BPHCT-131

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME

(BSCG)

MECHANICS

Valid from 1st July, 2019 to 30th June, 2020

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2019-2020)

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:

ROLL 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 July, 2019 to 30th June, 2020**. If you have failed in this assignment or fail to submit it by June, 2020, then you need to get the assignment for the year 2020-21, 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: slamba@ignou.ac.in, srjha@ignou.ac.in

We wish you good luck.

Tutor Marked Assignment
MECHANICS

Course Code: BPHCT-131
Assignment Code: BPHCT-131/TMA/2019-20

Max. Marks: 100

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

PART A

1. a) Calculate the area of a triangle whose vertices are given by (3, –1, 2), (1, –1, 2) and (4, –2, 1). (5)

   b) Determine the unit tangent vector to the following curve at $t = 1$

   $$\vec{\mathbf{r}} = 2t^2\hat{\mathbf{i}} + (t^3 - 4t)\hat{\mathbf{j}} + (5t - t^2)\hat{\mathbf{k}}$$ (5)

2. Solve the following ordinary differential equations:

   a) $\frac{dy}{dx} + y\cot x = e^{\cos x}$ for $x = \frac{\pi}{2}$, $y = -2$ (10)

   b) $\frac{d^2y}{dx^2} + \frac{dy}{dx} + y = 0$ (5)

3. a) In a safety test, a car of mass 1000 kg is driven into a brick wall. Its bumper behaves like a spring $(k = 5 \times 10^6\ \text{Nm}^{-1})$ and is compressed by a distance of 3 cm as the car comes to rest. Determine the initial speed of the car. (5)

   b) A plane is flying with a constant speed along a straight line at an angle of 30° with the horizontal. The weight of the plane is 100000 N and its engine provides a thrust of 120000 N in the direction of flight. Two additional forces are exerted on the plane: the lift force perpendicular to the plane's wings, and the force due to air resistance opposite to the direction of motion. Draw the free-body diagram showing all forces on the plane. Determine the lift force and the force due to air resistance. (2+4+4)

4. A child of mass 30 kg skates down from the top of a ramp having a constant slope of 15°. The child's speed increases from $1.5\,\text{ms}^{-1}$ to $3.0\,\text{ms}^{-1}$ as she reaches the bottom of the ramp. A force of kinetic friction of magnitude 50 N opposes her motion. Draw the appropriate force diagram and determine the length of the ramp. Take $g = 10\,\text{ms}^{-2}$. (3+7)

PART B

5. A wheel 2.0 m in diameter lies in the vertical plane and rotates about its central axis with a constant angular acceleration of $4.0\,\text{rads}^{-2}$. The wheel starts from rest at $t = 0$ and the radius vector of a point *A* on the wheel makes an angle of 60º with the horizontal at this instant. Calculate the angular speed of the wheel, the angular position of the point *A* and the total acceleration at $t = 2.0\,\text{s}$. (5)

6. Titan, a satellite of Saturn, has a mean orbital radius of 1.22×10^{9} m. The orbital period of Titan is 15.95 days. Hyperion, another satellite of Saturn, orbits at a mean radius of 1.48×10^{9} m. Estimate the orbital period of Hyperion. (10)

7. A steel ball *A*, of mass 20.0 kg moving with a speed of $2.0\,\text{ms}^{-1}$ collides with another ball *B* of mass 10.0 kg which is initially at rest. After collision, *A* moves with a speed of $1.0\,\text{ms}^{-1}$ at an angle of 30º with its original direction of motion. Determine the final velocity of *B*. (10)

8. A simple harmonic oscillator has amplitude 10 cm and it completes 120 oscillations in 60 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)

9. For a damped harmonic oscillation, the equation of motion is

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

with $m=0.20\,\text{kg}$, $\gamma=0.04\,\text{kgs}^{-1}$ and $k=65\,\text{Nm}^{-1}$. 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)

10. The equation of transverse wave on a rope is

$$y(x, t) = 7 \sin (4.0t - 0.02x)$$

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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