Code: DE-02 **Subject: APPLIED MECHANICS**

JUNE 2007

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. A body subjected to three forces is in equilibrium. Which of the following statements should be satisfied?

(A) forces must be concurrent
(B) forces must be parallel
(C) forces are neither parallel nor concurrent
(D) forces must be coplanar and concurrent

b. The mass moment of inertia of a thin circular disc of mass 'm' and radius 'r' about any diameter is

(A) mr^2 **(B)** $\frac{mr^2}{2}$
(C) $\frac{mr^2}{4}$ **(D)** $\frac{mr^2}{8}$

c. Two balls A and B of equal masses are travelling at 6 m/s and 4 m/s respectively. After elastic impact, the two balls have velocities

(A) same in the same direction
(B) interchanged in the same direction
(C) reversed as compared to original directions
(D) of A becomes zero and that of B becomes 10 m/s

d. A projectile is projected with a velocity 'v' at an angle of $45°$. What is the maximum height reached by it?

(A) $\frac{v^2}{2g}$ **(B)** $\frac{v^2}{4g}$
(C) $\frac{v^2}{6g}$ **(D)** $\frac{v^2}{8g}$

e. In a screw jack α is the helix angle and ϕ is the friction angle, then the maximum efficiency for lifting load will be when

(A) $\alpha = 45° - \frac{\phi}{2}$ **(B)** $\alpha = 45° + \frac{\phi}{2}$

(C) $\alpha = 60° - \frac{\phi}{2}$ **(D)** $\alpha = 60° + \frac{\phi}{2}$

f. A beam 5 m long is simply supported at its ends. It is subjected to a transverse load of 20 kN at a distance of 1 m from the left end. The maximum shear force on the beam is

(A) 4 kN **(B)** 8 kN

(C) 16 kN **(D)** 20 kN

g. The deflection at the free end of a cantilever beam of length ℓ subjected to a concentrated transverse load W is

(A) $\frac{W\ell^3}{2EI}$ **(B)** $\frac{W\ell^3}{3EI}$

(C) $\frac{W\ell^3}{4EI}$ **(D)** $\frac{W\ell^3}{8EI}$

h. A lifting machine has an efficiency of 60%, this machine is

(A) ideal machine **(B)** reversible machine

(C) irreversible machine **(D)** self-locking machine

i. A tensile force 'P' acts on a body of length 'L', area of cross section 'A' and young's modulus 'E'. The change in length due to force 'P' is given by

(A) $\frac{PL}{AE}$ **(B)** $\frac{PE}{AL}$

(C) $\frac{PA}{LE}$ **(D)** $\frac{AL}{PE}$

j. A solid circular shaft of diameter 'd' is subjected to torque 'T'. If the diameter of shaft is doubled and is subjected to same torque 'T', then the shear stress set up in the second shaft as compared to the first is

(A) same **(B)** half

(C) one fourth **(D)** one eighth

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

Q.2 a. State parallelogram law of forces. **(2)**

b. A bar AB shown in Fig.1 is hinged at A and is held at B by a horizontal rope which passes over a pulley and supports a load W to counter balance a load P of 4000 N at the centre of bar. Find the value of load W and also the reaction at the hinge and its direction. **(14)**

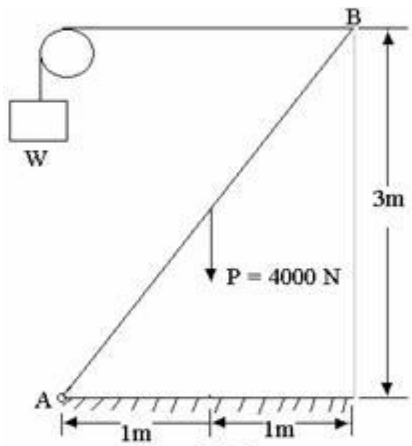
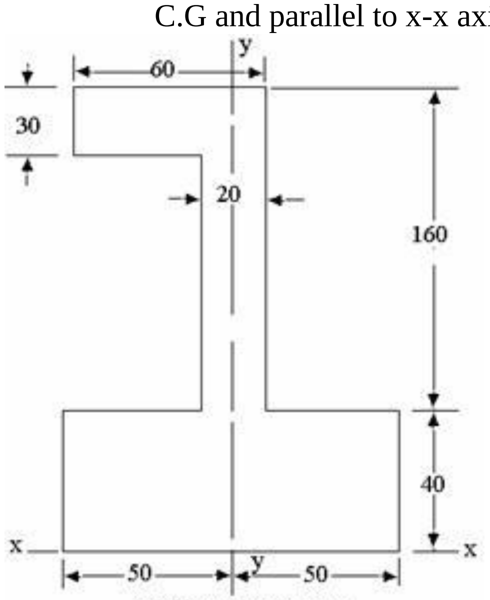


Fig.1

Q.3 a. Define moment of inertia. **(2)**

b. For the plane figure shown in Fig.2, determine the position of C.G with respect to x-x and y-y axes. Also find the moment of inertia about an axis passing through C.G and parallel to x-x axis. **(14)**



All dimensions in mm

Fig.2

Q.4 a. Define velocity ratio, mechanical advantage and efficiency of a machine. **(3)**

b. In a differential wheel and axle, the diameter of wheel is 25 cm. The larger and smaller diameters are 10cm and 9 cm respectively. Find the velocity ratio and the load which can be lifted, if the effort available is 100 N. Assume efficiency to be 60%. **(7)**

c. Prove that the condition for a self-locking machine is that its efficiency is less than 50%. **(6)**

Q.5 A truss is loaded as shown in Fig.3. Find the reactions and forces with their nature in all the members. Tabulate the results. **(16)**

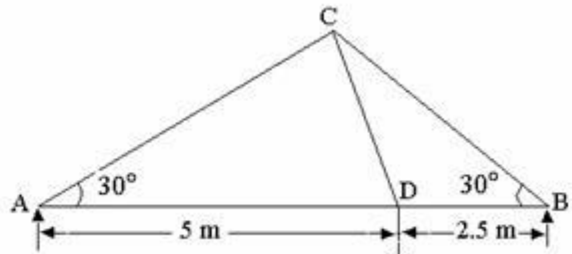


Fig.3

Q.6 a. State the law of conservation of momentum. **(2)**

b. A body of weight 20 N moving with a velocity of 10 m/s strikes another body of weight 30 N moving in the same direction at a speed of 5 m/s. Find the velocities of the two bodies after impact, if the coefficient of restitution is 0.9. What would be their final velocities after impact, if the bodies moved in opposite directions with the same velocities? **(14)**

Q.7 a. Define stress, strain and state Hooke's law. **(3)**

b. The bar shown in Fig.4 is subjected to a tensile load of 40 kN and produces a total extension of 0.285 mm in the bar. Determine the Young's modulus of the material. **(13)**

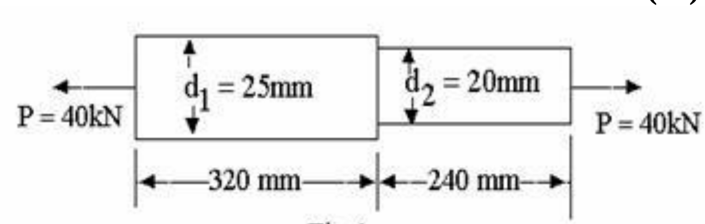


Fig.4

Q.8 a. Define shear force and bending moment. **(2)**

b. A simply supported beam of span 5 m has a cross section of 150 mm wide and 250 mm depth. If the permissible stress is $20\ N/mm^2$. Find

(i) the maximum intensity of uniformly distributed load it can carry.
(ii) the maximum concentrated load that it can carry, if applied at 2 m from one of the ends. **(14)**

Q.9 Derive an expression for the slope and deflection at the free end of a cantilever beam of uniform cross section of length ℓ, when it carries a concentrated load W at a distance 'a' from the fixed end $[a < \ell]$.
(16)