BPHCT-131

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME
(BSCG/BSCM)

MECHANICS

Valid from 1st January, 2026 to 31st December, 2026

School of Sciences
Indira Gandhi National Open University,
Maidan Garhi, New Delhi-110068
(2026)

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, 2026 to 31st December, 2026**. If you have failed in this assignment or fail to submit it by December 31, 2026, then you need to get the assignment for the year 2027, 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/2026
Max. Marks: 100

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

PART A

1. a) Three vectors $\vec{\mathbf{a}}$, $\vec{\mathbf{b}}$ and $\vec{\mathbf{c}}$ satisfy the condition $\vec{\mathbf{a}}+\vec{\mathbf{b}}+\vec{\mathbf{c}}=\vec{\mathbf{0}}$. If $\left|\vec{\mathbf{a}}\right|=4,\ \left|\vec{\mathbf{b}}\right|=2$ and $\left|\vec{\mathbf{c}}\right|=3$ determine the value of $\vec{\mathbf{a}}.\vec{\mathbf{b}}+\vec{\mathbf{b}}.\vec{\mathbf{c}}+\vec{\mathbf{c}}.\vec{\mathbf{a}}$. (5)

   b) A curve is described by the following parametric equations

   $$x=2\cos t,\ y=2\sin t,\ z=\cos(3t)$$

   Determine the unit tangent vector to the curve at the point $t=\frac{\pi}{2}$. (5)

2. Solve the following ordinary differential equations:

   a) $(x+1)\frac{dy}{dx}=\left(2e^{-y}-1\right);\ y(0)=1$ (10)

   b) $\frac{d^2y}{dx^2}+11\frac{dy}{dx}+24y=0$ (5)

3. a) The maximum speed with which a 1000 kg car can make a turn in a circular path is 15.0 ms^{-1}. The radius of the circle in which the car is turning is 30.0 m. Determine the force of friction being exerted upon the car and the coefficient of friction between the car and the road. Take $g=10.0\,ms^{-1}$. (5)

   b) An 80 Kg person jumping from a height of 5.0 m hits the ground with a speed of nearly 10.0 ms^{-1}. Calculate the impulse experienced by the person during the collision with ground and the average force exerted on the person, if the collision with the ground lasts for 0.1 s. (5)

   c) A girl of mass 30 kg stands in an elevator. Obtain the force which the floor of the lift exerts on the girl

      i) when the lift has an upward acceleration of $4.0\,ms^{-2}$; ii) when the lift is rising at constant speed and iii) when the lift has a downward acceleration of $3.0\,ms^{-2}$. Draw the free body diagram. Take $g=10\ ms^{-2}$. (5)

   d) A block of mass 4.0 kg is moved up from the base a rough inclined plane making an angle of 30° with the horizontal with initial speed 8.0 ms^{-1}. The coefficient of kinetic friction between the block and the plane is 0.2. Calculate

      i) the maximum distance the block travels up the incline before coming to rest.

      ii) the speed of the block when it returns to the base of the inclined plane.

      iii) the energy lost over the entire motion. Take $g=10\ ms^{-2}$. (10)

PART B

4. a) A uniform disk of mass 6.0 kg and radius 0.5m is initially at rest on a frictionless vertical axle. A constant tangential force of 12 N is applied at the edge of the disk for 4.0 s. Determine the i) the angular acceleration of the disk ii) the angular speed after 4s iii) the angular momentum of the disk after 4s, and iv) the rotational kinetic energy after 4s. (10)

   b) A particle A of mass 2.0 kg moving along the *x*-axis with speed 5.0 ms^{-1} collides elastically with a particle B of equal mass which is initially at rest. After the collision, particle A moves at an angle of 60° above the x-axis. Calculate the velocities of the two particles after the collision. (10)

   c) Given that the time period of Halley's comet is 75.3 years, calculate the length of its semi-major axis. If the perihelion distance of the orbit is 0.88×10^{11} m, calculate the aphelion distance. (5)

5. a) An object undergoes SHM with frequency $f = 0.50$ Hz. The initial displacement is 0.05 m and the initial velocity is 2.5 ms^{-1}. Calculate the amplitude, maximum velocity and maximum acceleration of the object. (5)

   b) Two collinear harmonic oscillations, each of frequency ω_0, have amplitudes, a_1 and a_2 and initial phases, $\phi_1 = \frac{\pi}{3}$ and $\phi_2 = \frac{4\pi}{3}$, respectively.Show that, when these oscillations are superposed, the amplitude of the resultant motion is equal to $(a_1 - a_2)$. What will be the value of the resultant amplitude when $\phi_1 = \frac{\pi}{3}$ and $\phi_2 = \frac{7\pi}{3}$. (3+2)

   c) Restoring and frictional forces of magnitudes *kx* and $\gamma \frac{dx}{dt}$, respectively act simultaneously on an object of mass 0.2 kg attached to a spring. Under the influence of these forces, the mass oscillates with a frequency 1.5 Hz and its amplitude reduces to half in 4.0 s. Calculate the damping constant γ, the force constant *k* and the damping factor *b*. Also write the differential equation for the system. (4+2+2+2)

   d) A progressive wave is described by

$$y(x, t) = (2) \sin\left[800\pi t - \frac{\pi x}{30}\right] \text{cm}$$

   Determine its direction of propagation and calculate the amplitude, wave number, wavelength and frequency of the wave. (5)

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