

BPHCT-131

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME

(BSCG)

MECHANICS

Valid from 1st January, 2023 to 31st December, 2023



**School of Sciences
Indira Gandhi National Open University,
Maidan Garhi, New Delhi-110068
(2023)**

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:

.....

.....

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, 2023 to 31st December, 2023**. If you have failed in this assignment or fail to submit it by December 31, 2023, then you need to get the assignment for the year 2024, 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

Course Code: BPHCT-131

Assignment Code: BPHCT-131//TMA/2023

Max. Marks: 100

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

PART A

1. a) Determine two unit vectors perpendicular to both $\vec{A} = \hat{i} - 2\hat{j} + 3\hat{k}$ and $\vec{B} = -2\hat{i} + 4\hat{j}$. (5)

b) For any two vectors \vec{u} and \vec{v} show that:

$$(\vec{u} \cdot \vec{v})^2 - [(\vec{u} \times \vec{v}) \times \vec{v}] \cdot \vec{u} = u^2 v^2 \quad (5)$$

2. Solve the following ordinary differential equations:

a) $\frac{d^2 y}{dx^2} + 2\frac{dy}{dx} + 2y = 0, \quad y(0) = 2, \quad y'(0) = 1$ (10)

b) $\frac{1}{x} \sin y dx + (\ln x \cos y + y) dy = 0$ (5)

3. a) A car has a weight of 12,000 N. The coefficient of kinetic friction between its wheels and the wet highway is 0.5. The car is travelling at 20 ms^{-1} when brakes are applied. How far does the car travel before it comes to a complete stop? Take $g = 10 \text{ ms}^{-2}$. (5)

b) A crate of mass 20.0 kg is pulled by a force of 180 N, up an inclined plane which makes an angle of 30° with the horizon. The coefficient of kinetic friction between the plane and the crate is $\mu_k = 0.225$. If the crate starts from rest, calculate its speed after it has been pulled 15.0 m. Draw the free body diagram. (10)

c) A ball having a mass of 0.5 kg is moving towards the east with a speed of velocity 8.0 ms^{-1} . After being hit by a bat it changes its direction and starts moving towards the north with a speed of 6.0 ms^{-1} . If the time of impact is 0.1 s, calculate the average force acting on the ball. (5)

d) The vertical circular ride in an amusement park has a radius of 40 m. You are sitting in a car that is just at the top of the ride. How fast must the car be moving so that you momentarily lift off your seat and feel weightless? Take $g = 10 \text{ ms}^{-2}$. (5)

PART B

4. a) A grinding wheel starts from rest and has a constant angular acceleration of 5 rad s^{-2} . At $t = 5 \text{ s}$ find the total acceleration at a point 1.0 m from the axis. (5)

b) An insect of mass 20 g crawls from the centre to the outside edge of a rotating disc of mass 200g and radius 20 cm. The disk was initially rotating at 22.0 rads^{-1} . What will be its final angular velocity? (5)

- c) The comet Encke has an aphelion distance of $6.1 \times 10^{11} \text{m}$ and perihelion distance of $5.1 \times 10^{11} \text{m}$. The mass of the sun is $2.0 \times 10^{30} \text{kg}$. Calculate the speed of the comet at the perihelion. (5)
- d) The mass (in kg) and position coordinates (in m) of a system of three particles A, B and C are as follows:

Particle	Mass	Position
A	2.0 kg	(0, 0)
B	1.0 kg	(2, 0)
C	3.0 kg	(1, 1)

Calculate the coordinates of the centre of mass of the system. (5)

- e) A particle of mass 10.0 kg, initially moving with a velocity of 5.0ms^{-1} collides elastically with a particle of mass 5.0 kg, initially moving with a velocity of -8.0ms^{-1} . What are the velocities of the two particles before and after the collision in the centre of mass frame of reference? (5)
5. a) The amplitude of oscillation of a simple harmonic oscillator is 40 cm. Show that its instantaneous kinetic energy is less than its average kinetic energy when the displacement is 30 cm. (5)
- b) Two collinear harmonic oscillations are represented by:

$$x_1 = 6 \sin \left(10\pi t + \frac{\pi}{6} \right) \text{ cm} ; x_2 = 8 \sin \left(10\pi t + \frac{\pi}{3} \right) \text{ cm}$$

Calculate the amplitude, phase constant, and the period of resultant oscillation obtained on superposing these two collinear oscillations. (10)

- c) The quality factor of a sonometer wire is 3000. The wire vibrates at a frequency of 250 Hz. Calculate the time in which its amplitude will reduce to half of its initial value. (5)
- d) A transverse wave travelling in the positive x-direction is given by $y(x, t) = 6 \sin(8t - .05x) \text{ cm}$, where x is in cm and t is in seconds. Calculate the velocity of the wave and the maximum particle velocity. (5)
