**Total No. of Questions : 12]** **[Total No. of Printed Pages : 11**

# [3661]-18

## F. E. Examination - 2009

## ENGINEERING MECHANICS

**(2003 Course)**

**Time : 3 Hours]** **[Max. Marks : 100**

***Instructions :***

*(1) Solve Q. No. 1 or Q.2, Q.3 or Q.4 and Q.5 or Q.6 from section I and Q.7 or Q.8, Q.9 or Q.10 and Q.11 or Q.12 from section II.*

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

*(3) Black figures to the rights indicate full marks.*

*(4) Neat diagrams must be drawn wherever necessary.*

*(5) Use of electronic pocket calculator is allowed.*

*(6) Assume suitable data, if necessary.*

---

## SECTION - I

**Q.1)** (A) Illustrate with neat sketches different types of Force Systems. **[04]**

(B) Three forces are applied to the bracket as shown in figure 1.1. Determine and show the equilibrant force for $\alpha = 40^o$ if the angle between two 30N forces always remain $50^o$. **[06]**

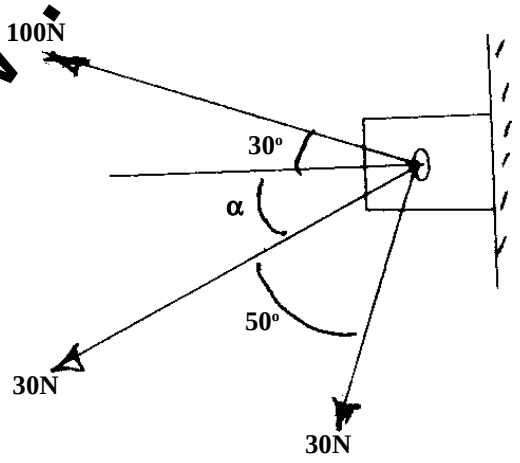


**Fig. 1.1**

(C) A homogeneous wire AB is bent into the shape shown in figure 1.2. Determine the centroid of bent up wire. The radius of circle is 200 mm. **[08]**

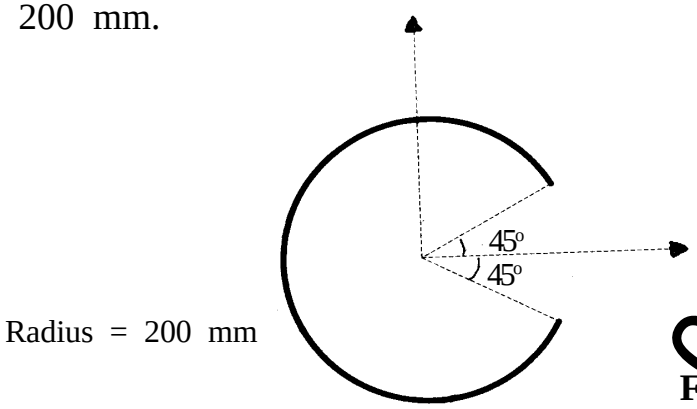


**Fig. 1.2**

**OR**

**Q.2)** (A) State and explain Varignon's Principle. **[04]**

(B) Determine reactions at support 'A' and 'B' for the bracket ACB supporting 330N force as shown in figure 2.1. **[06]**

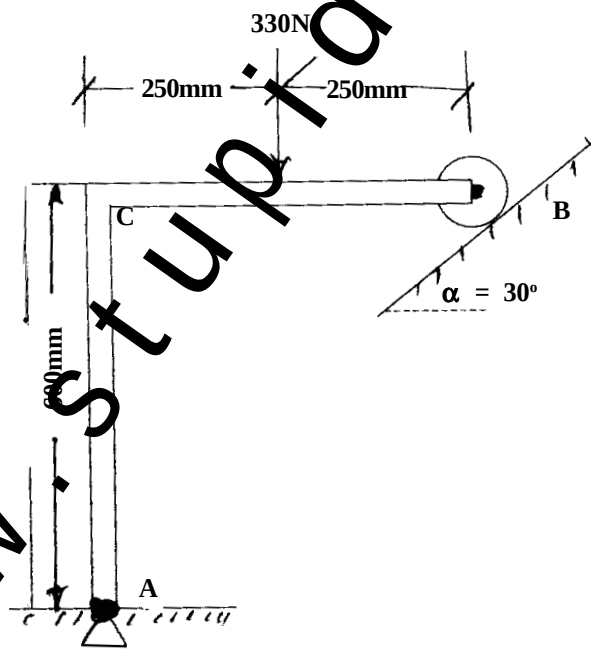


**Fig. 2.1**

(C) A force 'P' applied at 'B' and a block attached at 'C' maintain cable ABCD in the position shown. Knowing that 'P' has magnitude of 1320N determine :

(1) Reaction at 'A'

(2) Mass 'm' of the block

(3) Tension in each portion of the cable. (Refer figure 2.2) **[08]**

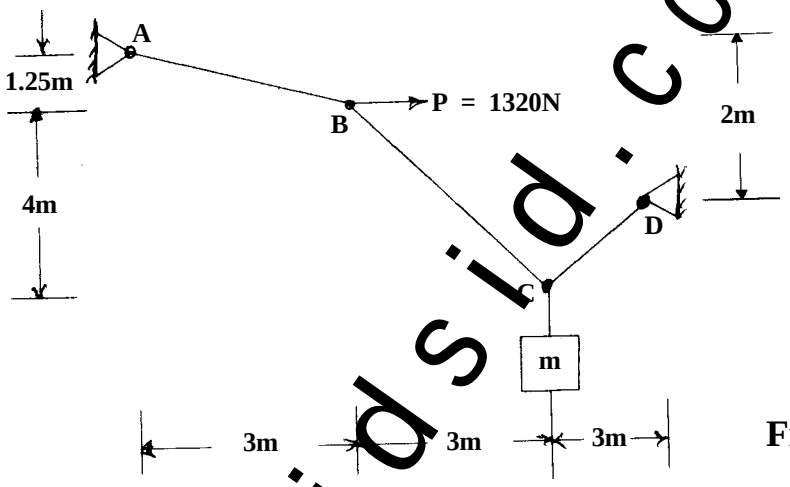


**Fig. 2.2**

**Q.3)** (A) Determine the forces in the members AB, BF, EF and CD of the truss shown in figure 3.1. Also state whether the members are tension or compression. **[08]**

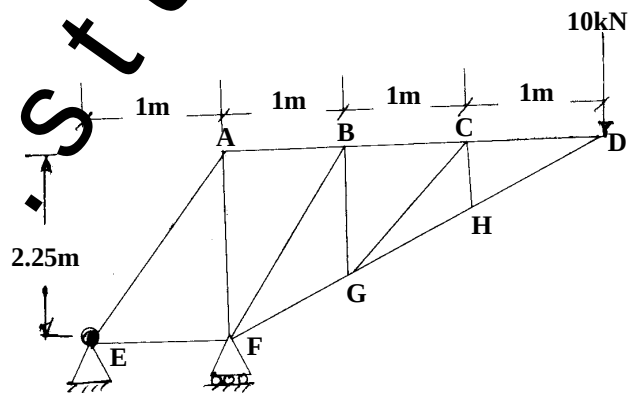


**Fig. 3.1**

(B) For the cantilever, determine range of values of force 'P' for which the magnitude of the fixing moment at 'A' dose not exceed 5000 N/m. (Refer figure 3.2) **[08]**

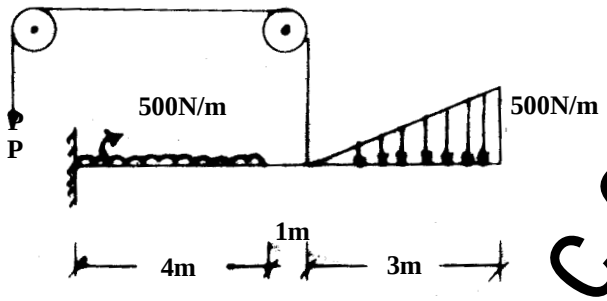


**Fig. 3.2**

**OR**

**Q.4)** (A) Referring to figure 4.1, calculate the force 'P' required to just raise the block 'B' of weight 1000N. The wedge may be assumed of negligible weight. Assume coefficient of friction between block and wedge 0.3 and at all other surfaces 0.2. **[08]**

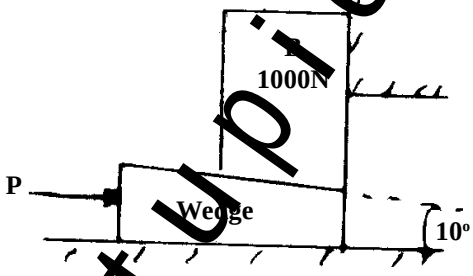


**Fig. 4.1**

(B) Determine the components of the reactions at 'A' and 'D' when a force of 24N directed vertically downword is applied at 'B'. (Refer figure 4.2) **[08]**

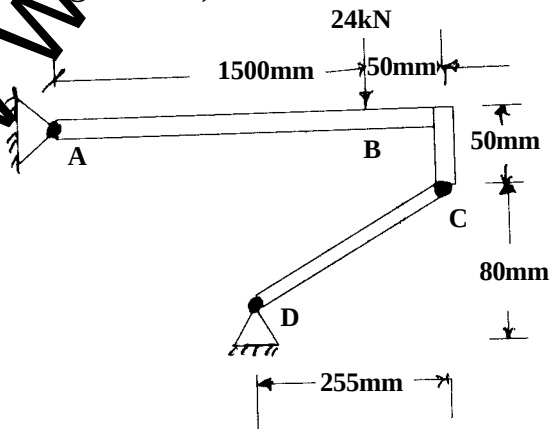


**Fig. 4.2**

**Q.5)** (A) A square foundation mat supports the four column loads as shown in figure 5.1. Determine the magnitude and point of application of the resultant of the four loads. **[08]**

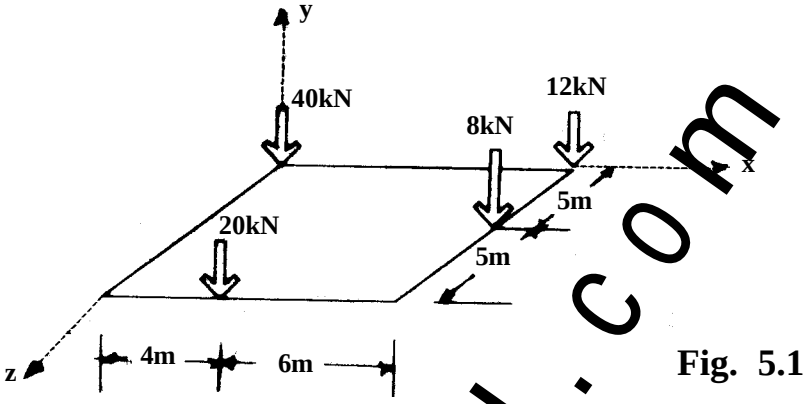


**Fig. 5.1**

(B) For the beam ABCDE find reactions at support using virtual work method. Refer figure 5.2. **[08]**

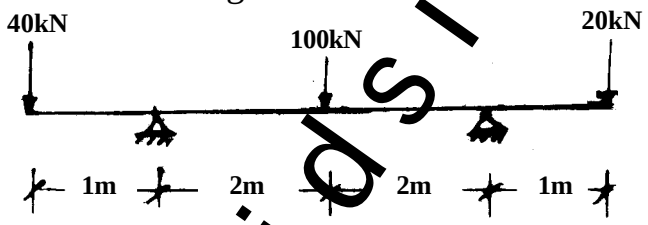


**Fig. 5.2**

**OR**

**Q.6)** (A) A 2.4m long boom is held by a ball-and-socket joint at 'C' and by two cables AD and AE. Determine the tension in each cable. (Refere figure 6.1) **[08]**

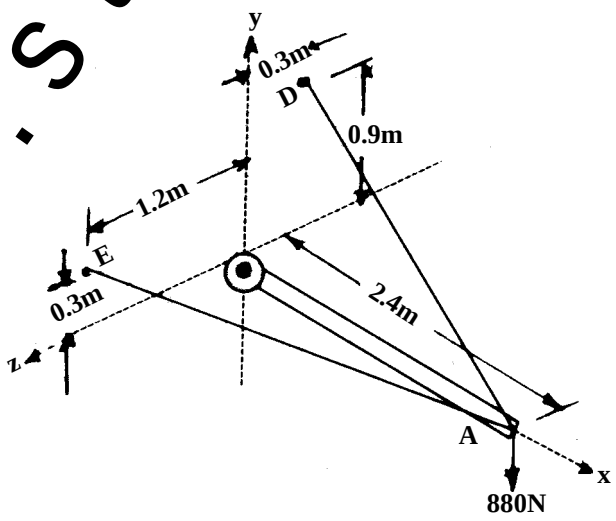


**Fig. 6.1**

(B) Using method of virtual work, determine angle 'θ' to maintain the equilibrium for the mechanism shown in figure 6.2. Take $W_A$ = 100N and $W_B$ = 150N. **[08]**

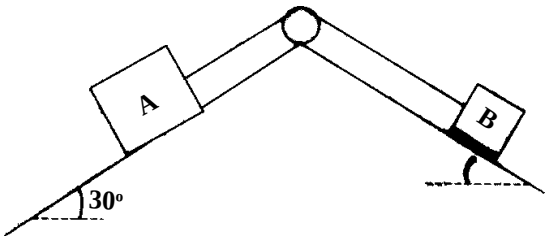


**Fig. 6.2**

## SECTION - II

**Q.7)** (A) Starting from first principle, obtain equations of motion for uniformly accelerated rectilinear motion. **[04]**

(B) A particle moves along a horizontal path such that its acceleration is given by a = (8 – 4t) m/s$^2$. Determine distance travelled by particle during t = 0s to t = 3s. Also draw a – t diagram and v – t diagram only. **[06]**

(C) The 100 kg crate is subjected to the action of two forces as shown in figure 7.1. If it is originally at rest, determine the distance, it slides in order to attain speed of 10 m/s. The kinetic coefficient of friction between crate and surface is 0.2. **[08]**

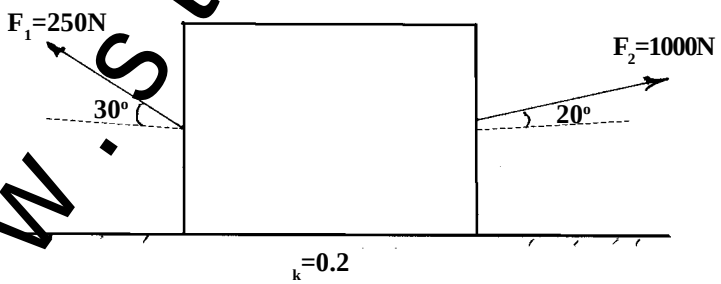


**Fig. 7.1**

**OR**

**Q.8)** (A) A car travels along a straight line with velocity described by the v – t diagram shown in figure 8.1. Determine the total distance the car travels until it stops when t = 50s. Also plot a – t diagram. **[04]**

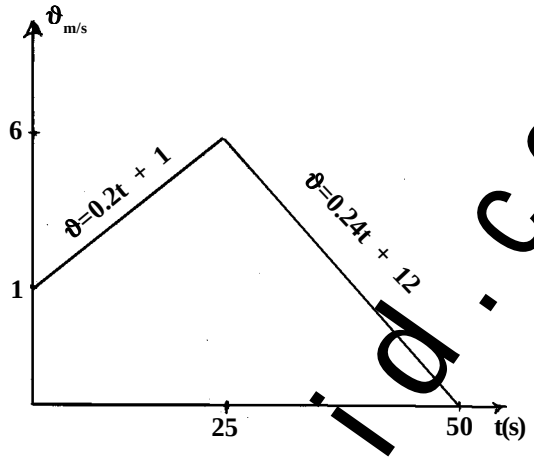


**Fig. 8.1**

(B) The 50N ball is projected vertically from the tube by spring action as shown in figure 8.2. Determine how far the spring must be compressed to project the ball from compressed position to a height of 2.4m at which point, it has velocity 1.8 m/s. Assume K = 5000 N/m. **[06]**

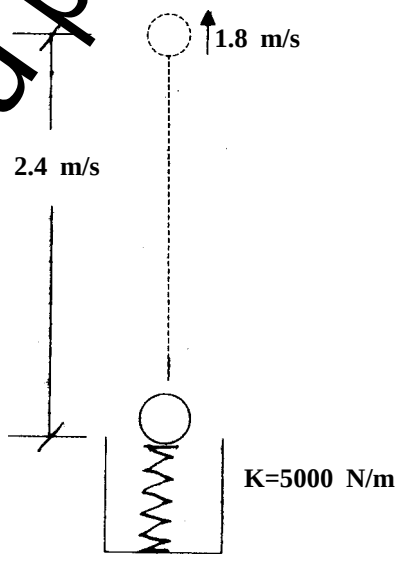


**Fig. 8.2**

(C) The system shown in figure 8.3 is released from rest. Find –

(1) Tension in string

(2) Relative acceleration of 'A' w.r.t. 'B' at t = 2s. Assume $\mu_k$ = 0.2. **[08]**

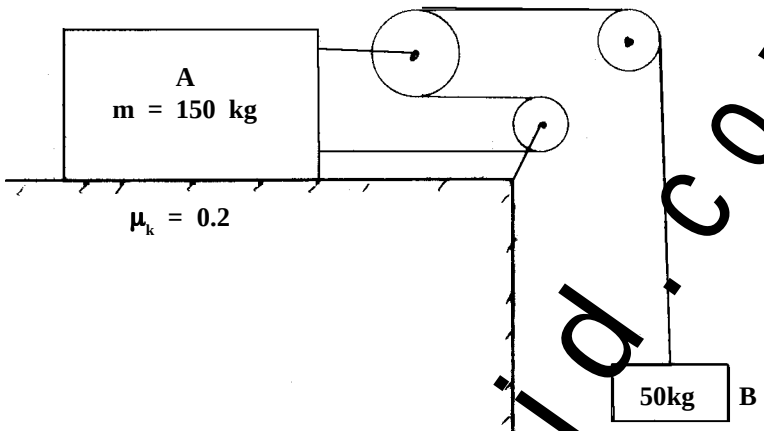


**Fig. 8.3**

**Q.9)** (A) The y - co-ordinate of a particle in curvilinear motion is given by $y = (4t^3 - 3t)$m. Also the particle has an acceleration in x-direction given by $a_x = (12t)$ m/s$^2$. If velocity of particle in x-direction is 4m/s at t = 0, calculate tangential and normal componants of acceleration at t = 1s. **[08]**

(B) A bob of 1.5m pendulum describes an arc of a circle in a vertical plane. When the angle of cord is 35° with vertical, the tension in the cord is 1.5 times the weight of bob. Find velocity and acceleration of the bob in this position. (Refer figure 9.1) **[08]**

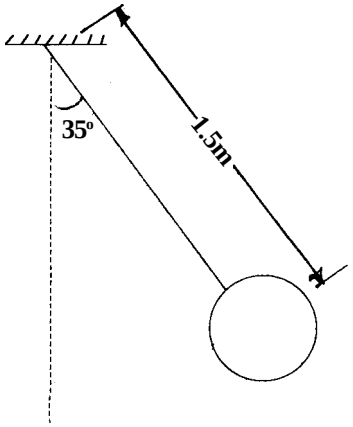


**Fig. 9.1**

**OR**

**Q.10)** (A) Derive equation of path followed by projectile when projected on horizontal plane with velocity 'u' m/s and angle of projection '$\alpha$'. A projectile is fired with speed 150 m/s. from a gun elevated at angle $60^o$ with plane AB as shown in figure 10.1. Determine the point where it strikes the plane AB whose equation is $y = 0.176x$. **[08]**

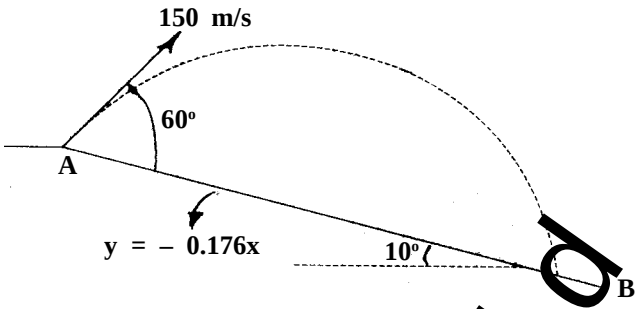


**Fig. 10.1**

(B) Two blocks A and B having same mass 'm'. The block 'A' is moving to right with a speed 3.6m/s when it collides with block 'B' which is at rest. Determine how far block B will slide before coming to stop. Assume $\mu_k = 0.3$ and e = 0.6. Neglect size of blocks. **[08]**

**Q.11)** (A) Two blocks of masses 20 kg and 25 kg are connected by a light in extensible string which passes over 25cm diameter pulley of 2.5kg mass as shown in figure 11.1. Neglecting friction, find acceleration of the system and tensions in the string when the masses are released from rest. Assume radius gyration of pulley equal to its radius. **[08]**

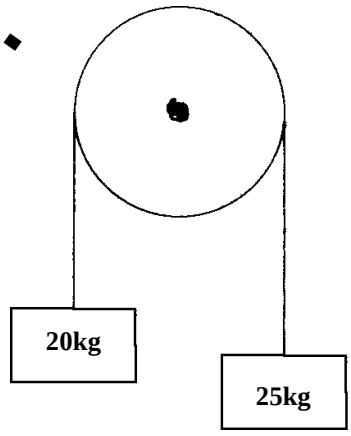


**Fig. 11.1**

(B) An angular acceleration $\alpha = (0.4t^2 + 0.6)$ rad/s$^2$ is imparted to a disc of 0.15m radius by a motor. If initial angular velocity of disc is 5 rad/s, find velocity and acceleration of block 'B' at time t = 1.5s (Refer figure 11.2). **[08]**

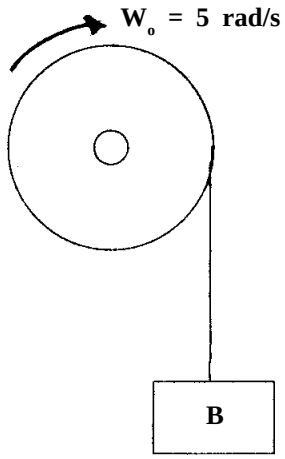


**Fig. 11.2**

**OR**

**Q.12)**(A) At the instant shown in figure 12.1, the rod AB is rotating clockwise at 2.5 rad/s. If end 'C' of the rod BC is force to move on horizontal surface, compute angular velocity of rod BC and velocity of its end point 'C'. **[08]**

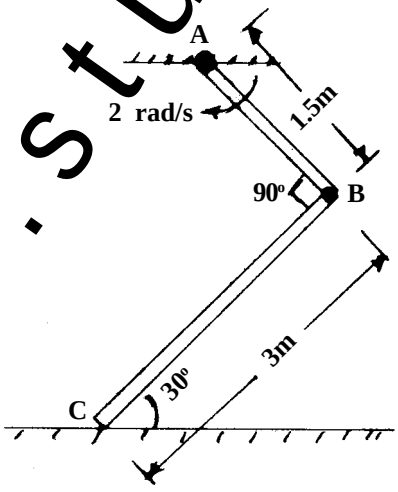


**Fig. 12.1**

(B) A thin uniform bar of mass 50kg and length 1m is suspended by two vertical inextensible strings. If the right hand string 'BD' is cut, find angular acceleration of bar and tension induced in the left string AC (Refer figure 12.2). **[08]**

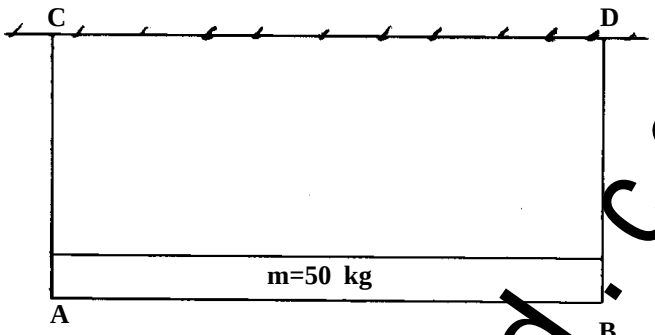


**Fig. 12.2**