



Name :

Roll No. :

Invigilator's Signature :

CS/B. Tech/SEM-1/ME-101/2009-10

2009

MECHANICAL SCIENCE – I

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives of the following : $10 \times 1 = 10$

i) Lami's theorem is applicable to

- a) Equilibrium of two co-planar, concurrent forces
- b) Equilibrium of three co-planar, concurrent forces
- c) Equilibrium of three co-planar, non-concurrent forces
- d) none of these.

ii) Strain energy is the

- a) maximum energy which can be stored in a body
- b) energy stored in a body when stressed to the elastic limit
- c) energy stored in a body when stressed to the breaking point
- d) none of these.

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- ii) Poisson's ratio is defined as
- a) Longitudinal stress by lateral stress
 - b) Lateral stress by longitudinal stress
 - c) Longitudinal strain by lateral strain
 - d) Lateral strain by longitudinal strain.
- iv) Free body diagram of a body is drawn
- a) by isolating the body its surrounding
 - b) by indicating the forces acting on it
 - c) both of these
 - d) none of these.
- v) If a momentum of a body is doubled, its kinetic energy will
- a) increase by two times
 - b) increase by four times
 - c) remain same
 - d) get halved
 - e) reduced to four times.
- vi) A body falling freely from a height of 10 m rebounds from the floor. If it losses 20% of its energy in the impact how high will it rebounds ?
- a) 10 m
 - b) 8 m
 - c) 12 m
 - d) none of these.

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vii) The dot product of two orthogonal vector is

- a) one b) zero
- c) no definite value d) none of these.

viii) The centre of gravity of a uniform lamina lies at

- a) the centre of heavy portion
- b) the bottom surface
- c) the mid-point of its axis
- d) none of these.

ix) If the velocity of projectile is u and the angle of projection is α , the maximum height attained by a projectile above the horizontal plane is

- a) $u^2 \cos^2 \alpha / 2g$
- b) $u^2 \sin^2 \alpha / 2g$
- c) $u^2 \tan^2 \alpha / 2g$
- d) $u^2 \sin^2 \alpha / g$.

x) Three forces $\sqrt{3}p$, p and $2p$ acting on a particle are in equilibrium. If the angle between first and second be 90° , the angle between second and third will be

- a) 30° b) 60°
- c) 120° d) 150° .

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GROUP - B
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. a) State D' Alembert's principles.
- b) A smooth circular cylinder of radius 1.5 is lying in a rectangular groove is shown in Figure 1. Find the reactions at the surfaces of contact, if there is no friction and the cylinder weighs 1000 N. $1 + 4$

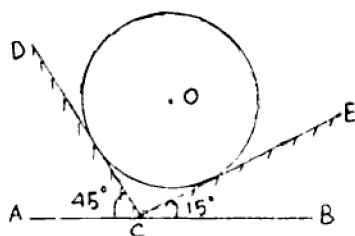


Figure 1

3. Refer to the Figure 2, determine the range of values of mass m_0 so that the 100 kg block will neither move up nor slip down the inclined plane. The coefficient of static friction for the surfaces in contact is 0.3.

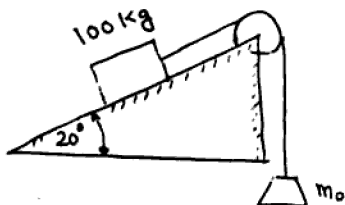


Figure 2

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4. a) State Varignon's principle.
- b) A circular roller of weight 100 N and radius 10 cm hangs by a tie rod $AB = 20$ cm and rests against a smooth vertical wall at C as shown in Figure 3. Determine the force F in the rod.

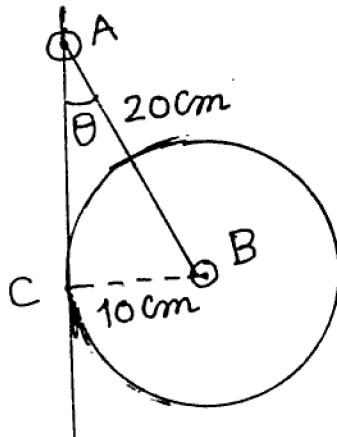


Figure 3

5. Referring to Figure 4, $r = 12$ cm, $Q = 500$ N and $h = 6$ cm. Find magnitude of P required to start the roller over curb.

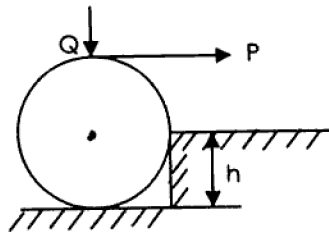


Figure 4

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6. Two smooth circular cylinders of Figure 5, each of weight $W = 100\text{ N}$ and radius $r = 6\text{ cm}$ are connected by a string AB of length $l = 16\text{ cm}$ and rest upon a horizontal plane, supporting a third cylinder of weight $Q = 200\text{ N}$ and radius $r = 6\text{ cm}$ above them. Find the tension S in the string AB and the pressure produced by the floor at points of contact D and E .

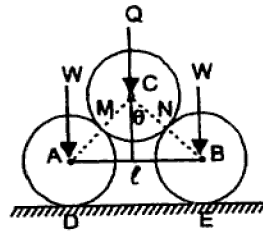


Figure 5

GROUP - C**(Long Answer Type Questions)**Answer any *three* of the following. $3 \times 15 = 45$

7. a) A 150 kg man stands on the mid-point of a 50 kg ladder as shown in Figure 6. Assuming that floor and the wall are perfectly smooth, find the reactions at points A and B.

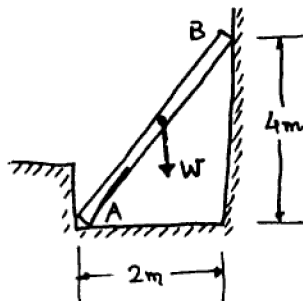
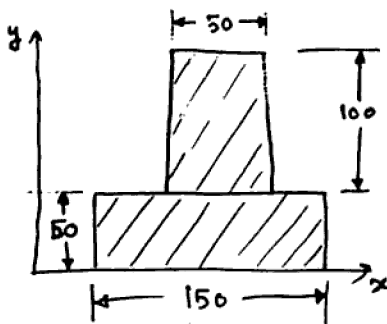


Figure 6

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- b) Determine the moment of inertia for the T section (as shown in Figure 7) with respect to a centroidal axis parallel to x-axis. All dimensions are in mm. 8 + 7

**Figure 7**

8. a) Prove that the volumetric strain of a rectangular bar is the algebraic sum of strains of length, width and height.
- b) Show that elongation of a conical bar under its own weight is independent of its base diameter but on length only.

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- c) Determine the strain energy stored within a bar of length l , cross-sectional area A , density ρ and modulus of elasticity E , hanging vertically due to its own height.

6 + 4 + 5

9. a) Two spheres P and Q rests in the channel as shown in Figure 8. The sphere P has a diameter 400 mm and weight of 200 N, whereas the sphere Q has diameter 500 mm and weight 500 N. If bottom width of the channel is 500 mm and with one side vertical and other side inclined at 60° , determine the reaction induced in the contacts.

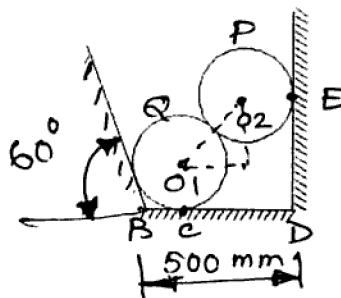


Figure 8

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- b) In the Figure 9 shown, find the minimum value of horizontal force P applied to the lower block that will keep the system in equilibrium. Given, coefficients of friction between lower block and floor = 0.25, between the upper block and the vertical wall = 0.30, between the two blocks = 0.20. 8 + 7

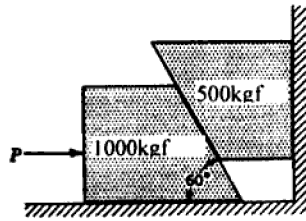


Figure 9

10. a) State the principle of virtual work. 3
- b) Two blocks weighing W_1 and W_2 resting on smooth inclined planes are connected by an inextensible string passing over a smooth pulley as shown in Figure 10. Find the value of W_2 when $W_1 = 500$ N and $\alpha = 30^\circ$, $\beta = 60^\circ$. 7

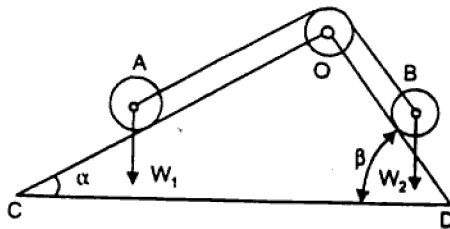
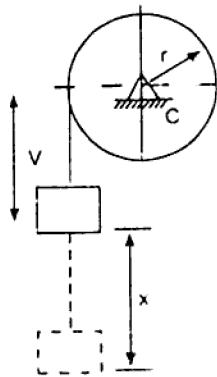


Figure 10

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- c) Determine velocity V of the falling weight W of the system as shown in Figure 11 as a function of its displacement from the initial position of rest. Assume weight of the cylinder as $2W$. 5

**Figure 11**

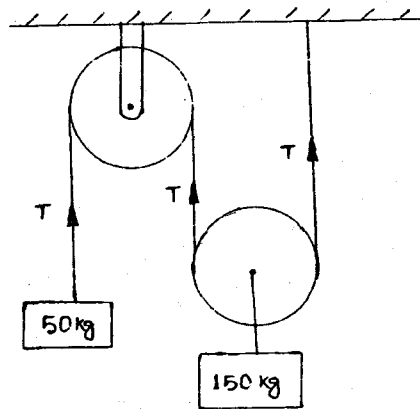
11. a) From top of a tower, 60 m high a bullet is fired at an angle of 20° up the horizontal with velocity 120 m/s. Determine
- time of flight
 - horizontal range of ground
 - maximum height of the bullet from ground
 - velocity of the bullet after 8 seconds.

Assume horizontal ground at the foot of the tower.

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- b) Determine the tension in the strings and accelerations of two blocks of masses 150 kg and 50 kg connected by a string and a frictionless, weightless pulley as shown in Figure 12.

10 + 5

**Figure 12**