Code : 011201

B.Tech 2nd Semester Exam., 2016

ENGINEERING MECHANICS

Time : 3 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.

1. Choose the correct option (any *seven*) : 2×7=14

(a) A system of three forces acts on a body and keeps it in equilibrium. The forces need to be

(i) coplanar only

(ii) concurrent only

(iii) coplanar as well as concurrent

(iv) coplanar but may or may not be concurrent

(b) The time-acceleration graph of a body moving with uniform acceleration is a straight line

(i) passing through the origin

(ii) inclined to the time axis

(iii) parallel to acceleration axis

(iv) parallel to time axis

(c) The equation of a projectile is $y = \sqrt{3}x - \frac{1}{2}gx^2$. The angle of projection is given by

(i) $\tan\theta = \frac{1}{\sqrt{3}}$

(ii) $\tan\theta = \sqrt{3}$

(iii) 60°

(iv) 0

(d) A body has linear momentum P and translational kinetic energy E. If momentum becomes $2P$, the kinetic energy will have the value

(i) $4E$

(ii) $2E$

(iii) E

(iv) $0{\cdot}5E$

(e) The apparent weight of a man in a lift is less than the real weight, when the lift is going down

(i) freely

(ii) under the force of gravity

(iii) with some constant velocity

(iv) with some acceleration

(f) For perfectly elastic bodies, the value of coefficient of restitution is

(i) 1

(ii) 0·5 to 1

(iii) 0 to 0·5

(iv) 0

(g) An attempt to turn a key into a lock manifests in the application of

(i) coplanar force

(ii) moment

(iii) couple

(iv) torque

(h) A zero angle of friction implies that

(i) frictional force is infinite

(ii) frictional force is zero

(iii) frictional force acts normal to the plane

(iv) frictional force acts along the direction of motion

(i) Two forces of equal magnitude P act at an angle θ to each other. Their resultant is equal to the force P. The angle θ is equal to

(i) 0°

(ii) 60°

(iii) 90°

(iv) 120°

(j) The moment of inertia of an area is always least with respect to

(i) centroidal axis

(ii) vertical axis

(iii) radius of gyration

(iv) depend upon configuration of the area

2. (a) Write down the set of equations of equilibrium for (i) concurrent coplanar force system and (ii) non-concurrent non-coplanar force system. 6

(b) A boat is pulled along the river by two ropes with pulls P and Q inclined at 30° and 40° to the x-axis as shown in Fig. 1 below :

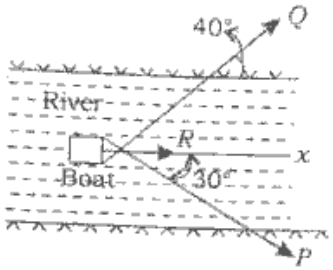

Fig. 1

(i) Find P and Q, if their resultant R is 1000 N.

(ii) If the pull P is inclined at 30° to x-axis, find the minimum value of Q if $R = 1000$ N. 8

3. (a) What do you mean by the term 'wrench'? 5

(b) Replace the system of forces and couple as shown in Fig. 2 below by a single-couple moment. A couple moment of 1000 N-m is acting in the diagonal plane $ABCD$: 9

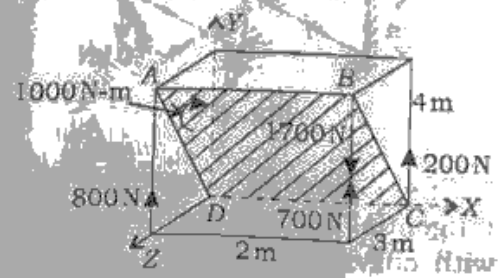

Fig. 2

4. (a) What are Coulomb's laws of friction, angle of friction and angle of repose? 6

(b) Determine the effort required to tip the box as shown in Fig. 3 below about A. Also find the minimum coefficient of friction if the box tips before it slides : 8

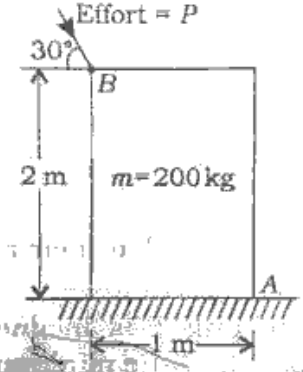

Fig. 3

5. Determine the forces in all the members of the truss as shown in Fig. 4 below. Indicate the results in tabular form : 14

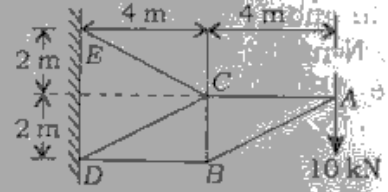

Fig. 4

6. (a) Define normal acceleration and tangential acceleration in connection with curvilinear motion. 6

(b) The acceleration of a particle is expressed as $a = 10 - x$. The particle starts with no initial velocity at the position $x = 0$. Determine *(i)* the velocity of the particle when $x = 8$ m, *(ii)* the position of the particle where the velocity is again zero and *(iii)* the velocity of the particle when acceleration becomes zero. 8

7. A cart A as shown in Fig. 5 below having a mass of 200 kg is held on an incline so as to just touch an undeformed spring whose spring constant $k = 50$ N/mm. If body A is released very slowly, what distance down the incline must A move to reach an equilibrium configuration? If body A is released suddenly, what is its speed when it reaches the aforementioned equilibrium configuration for a slow release? 14

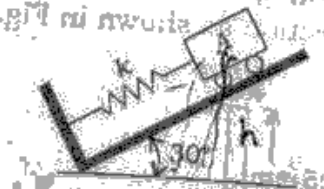

Fig. 5

8. (a) State d'Alembert's principle. How is it applied in solving problems related to dynamics? 5

(b) Two blocks A and B, each of 1 kg mass and resting on a rough inclined plane are released from the position as shown in Fig. 6 below. The static friction between block A and surface of incline is 0·12, and that between block B and surface of incline is 0·3. Make calculations for the time at which impact would occur and the velocity of blocks immediately after impact. Take coefficient of restitution equal to 0·75 : 9

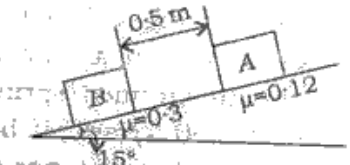

Fig. 6

9. (a) State and prove the perpendicular axes theorem for the plane area. 5

(b) Determine the moment of inertia about the x and y centroidal axes of a given angle section as shown in Fig. 7 below : 9

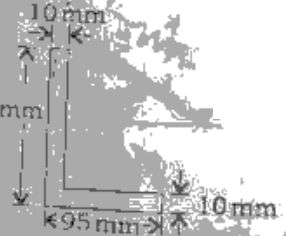

Fig. 7

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