Bengal Engineering and Science University, Shibpur
BE 3rd Semester(AE& ME) Final Examination 2013
Fundamentals of Solid Mechanics (AM308)

Time : 3hours Full Marks: 70

Answer any three questions from each half

First Half

1) a) A rigid bar AB is hinged at A and supported in a horizontal position by two identical vertical steel wires as shown in Fig. 1a. Find the tensile forces S_1 and S_2 induced in these wires by a vertical load P applied at B as shown.

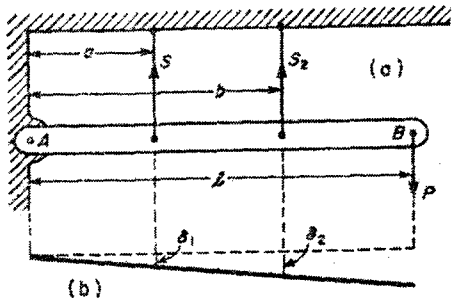

Fig. 1a

b) A thin-walled cone (wall thickness t) is supported on a horizontal base as shown in Fig. 1b and subjected to internal gas pressure p. Neglecting the weight of the cone itself, find the principal membrane stresses σ_1 and σ_2 at the level h below the apex. The apex angle of the cone is 2α as shown.

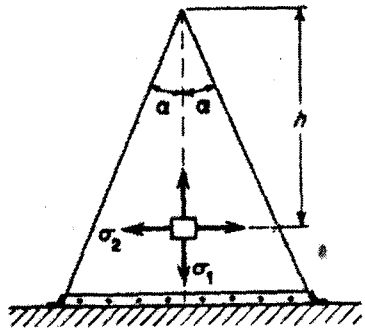

Fig.1b

2. (a) Prove that T (Torque)= GθJ

(b)A prismatic shaft of diameter d has built-in ends and is subjected to the action of externally applied twisting moments T_1 and T_2 as shown in Fig.2b. Find the internal torques T_a, T_b, T_c, in the three portions a, b, c of the shaft. The following numerical data

are given : $a = 75$ cm, $b = 125$ cm, $c = 100$ cm, $T_1 = 12{,}000$ kg-cm, and $T_2 = 24{,}000$ kg-cm

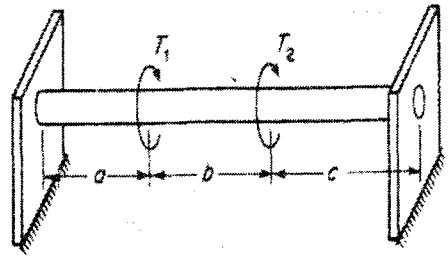

Fig. 2b

3. a) A simply supported beam carries a linearly varying transverse load as shown in Fig.3a. The intensity of load at each end of the beam is w_o. Develop general expressions for V_x and M_x at a cross-section distance x from support A. At what value of x will the bending moment be a maximum? What is the shear force at the middle cross-section of the beam?

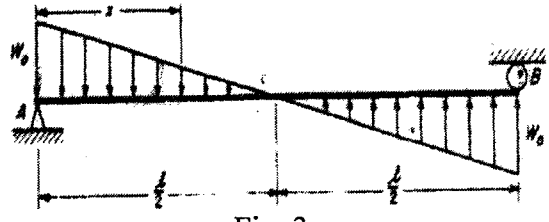

Fig. 3a

b) A simply supported beam having a span $l = 3.6$ m is to carry a uniformly distributed load of intensity $w = 1{,}600$ kg/m. The cross-section is to be rectangular with depth h and width $b = h/2$. If the allowable bending stress in tension or compression is $\sigma_w = 84$ kg/cm^2, what is the required depth h for the cross-section?

4.(a) Develop the general expression of shear stress in beam.
(b)A box beam like that shown in Fig.4(b) is made of four 15 X2.5cm wood planks connected by screws, each of which can safely transmit a shear force of 125 kg. Calculate the minimum spacing of screws along the length of the beam if the maximum shear force $V = 500$ kg.

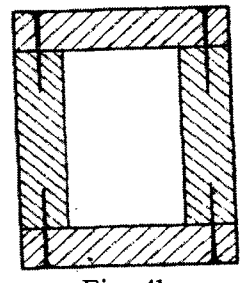

Fig. 4b

5.a) Find the magnitudes and directions of principal stresses either analytically or by constructing Mohr's circle for the element if $\sigma_x = -350$ kg/cm^2, $\sigma_y = 210$ kg/cm^2 and $\tau_{xy} = 210$ kg/ cm^2.
(b) Develop the equation for a short column.

2nd Half

(Answer any three questions)

6. A steel shaft supported in bearings at A and B and carrying pulleys at C and D, is to transmit 100 hp at 500 rpm from the drive pulley D to the offtake pulley C as shown in Fig. 6. The following numerical data are given : $P_1 = 2P_2$, $Q_1 = 2Q_2$, $R_d = 15$ cm, $R_c = 20$ cm, $l = 1.2$m, $a = 30$ cm, and the working stress in shear is Tw = 420 kg/cm^2. Calculate the required diameter d of the shaft.

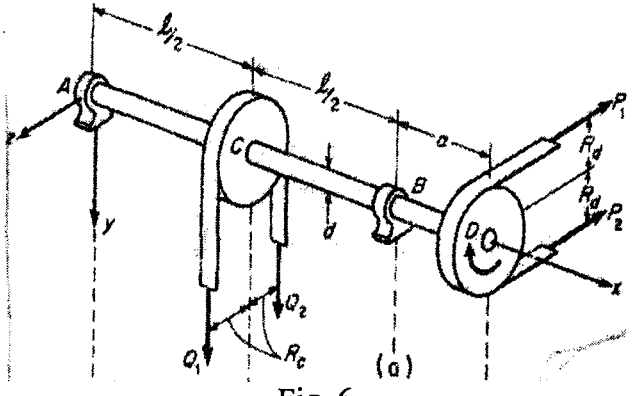

Fig. 6

7 a) A simply supported prismatic beam AB carries a uniformly distributed load of intensity w over its span l as shown in Fig. 7a. Develop the equation of the elastic line and find the maximum deflection δ at the middle of the span.

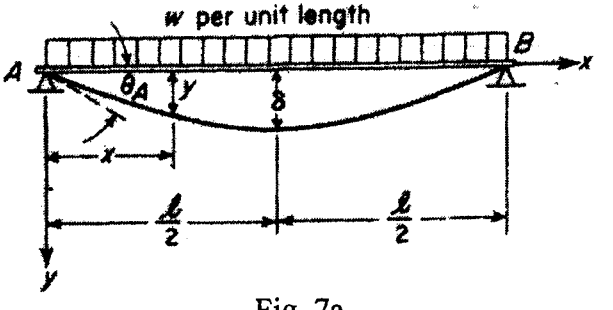

Fig. 7a

b) A cantilever beam of length l carries two forces P at its third-points as shown in Fig. 7b. Using the moment area method, find the deflection δ_A at the free end A. The flexural rigidity of the beam is uniform throughout its length.

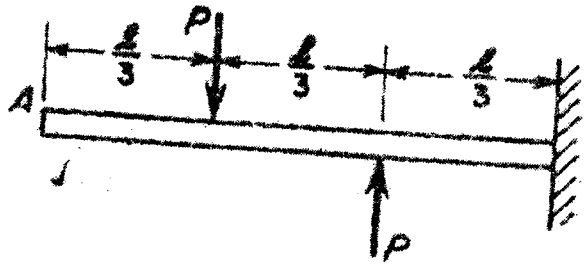

Fig. 7b

8.(a)Develop the expression of strain energy for bending ,torsion and tension.

(b) A solid circular rotor of weight $W = 175$ kg and radius $r = 25$ cm is supported by a bearing at the end of a simply supported beam as shown in Fig. 8b. Initially the rotor turns at a constant angular speed of 30 rpm. If the bearing suddenly freezes so that the rotor stops almost instantly, what dynamical reaction will be produced at A? Bearing and support at B are independent, and the beam has a rectangular cross-section 2.5 cm wide by 10 cm deep.

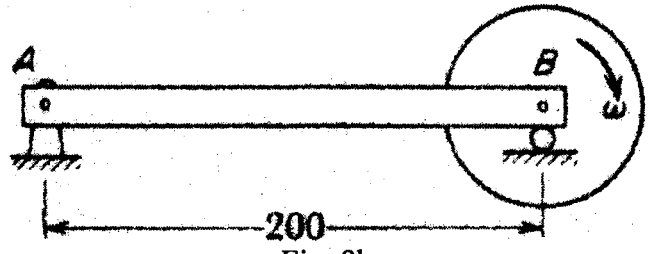

Fig. 8b

9. (a)What is theory of Castigliano, describe in detail.

(b) Find the redundant moment M_A at the built-in end A of the statically indeterminate beam supported and loaded as shown in Fig. 9b. with the help of that theorem.

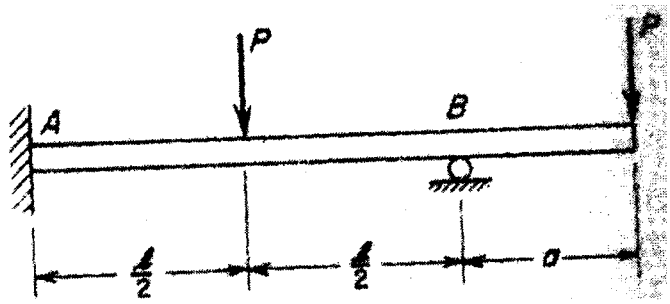

Fig.9b

10 (a) Develop the equation of buckling for a beam one end fixed another end free. What is the use of secant formula.

(b) Write down details about energy based failure theories.