Bihar Engineering University, Patna
End Semester Examination - 2022

Course: B.Tech.   Semester: III   Time: 03 Hours
Code: 101304   Subject: Engineering Mechanics   Full Marks: 70

Instructions:-

(i) The marks are indicated in the right-hand margin.
(ii) There are **NINE** questions in this paper.
(iii) Attempt **FIVE** questions in all.
(iv) Question No. **1** is compulsory.

Q.1 Choose the correct answer of the following (Any seven question only):   [2 x 7 = 14]

(a) The principle of virtual work states that the Virtual Work is zero for
    (i) A body moving with constant linear velocity
    (ii) A body rotating with constant angular velocity
    (iii) A body in equilibrium
    (iv) A body moving with constant linear acceleration

(b) What is Kinematics?
    (i) Branch of dynamics which deals with the study of bodies under motion without considering forces
    (ii) Branch of dynamics which deals with the study of bodies at rest
    (iii) Branch of dynamics which deals with the study of bodies under motion by considering forces
    (iv) Branch of dynamics which deals with the study of bodies under the motion.

(c) The moment of inertia of a thin rod of mass 'm' and length 'l' about an axis through its center of gravity at perpendicular to its length is:
    (i) $Ml^2/4$ (ii) $Ml^2/6$ (iii) $Ml^2/8$ (iv) $Ml^2/12$

(d) The principle of transmissibility of a force states that :
    (i) A force can be replaced by a couple with the same effect
    (ii) A force can be transmitted through a rigid body without changing its effect
    (iii) A force can be transmitted through a non-rigid body without changing its effect
    (iv) A force can be resolved into its components without changing its effect

(e) In a single-degree damped vibrating system, a suspended mass of 5 kg makes 21 oscillations in 11 seconds. The stiffness of the spring will be
    (i) 0.72 N/mm   (ii) 0.85 N/mm   (iii) 0.60 N/mm   (iv) 0.77 N/mm

(f) The maximum value of static friction is called:
    (i) limiting friction   (ii) rolling friction
    (iii) normal friction   (iv) coefficient of static friction

(g) During inelastic collision of two particles, which one of the following is conserved?
    (i) total linear momentum only
    (ii) total kinetic energy only
    (iii) both linear momentum and kinetic energy
    (iv) neither linear momentum nor kinetic energy

(h) The resultant of two forces 3P and 2P is R. if the first force is double the resultant is also doubled. Then the angle between the two forces is:
    (i) 30^0 (ii) 60^0 (iii) 120^0 (iv) 150^0

(i) The coefficient of friction between two surfaces depends on:
    (i) The weight of the object   (ii) The surface area in contact
    (iii) The nature of the surfaces in contact   (iv) The speed of the object

(j) A plane truss structure has 7 members, 5 joints and 4 reaction forces. How many degrees of indeterminacy does the structure have?
    (i) 0   (ii) 1   (iii) 2   (iv) 3

Q.2 (a) Describe the principle of Virtual work. [7]

(b) Two uniform bars of equal length l are hinged and supported as shown in fig. 1. [7]
For a given vertical force P, determine the value of the horizontal force that would hold the system in equilibrium. Neglect weight of the bars.

Q.3 Fig. 2 shows the cross-section of a cast iron beam. Determine the moments of inertia of the section about horizontal and vertical axes passing through the centroid of the section. [14]

Q.4 (a) State and prove the parallelogram law of forces. [6]

(b) A horizontal line ABCD is 10m long. Forces of 100N, 150N, 200N & 250 N act at A,B,C & D respectively with downward direction. The line of these forces makes an angle of 90^0, 60^0, 45^0 and 30^0 respectively with AD. Find the magnitude, direction and position of the resultant force. [8]

Q.5 (a) A force of 250N pulls a body of weight 500N up an inclined plane, the force being applied parallel to the plane. If the inclination of the plane to the horizontal is 20^0, find the coefficient of friction. [8]

(b) Define coefficient of friction, angle of repose & cone of friction. [6]

Q.6 (a) Define damped and undamped vibration with free body diagram. [6]

(b) A cantilever shaft 100mm and 1m long has a disc of 100 kg at its free end. Find the natural frequency of longitudinal vibration. Take $G = 200GN/m^2$. [8]

Q.7 (a) How a truss if different from a beam. What are the methods of analysis of a truss? What are the assumptions made for the analysis of a truss? [4]

(b) The truss shown in the fig. 3 below carries the force $F_1 = 10$ kN and $F_2 = 20$ kN (given a = 3 m). Calculate the forces in the members 2,4,6,8 and 12 using method of sections. [10]

Q.8 (a) A flywheel starts rotating from rest and is given an acceleration of 1.2 rad/s^2. (i) Find the angular velocity and the speed in rpm after 1 minutes 20 seconds. (ii) If now the flywheel is brought to rest with a uniform retardation of 0.4 rad/s^2, determine the time taken by the flywheel to come to rest. [7]

(b) The motion of a particle is given by $a = t^3 - 3t^2 + 5$, where 'a' is the acceleration in m/s^2 and t is the time in second. The velocity of the particle at $t = 1$ s is 6.25 m/s, and the displacement is 8.30 meters. Calculate the displacement and velocity at $t = 2$ s. [7]

Q.9 (a) A ball impinges directly on a similar ball at rest. Due to impact, the first ball comes to rest and half of the initial kinetic energy gets lost. Calculate the coefficient of restitution. [7]

(b) Write short note on any two of the following: [3½ x 2=7]
(i) General plane motion
(ii) Principle of Transmissibility
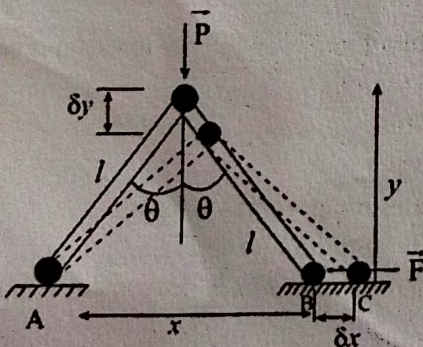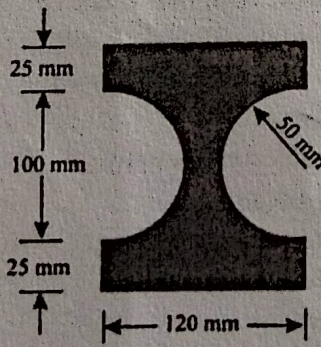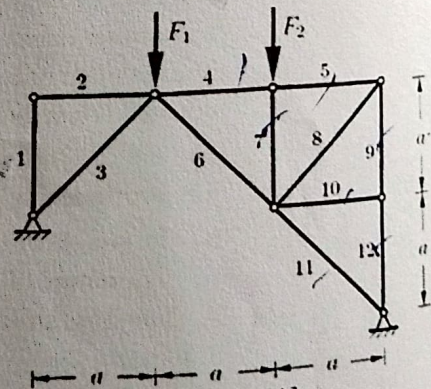(iii) Free vibrations and forced vibrations

Fig. 1 [Q. 2 (b)]

Fig. 2 [Q. 3]

Fig. 3[Q. 7(b)]