Bengal Engineering and Science University, Shibpur
B.E. (EE) Part-II 3rd Semester Examination, December 2012
STRENGTH OF MATERIALS AND THEORY OF MACHINES (AM-307)

Time: 3 hours Full Marks: 70

Use separate answerscript for each half.
Answer any SIX questions, taking THREE from each half.
Assume reasonable data, not supplied with the problem.
Two marks are reserved for neatness in each half.
The questions are of equal value.

FIRST HALF

1. a) Discuss briefly a pivoted-carriage balancing machine.
b) A shaft, rotating at a uniform speed, carries two disc A and B of masses 5 kg and 4 kg, respectively. The CG of each disc is 2.5 mm from the axis of rotation, and the angle between the radii containing the centres of gravity is 90°. The shaft has bearings at C and D, between A and B, such that AC=300 mm, AD=900 mm, and AB=1200 mm. It is desired to make the dynamic forces on the bearings equal and opposite, and to have a minimum value for a given speed by means of a mass in the plane E at a radius of 25 mm. Determine (i) the magnitude of the mass to be attached at E and its angular position with respect to that at A, (ii) the distance of the plane E from the plane through A, and (iii) the dynamic force on the bearing with the attached mass in the plane E for a speed of 250 rpm.

2. a) Derive an equation for the fluctuation of energy in case of a flywheel.
b) A shearing machine has to cut flat strips 12 cm wide by 1.5 cm thick and it may be assumed that 6 Nm of work is required per mm^2 cut. The flywheel of radius of gyration 70 cm has a speed of 200 rpm at start of each cut. Assuming that the energy required for cutting is supplied wholly by the flywheel and its speed reduction is not to exceed 12% of maximum, find the mass of the flywheel necessary and the torque that must be applied to the flywheel so that it can regain full speed in four seconds available time.

3. a) Derive an equation for the equilibrium speed of a Porter governor.
b) The upper arms of a Porter governor are pivoted on the axis of rotation and the lower arms are pivoted to the sleeve at a distance of 25 mm from the axis of rotation. The length of each arm is 300 mm and the mass of each ball is 5 kg. The equilibrium speed is 250 rpm. When the radius of rotation is 200 mm, find the required load on the sleeve. If the friction is equivalent to a force of 0.5 N at the sleeve, find the coefficient of insensitiveness at 200 mm radius.

4. The turning moment curve for one revolution of multi-cylinder engine shows the following intercepted areas below and above the line of resisting torque: -3.5, +7.2, -6.11, +8.81, -5.31, +4.43, -5.52 cm^2. The vertical and the horizontal scales

are 1 cm= 350 kg-m torque and 1 cm to 25 deg respectively. The engine has a mean speed of 240 rpm, the fluctuation of speed is not to exceed 1.5 per cent of the mean speed. Determine a suitable diameter and cross-section of the flywheel rim if the hoop stress due to centrifugal force is not to exceed 60 kgf/cm^2. The density of the material is 0.008 kg per cm^3 and the width of the rim is to be three times the thickness.

5. a) Write the differential equation of motion for the system shown in Fig. Q5a and determine the natural frequency of the damped oscillation and the critical damping coefficient.
b) Determine the natural frequency of a spring-mass system which has lumped mass m, spring mass m_s and the stiffness of the spring k, considering the effect of the mass of the spring.

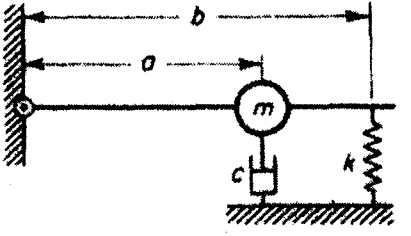

Fig. Q5a

2nd Half (AM 307)

(Answer Any Three Questions)

6.(a)Write short notes on

(i) Stress Strain Diagram (ii) Mohrs' Circle (iii) Pure shear

(b) Deduce the Differential form of Bending moment & Shear force for different cases.

7. A copper rod with circular cross sections rests inside a steel frame as shown in figure . The two side member of the frame are each 6.25 cm^2 in cross section. At a temperature t= -18 centigrade there is a 0.025mm clearance between the upper end of the rod and the top of the frame as shown. Calculate the compressive force S in the copper rod when the temperature of the entire system is raised to 22 degree centigrade. Neglect the bending of the frame.

(Take $\alpha_c = 18.5X10^{-6}$, $\alpha_s = 12 X 10^{-6}$, Ec = $12x10^5$kg /cm^2, Es = $2x10^6$ kg/cm^2)

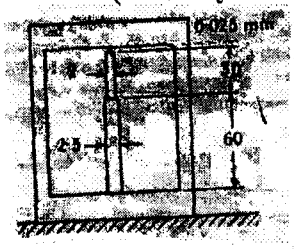

fig Q-7

8.(a)A prismatic shaft of diameter d has built in ends and is subjected to the action of the externally applied twisting moments T1 & T2 as shown in fig-8 . Find the internal torques Ta ,Tb & Tc in three portions a, b, c of the shaft. The following numerical data are given a = 75cm, b = 125cm , c=100cm, T1 =12000 kg-cm T2= 24000 kg-cm. (G =$84x10^4$ kg/cm^2)

(b) Prove that T (Torque)= GθJ

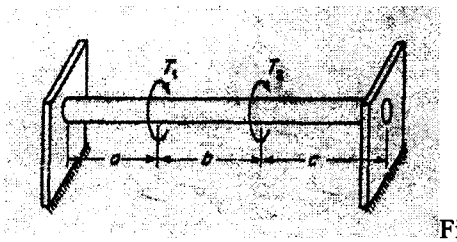

Fig-Q 8(a)

9. (a) A cast iron water pipe 12 meter long, 500mm inside diameter , 25 mm thickness runs full of water and supported at its end. Calculate the maximum stress in metallic pipe if density of cast iron is 7200kg/ m^3 and that of water is 1000kg/m^3.

(b)Draw and calculate the Shear force and Bending Moment diagram for horizontal bar AB Fig for Q-9

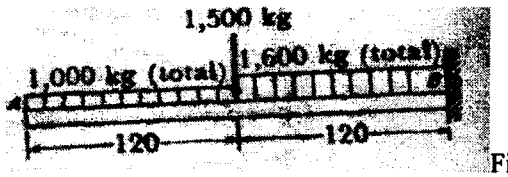

Fig-Q 9(b)

10. (a) Prove that G = E/2(1+μ) considering a pure shear case.

(b) A thin walled cone (Wall thickness t) is supported on a horizontal base as shown Fig for Q-10 (b) and subjected to internal gas pressure p. Neglecting the weight of the cone itself, Find the principal membrane stresses $\sigma_1$and σ_2 at the level h below the apex the apex angle cone is 2α as shown.

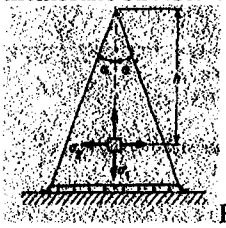

Fig Q 10(b)