

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.



- iii) 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.

a) one                      b) zero

b) no definite value       d) none of these.

- the centre of heavy portion
- the bottom surface
- the mid-point of its axis
- none of these.

- $u^2 \cos^2 \alpha / 2g$
- $u^2 \sin^2 \alpha / 2g$
- $u^2 \tan^2 \alpha / 2g$
- $u^2 \sin^2 \alpha / g$ .

a)  $30^\circ$

b)  $60^\circ$

c)  $120^\circ$

d)  $150^\circ$ .



**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**

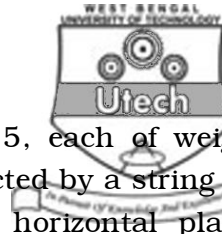


4. a) State Varignon's principle.
- b) A circular roller of weight 100 N and radius 10 cm hangs by a ties rod  $AB = 20$  cm and rests against a smooth vertical wall at  $C$  as shown in Figure 3. Determine the force  $F$  in the rod.

**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**



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**

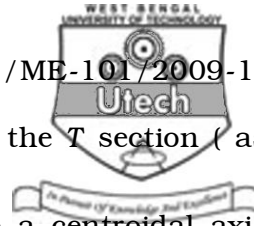
**GROUP – C**

**( 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**



- 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.



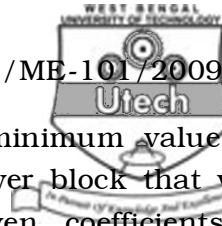
- c) Determine the strain energy stored within a bar of length  $l$ , cross-sectional area  $A$ , density  $\rho$  and modulus of elasticity  $E$ , hanging vertically due to its own height.

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  $60^\circ$ , determine the reaction induced in the contacts.

**Figure 8**





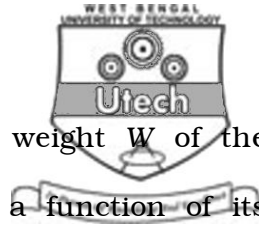
- b) In the Figure 9 shown, find the minimum value of horizontal force  $P$  applied to the lower block that will keep the system in equilibrium. Given, coefficients of friction between lower block and floor =  $0.25$ , between the upper block and the vertical wall =  $0.30$ , between the two blocks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

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**



- 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  $20^\circ$  up the horizontal with velocity 120 m/s. Determine
- i) time of flight
  - ii) horizontal range of ground
  - iii) maximum height of the bullet from ground
  - iv) velocity of the bullet after 8 seconds.

Assume horizontal ground at the foot of the tower.



- 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**

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