BPHCT-131

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME

(BSCG)

MECHANICS

Valid from 1st January, 2022 to 31st December, 2022

School of Sciences
Indira Gandhi National Open University,
Maidan Garhi, New Delhi-110068
(2022)

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, 2022 to 31st December, 2022**. If you have failed in this assignment or fail to submit it by December**, 2022**, then you need to get the assignment for the year **2023**, 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/2022
Max. Marks: 100

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

PART A

1. a) Three vectors $\vec{\mathbf{u}}$, $\vec{\mathbf{v}}$ and $\vec{\mathbf{w}}$ satisfy the condition $\vec{\mathbf{u}} + \vec{\mathbf{v}} + \vec{\mathbf{w}} = \vec{\mathbf{0}}$. If $|\vec{\mathbf{u}}| = 3$, $|\vec{\mathbf{v}}| = 2$ and $|\vec{\mathbf{w}}| = 5$, respectively, determine the value of $\vec{\mathbf{u}}.\vec{\mathbf{v}} + \vec{\mathbf{v}}.\vec{\mathbf{w}} + \vec{\mathbf{w}}.\vec{\mathbf{u}}$. (5)

   b) For a particle undergoing uniform circular motion, show that

   (i) the velocity of the particle is perpendicular to the position vector, and

   (ii) the acceleration of the particle is perpendicular to its velocity. (5)

2. Solve the following ordinary differential equations:

   a) $3\frac{d^2y}{dx^2} + \frac{dy}{dx} - 14y = 0;\ y(0) = 1,\ y'(0) = -1$ (10)

   b) $x\frac{dy}{dx} = x^2 + 5y$ (5)

3. a) A box of mass 10 kg is pulled by a mass-less rope with a force of 40 N. The rope makes an angle of 30° with the horizontal. Draw the free-body diagram showing all forces on the box. Determine the acceleration of the box if the coefficient of kinetic friction between the floor and the box is 0.2. Take $g = 10\ \mathrm{m\,s^{-2}}$. (5)

   b) A ball of mass 100 g strikes a wall with the speed $2.0\ \mathrm{m\,s^{-1}}$ and bounces off the wall in the opposite direction with the same speed. Calculate the impulse of the ball. (5)

4. a) A child of mass 30 kg travels in a lift. Calculate the force exerted on the child by the floor of the lift when the lift moves (i) downward with an acceleration of $1.0\ \mathrm{m\,s^{-2}}$, (ii) upward with an acceleration of $1.0\ \mathrm{m\,s^{-2}}$. What is the weight of the child when the lift falls freely? Take $g = 10\ \mathrm{m\,s^{-2}}$. (2+2+1)

   b) A satellite of mass 200 kg is displaced by a distance of $2R_E$ from a point on the Earth's surface, where R_E is the radius of the Earth. Calculate the work done on the satellite by the force of gravitation. Take the values of the constants in your calculation from the astrophysical data given in the course. (5)

   c) A child of mass 30 kg slides from rest down a wooden pole by a distance of 3.0 m. Calculate the average force of friction acting on the child if her speed is $2.0\ \mathrm{m\,s^{-1}}$ when she hits the ground. Take $g = 10\ \mathrm{m\,s^{-2}}$. (5)

PART B

5. a) The average angular acceleration of a stone lodged in a rotating car wheel is $100\ \text{rad}\,\text{s}^{-2}$. What will the stone's final angular speed be after 3.0 s, if it starts from rest? Also calculate its angular displacement during this time. (5)

   b) A star having rotational inertia of $10 \times 10^{48}\ \text{kg}\,\text{m}^2$ is rotating at an angular speed of 2.0 revolutions per month about its axis. The only force on it is the force of gravitation. When its nuclear fuel is exhausted, it shrinks to a neutron star having rotational inertia of $6.0 \times 10^{48}\ \text{kg}\,\text{m}^2$. Determine the angular speed of the neutron star in revolutions per month. (5)

6. The orbit of a satellite about the Earth is given by

$$r = \frac{10000}{1 + 0.6\cos\theta}\ \text{km}$$

   What is the eccentricity and shape of the orbit? Also calculate the apogee and perigee distances. (5)

7. A steel ball *A* collides elastically with another steel ball *B* (at rest initially) and the ball *B* is observed to move off at an angle θ with the initial direction of motion of *A*. The mass of *B* is five times that of *A*. Determine the direction in which *A* moves after collision and the speeds of the two balls. (10)

8. The displacement of an object executing simple harmonic oscillations is given by:

$$x = 0.02 \sin 2\pi\,(t + 0.01)\ \text{m}$$

   Determine (a) amplitude of the oscillatory motion, (b) time-period of oscillation, (c) maximum velocity, (d) maximum acceleration, and (e) initial displacement of the object. (10)

9. a) Derive an expression for the logarithmic decrement of a damped oscillator. (5)

   b) A block attached to a spring is made to oscillate with initial amplitude of 8.0 cm. After 2.2 minutes, the amplitude decreases to 5.0 cm. Calculate (i) the time when the amplitude becomes 2.0 cm, and (ii) the value of damping constant γ for this motion. (5)

10. A sound wave of frequency 300 Hz travels with speed $340\,\text{m}\,\text{s}^{-1}$ along the negative *x*-direction. Each point of the medium moves up and down through a total distance of 5.0 mm. Determine the necessary parameters to represent the wave mathematically. (5)

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