BPHCT-131

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME

(BSCG)

MECHANICS

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

School of Sciences
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(2022)

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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