Bengal Engineering and Science University, Shibpur
B.E. (EE) Part-II 3rd Semester Examination, December 2011
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)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.
2. A truncated conical tank having the dimensions shown in fig Q2 is filled up with water ($w = 1gm/cm^3$). Calculate the membrane stresses σ_1 & σ_2 for an element A of the wall situated as shown in the Figure if t = 0.03
3. (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 Q3 . 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)= $G\theta J$
4. Calculate the bending moment (BM) & shear force (SF) at A B C D E point as shown in fig Q4. Also draw the BM & SF diagram along the shaft.
5. In fig Q5 an absolutely rigid bar BD is hinged B and supported by two guy wires attached to the vertical wall A. The steel guy wires are identical except for length and just taut but free from stress before the load is applied. Find the tensile forces S1 & S2 produced in the guy wires by load P.

SECOND HALF

6. a) Discuss briefly a pivoted-carriage balancing machine.
   b) A generator rotor is balanced by using a cradle machine. The following observations were made for plane I.

Run	Amplitude in microns
No trial mass	50.0
Trial mass 250 gm at 0°	37.4
Trial mass 250 gm at 180°	73.5
Trial mass 250 gm at 90°	77.8

   Determine the magnitude and location of correcting mass.

7. a) Derive an equation for the fluctuation of energy in case of a flywheel.
   b) The crank shaft torque of an engine can be expressed by the equation $T = [30000 + 15000\ sin2\theta - 20000\ cos4\theta]Nm$. If the speed of the engine is not to exceed 0.5 per cent above or below a mean speed of 250 rpm, determine the mass of a suitable flywheel.

8. a) Define the following terms: i) Sensitiveness, ii) Stability and iii) Controlling force curve.
b)In a Hartnell type governor the two masses are 4 kg each and the load on the sleeve is 40 N. If with the weight arms vertical, the path radius is 80 mm and the equilibrium speed neglecting friction is 420 rpm, find the corresponding compression force in the spring. Find also the friction force at the sleeve which can be overcome in this position for an increase in speed of 1%. If the sleeve movement is to be 20 mm for increase of 5% from 420 rpm position, find the required spring stiffness. Neglect the gravity effect on the masses. Horizontal and vertical arms are equal.

9. a) In the arrangement shown in Fig. Q9a the sleeve M of mass $m = 0.20\ kg$ is fixed between two identical springs whose combined stiffness is equal to $x = 20\ N/m$. The sleeve can slide without friction over a horizontal bar AB. The arrangement rotates with a constant angular velocity $\omega = 4.4\ rad/s$ about a vertical axis passing through the middle of the bar. Find the period of small oscillations of the sleeve. At what values of ω will there be no oscillations of the sleeve?
b) Find the frequency of small oscillations of the arrangement shown in Fig. Q9b. The radius of the pulley is R, its moment of inertia relative to the rotation axis is I, the mass of the body is m, and the spring stiffness is k. The mass of the thread and the spring is negligible, the thread does not slide over the pulley, there is no in the axis of the pulley.

10. a) A rigid uniform bar of mass m and length l is pinned at O and supported by a spring and viscous damper as shown in Fig. Q10a. Measuring θ from static equilibrium position, determine the equation for small θ, the equation for the undamped natural frequency, and the expression for critical damping.
b) A turbine disk of mass 30 kg with operating speed of 8000 rpm, is mounted at the center of a shaft of span 0.5 m and diameter 4 cm. The disk has an unbalance of 0.1 kg-cm. Assume the bearings to be rigid and the end conditions to be simply supported. Damping is represented by an equivalent viscous damping ratio of 0.08. Determine the critical speed, whirling amplitudes at operating speed, critical speed and a speed 25% more than the critical speed.

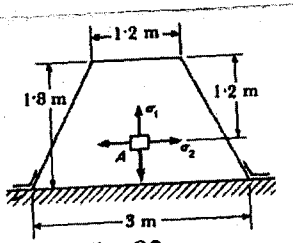

Fig. Q2

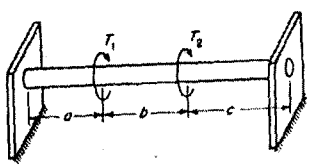

Fig. Q3

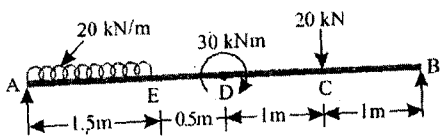

Fig. Q4

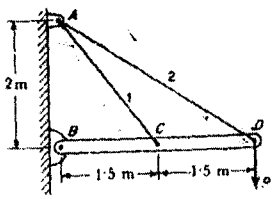

Fig.Q5

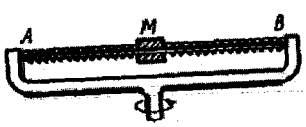

Fig. Q9a

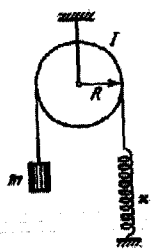

Fig. Q9b

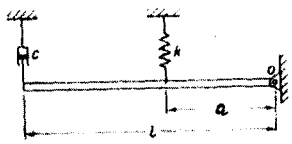

Fig. Q10a