Code: A-03   **Subject: APPLIED MECHANICS**

$$\boxed{\textbf{December 2005}}$$

Time: 3 Hours

Max. Marks: 100

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. A must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 A Choose the correct or best alternative in the following:
        (2x10)

a. The condition for a redundant truss is given by
   (A) $n = 2j - 3$ **(B)** $n = 2j - 4$
   (C) $n = j - 3$.   **(D)** $n = 2j - 2$
   where j = no. of joints and n = no. of members.

b. If 'L' is the side of a square plate, then moment of inertia about the diagonal of the plate is given by
   (A) $L^2 / 24$ **(B)** $L^2 / 12$
   (C) $L^2 / 6$ **(D)** $L^2 / 3$

c. The time taken by the bodies to regain original shape after compression due to collision is known as
   (A) time of compression   **(B)** time of restitution
   (C) time of collision   **(D)** time of motion

d. In a velocity-time graph, the area under the curve is
   (A) distance travelled by the particle.
   (B) change in acceleration.
   (C) change in velocity.
   (D) time taken to attain the velocity.

e. If flow conditions satisfy 'Laplace equation' then
   (A) flow is rotational.
   (B) flow does not satisfy continuity equation.
   (C) flow is irrotational and satisfy continuity equation.
   (D) flow is irrotational and does not satisfy continuity equation.

f. Maximum acceleration of a particle moving with simple harmonic motion takes place, when
   (A) it passes through its extreme position.
   (B) it passes through mid point.
   (C) it has maximum velocity.
   (D) it has half the maximum velocity.

g. The ratio of maximum horizontal shear stress to the mean stress in a circular beam is
   (A) 2/3   **(B)** 3/2
   (C) 3/4   **(D)** 4/3

B   State which of the statement is true and which are false.

h. The specific speed of a turbine with runner diameter 1.5 m is 150. If a turbine of specific speed 200 is desired, the diameter of the runner will be unchanged

i. The forces acting on a particle can be considered as concurrent

j. The velocity gradient at the point of separation is positive.

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Determine the magnitude, direction and point of application of the resultant force when a bar ABCDE is subjected to forces as shown in Fig.1 **(8)**
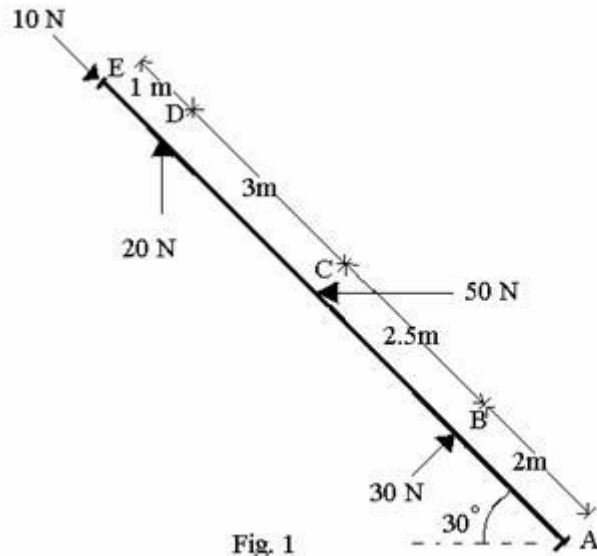

Fig. 1

b. For a smooth cylinder of weight W shown in Fig.2 find the angle θ when the contact force at B is one-half at A. **(8)**
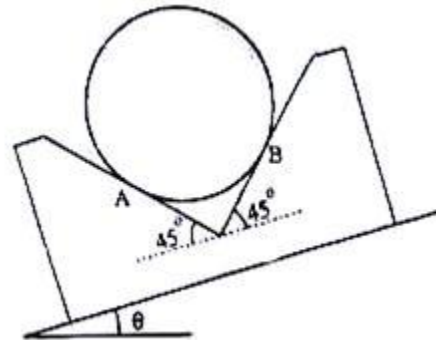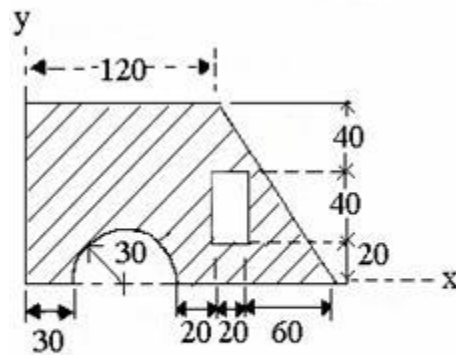

Fig.2

Q.3 a. Locate the centroid of the shaded area shown in Fig.3 **(8)**

All units are in mm.

Fig. 3

b. Determine the moment of inertia of the area under the parabola about the X-axis. Solve by using a vertical strip of area. **(8)**

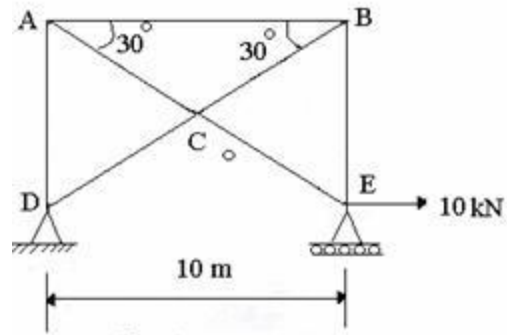**Q.4** a. What are the assumptions are to be made for the force analysis of trusses? **(4)**

Fig. 4

b. Determine the forces in all the members of the two dimensional truss shown in Fig.4 using method of joints. Show the magnitude and nature of forces in a table. **(12)**

Q.5   a. The three flat blocks are positioned on the 30° incline as shown in Fig.5, and a force P parallel to the incline is applied to the middle block. The upper block is prevented from moving by a wire, which attaches it to the fixed support. The coefficient of static friction for each of the three pairs of mating surfaces is shown. Determine the maximum value, which P may have before any slipping takes place. **(8)**
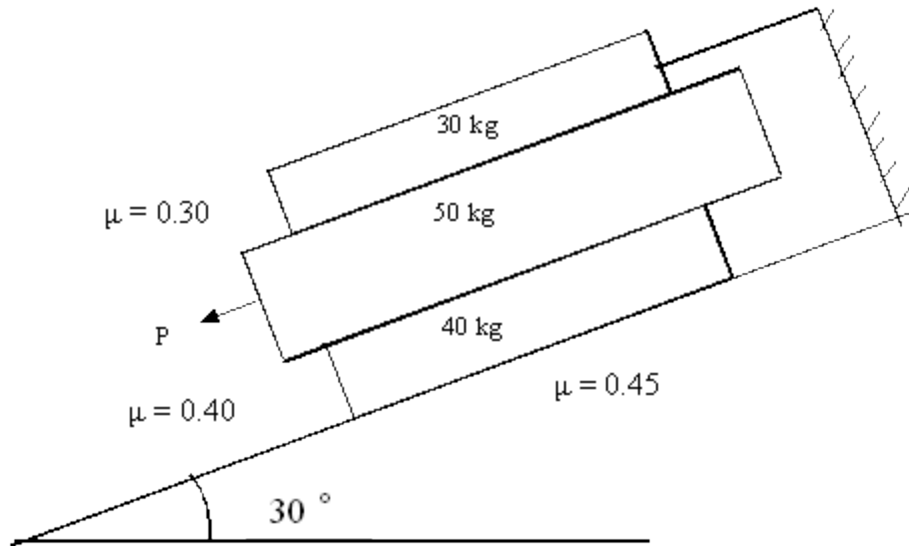
μ = 0.30   30 kg

50 kg

P   40 kg

μ = 0.40   μ = 0.45

30 °

Fig. 5

b. A particle moves along a straight line with velocity v = $(3\ t^2 - 6\ t)$ m/sec. If it is initially at origin, determine average velocity, average speed and distance travelled during interval $0 < t < 3.5$ secs.   **(8)**

Q.6 a. A bullet of mass 100 gm hits a freely suspended target of mass 10 kg. Due to impact, the bullet gets embedded in the target and the target with bullet moves with a velocity of 7 m/sec. Find the velocity of the bullet and the loss of kinetic energy using the law of conservation of momentum. **(8)**

b. A car of weight 9810 N accelerates from rest to a speed of 45 km/hr in a distance of 50 m against a resistance of 100 N. Find the average driving force acting on the

car. Using the average force, find the greatest power developed by the engine. **(8)**

Q.7 a. Define (i) Buoyancy (ii) Control volume (iii) Drag (iv) Turbulence. **(4)**

b. Determine the bulk modulus and lateral contractiom of a round bar of 0.0375m diameter and 2.4 m long when stretched by 0.0025m.Take Young's modulus of the material of the rod as 110 GN/m^2 and shear modulus as 42 GN/m^2. **(6)**

c. Consider a solid circular shaft and also a hollow circular shaft whose inside diameter is ¾ of the outside diameter. Compare the weights of the equal lengths of these two shafts required to transmit a given torsional moment if the maximum shear stress developed in the two shafts are equal. Assume entirely elastic action. **(6)**

Q.8   A beam has been subjected to forces and a moment as shown in Fig.6. Draw shear force and bending moment diagrams. Mark the values of the important ordinates. **(16)**
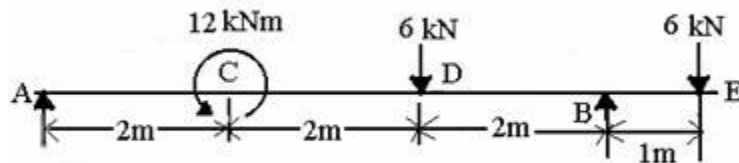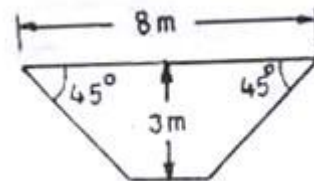

Fig. 6

Q.9 a. Sectional elevation of a tank is as shown in Fig.7. The width of the tank in direction perpendicular to the plane of the figure is 2 m. Find the total pressure on (i) a sloping face of the tank (ii) a vertical face of the tank (iii) the base of the tank. **(8)**

Fig.7

b.   The two velocity components of fluid flow are given below. Find out the third component so that they satisfy continuity equation.

$$u = x^2 + y^2 + 2 z^2$$
$$v = -x^2 y - y z - x y \tag{8}$$