance of 1.5 m. calculate the frictional force acting on the horizontal surface. Take $g = 10\,\text{ms}^{-2}$. (10)

   d) A small satellite is in a circular orbit around a planet at a distance of 4.0×10^8 m from the centre of the planet. The orbital speed of the satellite is 200 ms⁻¹. What is the mass of the planet? (5)

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 $m = 0.25$ kg, $\gamma = 0.05$ kgs⁻¹ and $k = 70$ 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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