JUNE 2005

Code: D-02 **Subject: APPLIED MECHANICS**
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 11 Questions in all.

- **Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: **(2x8)**

a. A mass of 2 kg is acted upon by two forces of 6 N and 8 N at right angles to each other. Its acceleration would be:
(A) 3 m/s^2. **(B)** 4 m/s^2.
(C) 5 m/s^2. **(D)** None of these.

b. A free body diagram shows the body and
(A) the supports. **(B)** the external forces.
(C) the internal forces. **(D)** the internal and external forces.

c. The radius of gyration of a circular ring of mass m and radius r about its diameter would be
(A) r. **(B)** $r/4$.
(C) $r/2$. **(D)** $r/\sqrt{2}$.

d. A block of weight W is at impending slip on a rough inclined plane with angle 2θ to the horizontal. The coefficient of friction is μ. If the angle of inclination is decreased to θ, the friction force on the block would be
(A) μW. **(B)** $\mu W\cos\theta$.
(C) $\mu W\cos 2\theta$. **(D)** $W\sin\theta$.

e. A car moving on a straight road travels 60 km with a speed of 20 km/h and the next 60 km with a speed of 60 km/h. Its average speed would be
(A) 30 km/h **(B)** 40 km/h
(C) 50 km/h **(D)** none of these

f. A thin disc of mass m and radius R is rolling without slip on horizontal ground with constant angular velocity ω. Its kinetic energy would be:
(A) $mR^2\omega^2/4$. **(B)** $mR^2\omega^2/2$
(C) $3mR^2\omega^2/4$ **(D)** none of these.

g. If the diameter of a shaft is doubled its stiffness increases by a factor of
(A) 16 **(B)** 8
(C) 4 **(D)** none of these.

h. The section modulus of a beam depends on

(A) The material of the beam. **(B)** The geometry of cross section.

(C) Both the material and geometry. **(D)** none of these.

PART I

Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. Determine the moment of the forces shown in Fig.1 about the hinge O. **(4)**

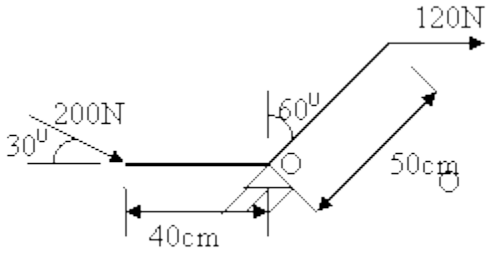


Fig.1

b. Determine the magnitude, direction and location on the beam for the resultant of the forces shown in Fig.2

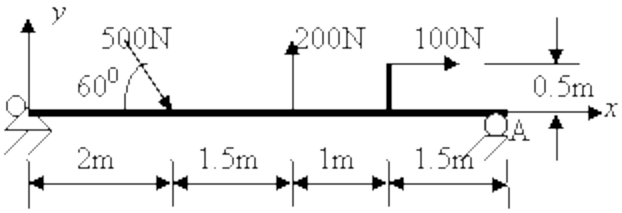


Fig.2

(10)

Q.3 a. Using the method of sections, determine the forces in the members BC and GC of the bridge truss shown in Fig.3. **(8)**

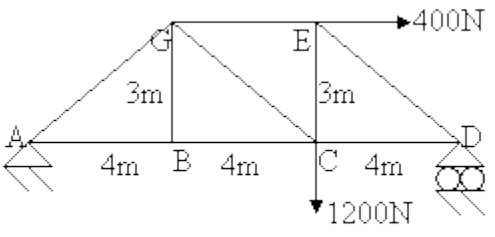


Fig.3

C

A

b. A two-member linkage has pin joints at A, B and C. Each member is 1 m long and has a weight of 100 N. Obtain the angle θ for equilibrium when a force of 50 N is acting at C as shown in Fig.4, using principle of virtual work. **(6)**

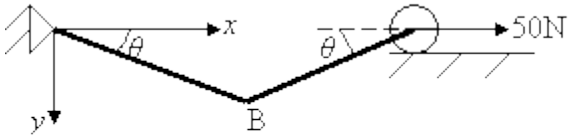
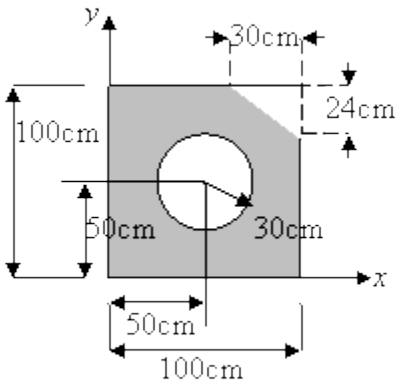


Fig.4

Q.4 a. Determine the centroid of the shaded area shown in Fig.5. **(8)**



b. For a plane lamina in the *xy* plane show that $I_{zz} = I_{xx} + I_{yy}$ **(6)**

Q.5 a. A light ladder 5 m long rests on a rough horizontal floor and against a smooth vertical wall at an angle of 30^0 to the wall. The coefficient of friction between the ladder and the horizontal surface is 0.4. Determine the maximum distance '*d*' along the ladder, which a man of 750 N can climb just before the ladder slips. **(8)**

b. A load of 480 N is to be raised using a wheel and axle. The axle has a diameter of 10 cm and the wheel has a diameter of 40 cm. A force of 160 N is required to lift the load. Determine the mechanical advantage, velocity ratio, efficiency and the friction load of the machine. **(6)**

Q.6 a. A particle moves along the *x* axis such that its velocity *v* is given as $v = (3t^2 - 6t)$ m/s, where *t* is the time in seconds. Initially at $t = 0$, it is at the origin O. Determine the time at which the velocity changes sign. Find the distance travelled

during the time interval t = 0 to t = 3.5 s and the average velocity and average speed during this time interval. **(8)**

b. A racing car travels around a horizontal circular track of radius 100m. If it increases its speed at a constant rate of $3m/s^2$, determine the acceleration when it is moving with a speed of 20 m/s. **(6)**

PART II
Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. Two blocks A and B of mass 100 kg and 200 kg start from rest. Determine the acceleration of each block and the tension in the string. Neglect friction and mass of the pulley. **(10)**

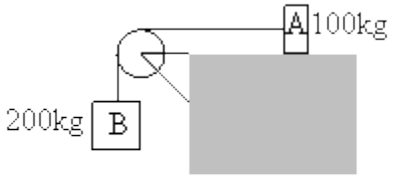


Fig.6

b. A mass of 5kg, at rest is acted upon by a horizontal impulse of 50 N. Determine the kinetic energy of the mass. **(4)**

Q.8 a. An aluminum bar of 50 mm diameter is subjected to a uniaxial load of 100 kN. The elongation is 0.3 mm over a gauge length of 300 mm and the diameter decreases by 0.015 mm. If the material is within elastic limit, calculate the Young's modulus and Poisson's ratio. **(6)**

b. A weight of 100 kN is suspended from a roof by two aluminum rods each 5 m long as shown in Fig.7. The ends A, B and C of the rods are hinged and the included angle between the rods is 100^0. If the working stress is 56 MPa, determine the diameter of the rods and the vertical deflection at B. Take Young's modulus E = 210 GPa. **(8)**

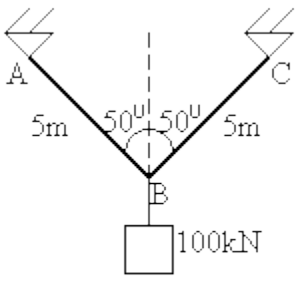


Fig.7

Q.9 The shafts AB of 5 cm diameter, 4 m length and CD of 3 cm diameter, 3 m length, are connected by gears P and Q of pitch diameters 24 cm and 6 cm, respectively. The end A of the shaft is fixed and a twisting moment of 100 N-m is applied at D. The shaft AB is of steel and CD of brass. The modulus of rigidity of steel and brass are 80 GPa and 40 GPa, respectively. Determine the angle of rotation at D. **(14)**

P

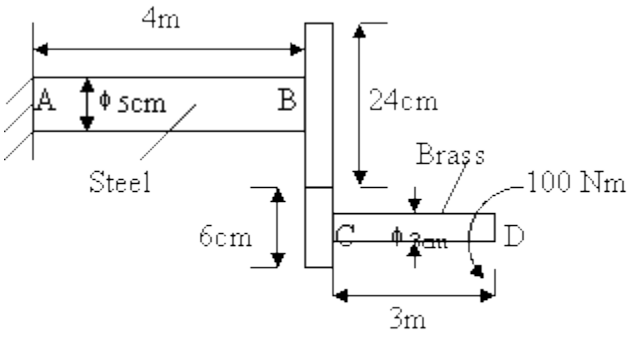


Fig.8

Q

Q.10 A beam is supported and loaded as shown. Draw the S.F. and B.M. diagrams. Determine the maximum S.F., B.M. and their location. Locate the point of contraflexure. **(14)**

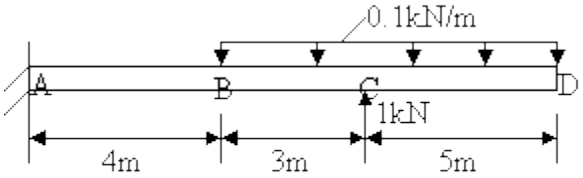


Fig.9

Q.11 A cast iron girder of I- section shown is simply supported over a span of 4 m. Calculate the uniformly distributed load per metre length that can be carried, without the tensile stress exceeding 15 MPa. Also find the maximum compressive stress in the beam. **(14)**

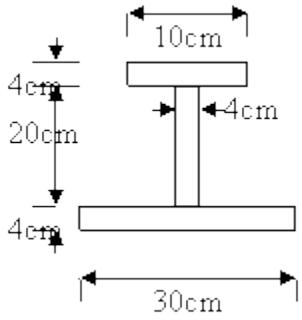


Fig.10