T.E. (Mechanical) (Sem. – I) Examination, 2010
DESIGN OF MACHINE ELEMENTS
(2003 Course)

Time : 4 Hours | Max. Marks : 100

N.B. *: 1) Answer **three** questions from Section – **I** and **three** questions from Section – **II**.*

*2) Answer to the **two** Sections should be written in **separate** books.*

*3) **Neat** diagrams must be drawn **wherever** necessary.*

*4) **Black** figures to the **right** indicate **full** marks.*

*5) **Use** of Logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is **allowed**.*

*6) Assume **suitable** data, if necessary.*

SECTION – I

1. a) What is preferred number series and where are they used ? **3**

   b) With the help of an illustration, explain briefly various phases involved in the process of machine design. **5**

   c) A mild steel bracket as shown in fig. 1 is subjected to a pull of 6 KN acting at 45° to vertical as shown. The bracket has a rectangular section whose depth is twice the thickness. Find the cross sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60 MPa. **8**

OR

2 a) Explain what do you understand, if service factor and factor of safety are 1.5 each. Explain when these factors are to be used. **4**

   b) Write a short note on : Importance of standardization in Machine Design. **4**

c) An offset bar is loaded as shown in fig. 2. Neglect the self weight of the bar. Determine the maximum offset 'X' if the allowable stress in tension is limited to 70 MPa. **8**

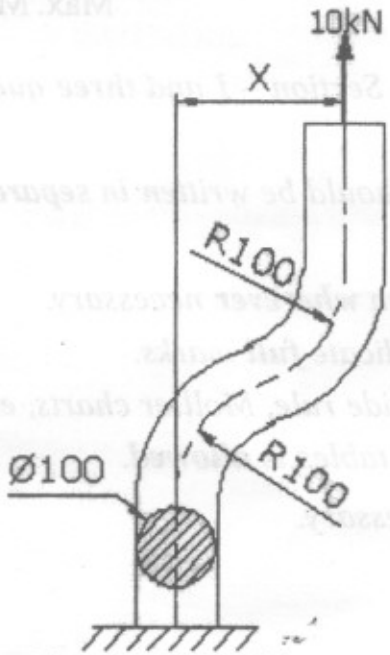

Figure - 2 Q.2 (c)

3. A transmission shaft is supporting a spur gear B and pulley D. The shaft is mounted on two bearings A and C as shown in fig. 3. Power is transmitted from pulley to the gear. The diameter of the pulley and gear are 450 mm and 300 mm respectively. The pulley is keyed to the shaft and the key effect may be assumed to be extending upto the bearing support.

20 KW power at 500 rpm is transmitted from pulley to the gear (pressure angle 20°). The ratio of belt tensions of tight and slack side is 3 : 1. The material for the shaft is steel 50C4 S_{ut} = 700 N/mm^2 and S_{yt} = 460 N/mm^2. Assume combined shock and fatigue factor for bending and torsional moments as 1.5. Determine

a) The shaft diameter using the ASME code.

b) Find various stresses in the rectangular key if the key selected is 12 mm wide, 10 mm height and 60 mm length.

c) Shaft diameter on the basis of torsional rigidity if the permissible angle of twist is 3° per metre length. The modulus of rigidity for the shaft material is 79300 N/mm^2. **16**

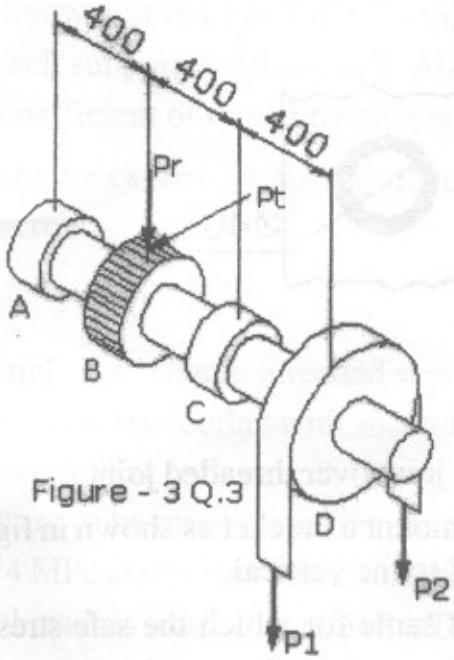

Figure - 3 Q.3

OR

4. a) Using 'Castigliano's theorem', find maximum deflection of simply supported beam with a point load at centre load and that of a cantilever beam with a point load at free end. **6**

b) A standard spline connection 8 × 52 × 60 mm is used for the gear and the shaft assembly of a gear box. A 20 KW power at 300 rpm is transmitted by the splines.

The normal pressure on the splines is limited to 6.5 N/mm^2. The coefficient of friction is 0.06

Calculate :

i) the length of the hub of the gear.

ii) the force required to shift the gear. **6**

c) Compare flexible coupling with rigid coupling state applications of both. **4**

5. a) Derive an expression for torque requirement to tighten the bolt with I.S.O metric screw threads. **4**

   b) A circular shaft of 40 mm in diameter, is welded to a support by means of a fillet weld as shown in fig. 4. Determine the size of the weld, if the permissible shear stress in the weld is limited to 80 N/mm^2. Derive an expression if any required. **14**

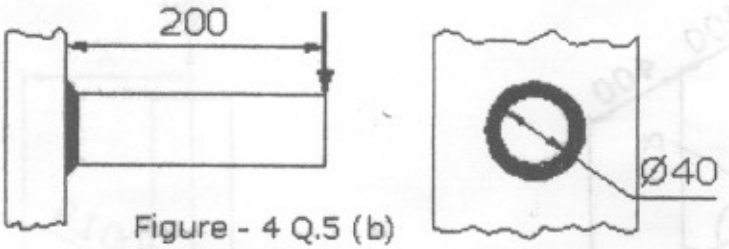

Figure - 4 Q.5 (b)

OR

6. a) State advantages and limitations of welded joint over threaded joint. **4**

   b) Determine the size of the bolts required to mount a bracket as shown in fig. 5. carrying a load of 40 KN at an angle of 60° to the vertical.

   The material of the bracket and the bolt is same for which the safe stresses can be considered as 70, 50 and 105 MPa in tension, shear and compression respectively. **14**

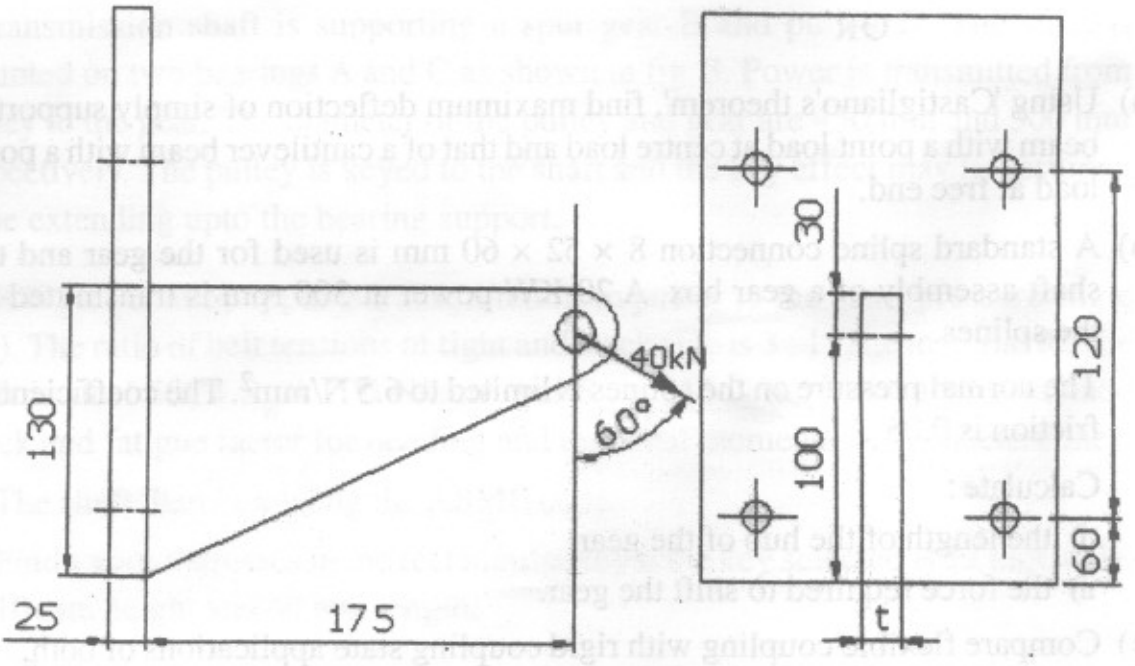

Figure - 5 Q.6 (b)

SECTION – II

7. a) A double start square threaded screw has nominal diameter 50 mm and pitch 8 mm. It is used in a screw jack with a nut having 48 mm length. Calculate maximum shear stress induced in screw body; transverse shear stresses in screw and nut ; and the bearing pressure between the threads if the screw jack supports load of 5 kN. Also state whether the screw is self locking if the coefficient of thread friction is 0.12. **12**

   b) Derive expression for torque required to lower the load using square threaded screw. **6**

OR

8. A single start square threaded screw is to be designed for load capacity of 12 kN. The screw has collar with mean radius 20 mm. The coefficients of friction at threads and at collar are 0.12 and 0.08 respectively. Design the screw and nut if they are to be made out of the same material which has permissible tensile stress of 74 MPa and permissible shear stress of 37 MPa. The bearing pressure between the threads is limited to 12 MPa. The available square threaded screws have pitch of 3 mm and nominal diameters 16 mm, 18 mm, 20 mm and 22 mm. **18**

9. a) Three identical helical compression springs are to be used to support a load of 3 kN. Select suitable wire for maximum spring index ranging from 4 to 6 and determine mean coil diameter, wire diameter, no. of active turns if the deflection due to the load in each spring is 40 mm. Available wires have allowable stress as below, **12**

d (in mm)	2.0	3.0	3.6
τ_p (in N/mm^2)	1450	1350	1300

   b) Derive expression for total shear stress induced in the helical tension spring wire, neglecting effect of stress concentration due to curvature. **4**

OR

10. a) A helical torsion spring having mean coil diameter 50 mm is made out of ϕ 5 mm wire. Determine the maximum torque that may be applied to the spring if the stress induced in the outer fiber is not to exceed 300 N/mm^2. Also determine stress induced in the internal fiber and angular deflection if the modulus of elasticity is 210 GPa and the spring has 10 active turns. **8**

b) Sketch and explain construction and working of multileaf spring. **5**

c) What is nipping of leaf spring ? Why is it provided ? **3**

11. a) A cantilever beam shown in Figure-6 is made of material having ultimate tensile strength 600 MPa, tensile yield strength 400 MPa and is subjected to a completely reversing load of P = $\pm$1.5 kN. Determine the diameter "d" assuming factor of safety to be 1.5, notch sensitivity factor at fillet to be 0.6, theoretical stress concentration factor to be 1.5, surface factor to be 0.8, size factor to be 0.9 and expected life to be 8000 cycles. The calculations are expected at 90% reliability for which reliability factor is 0.897. **10**

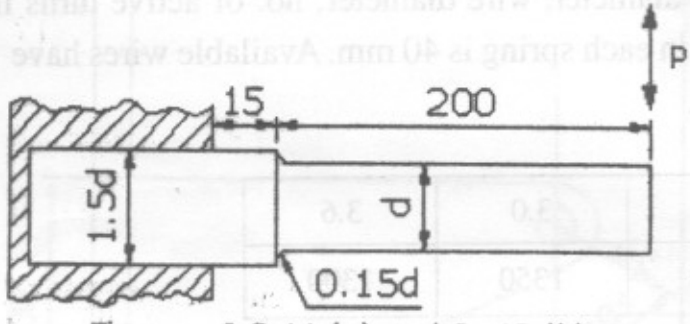

Figure - 6 Q.11 (a) and Q. 12 (b)

b) Write a note on Miner's equation. **6**

OR

12. a) Write a note on Goodman criterion. **4**

b) A cantilever beam shown in Figure -6 is made of material having ultimate tensile strength 600 MPa, tensile yield strength 400 MPa and is subjected to a varying load P varying from – 5 kN to + 15 kN. Determine diameter "d" assuming factor of safety to be 2, notch sensitivity factor at fillet to be 0.6, theoretical stress concentration factor to be 1.5, surface factor to be 0.8, size factor to be 0.9 using the Soderberg criterion. The calculations are expected at 90% reliability for which reliability factor is 0.897. **12**

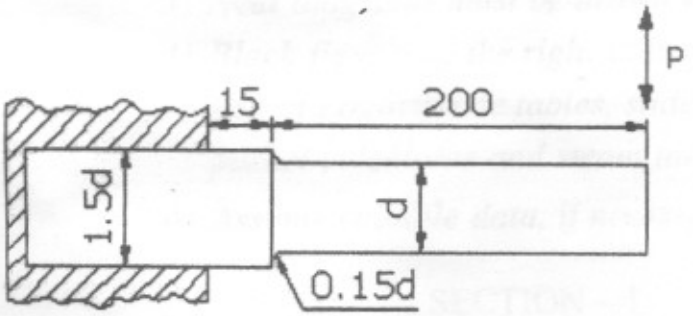

Figure - 6 Q.11 (a) and Q. 12 (b)