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Bihar Engineering University, Patna
End Semester Examination - 2022

Course: B.Tech.
Code: 101304

Semester: III
Subject: Engineering Mechanics

Time: 03 Hours
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) $MI^2/4$
 - (ii) $MI^2/6$
 - (iii) $MI^2/8$
 - (iv) $MI^2/12$
- (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°
 - (ii) 60°
 - (iii) 120°
 - (iv) 150°
- (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. 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. [7]
- 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° , 60° , 45° and 30° 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° , 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 $G = 200 \text{ GN/m}^2$. [8]
- Q.7 (a) How a truss is 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 $F_1 = 10 \text{ kN}$ and $F_2 = 20 \text{ kN}$ (given $a = 3 \text{ m}$). 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 . [7]
 (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.
 (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 $t = 1 \text{ s}$ is 6.25 m/s , and the displacement is 8.30 meters. Calculate the displacement and velocity at $t = 2 \text{ s}$. [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

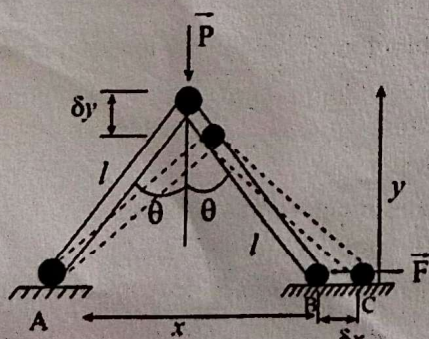


Fig. 1 [Q. 2 (b)]

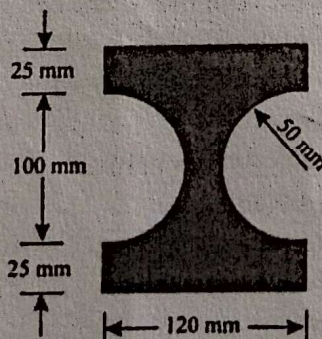


Fig. 2 [Q. 3]

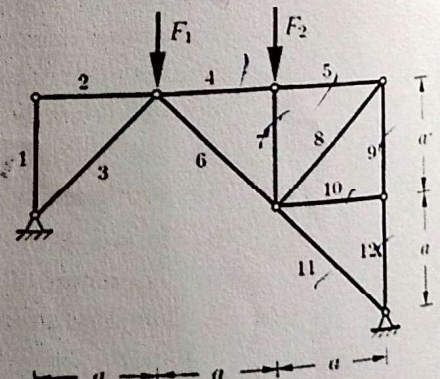


Fig. 3 [Q. 7(b)]