

CS/B.TECH/ME/PE/ODD SEM/SEM-5/ME-503/2016-17

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**MAULANA ABUL KALAM AZAD UNIVERSITY OF
TECHNOLOGY, WEST BENGAL**

Paper Code : ME-503

DESIGN OF MACHINE ELEMENTS

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own
words as far as practicable.*

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

$$10 \times 1 = 10$$

- i) Stress concentration in cyclic loading is more serious in
- a) Ductile Materials
 - b) Brittle Materials
 - c) Depends on other factors
 - d) Unpredictable.

- ii) In the calculation of shear stress in helical spring the Wahl's correction factor is used to take care of
 - a) combined effect of transverse shear stress and bending stress
 - b) combined effect of bending stress and curvature effect of the wire
 - c) combined effect of transverse shear stress and curvature effect of the wire
 - d) combined effect of transverse shear stress and torsional shear stress.
- iii) In welded joint the throat of weld as compared to size of weld is
 - a) about same size
 - b) about 0.7 times
 - c) about 0.5 times
 - d) about 0.25 times.
- iv) In a flange coupling, the flanges are coupled together by means of
 - a) bolt and nut
 - b) stud
 - c) headless taper bolt
 - d) none of these.
- v) The pipe joint mostly used for pipes carrying water at low pressures is
 - a) socket joint
 - b) union joint
 - c) sleeve joint
 - d) socket and spigot joint.
- vi) Von Mises' theory is applicable for
 - a) Ductile materials
 - b) Brittle materials
 - c) Elastic materials
 - d) All of these.

vii) The permissible stress in a fillet weld is 100 N/mm^2 . The weld has equal leg length of 15 mm each. The allowable shear load on weldment per cm length of weld is

- a) 22.5 kN b) 15.0 kN
- c) 10.6 kN d) 7.5 kN.

viii) Universal coupling is used to connect two shafts which have

- a) lateral misalignment
- b) exact alignment
- c) intersecting axes at a small angle
- d) none of these.

ix) For design analysis of long column

- a) Johnson's equation is suitable
- b) Rankine's equation is suitable
- c) Euler's equation is suitable
- d) Both (a) and (b).

x) Creep in belt drive is due to

- a) Material of the belt
- b) Material of the pulley
- c) Uneven tension and contraction due to varying tension.
- d) Expansion of the belt.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following $3 \times 5 = 15$

2. A forged steel bar, 50 mm in diameter, is subjected to a reversed bending stress of 250 MPa. The bar is made of steel 40C8 ($S_{ut} = 600 \text{ MPa}$). Calculate the life of the bar for a reliability of 90%. Assume Surface finish factor = 0.44, Size factor = 0.85, Reliability factor = 0.897.

3. Design a shaft as per A.S.M.E. based on the following data :

- i) Torque and bending moments applied are 450 N-m and 100 N-m respectively.
- ii) The load is applied with light shock. For this case the combined shock and fatigue factor applied to bending moment, $k_b = 1.5$ and the combined shock and fatigue factor applied to torsional moment, $k_t = 1.0$.

iii) The shaft material is having ultimate strength of 440 N/mm^2 , yield strength of 310 N/mm^2 and elastic limit of 250 N/mm^2 . Maximum shear stress, $\tau_{max} = 0.30S_{yt}$ or $0.18S_{ut}$ (whichever is minimum).

There is no keyway in the shaft.

4. With the help of a figure, briefly explain how Goodman diagram and Soderberg diagram are used for fatigue design of a component.

5. A hollow circular shaft is being designed to transmit 120 kW at 105rpm. The inside diameter of the shaft is to be one-half of the outside diameter. Assuming that the allowable shear stress is 45 MPa, calculate the minimum required outside diameter.
6. Derive the expression of torque required to raise a load by power screw.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Design a double riveted chain lap joint for MS plates 9.5 mm thick. Calculate the efficiency of the joint. The permissible stresses for the materials of the plates and the rivets are : $\sigma_t = 90$ MPa, $\tau = 75$ MPa, $\sigma_c = 150$ MPa. Draw a sketch of the lap joint with the dimensions shown. 9
- b) A flat belt drive has an angle of wrap of 160° on the smaller pulley. The angle of wrap is increased to 200° by using an idle pulley. The slack side tension is same in both the cases and the centrifugal tension is negligible. By what percentage the torque capacity of the belt drive is increased by adding the idler ? Use the coefficient of friction $\mu = 0.3$. 6
8. a) Two rods are connected by means of a cotter joint. The inside diameter of the socket and the outside diameter of the socket collar are 50 mm and 100 mm respectively. The rods are subjected to a

tensile force of 50 kN. The cotter is made of steel 30C8 ($S_{yt} = 400$ N/mm²) and the factor of safety is 4, the width of the cotter is 5 times of thickness. Calculate :

- i) width and thickness of the cotter on the basis of shear failure; and
- ii) width and thickness of the cotter on the basis of bending failure. 10
- b) Derive the equation for the length of flat belt for a cross belt drive. 5
9. Prove that the stress in all leaves of a multi-leaf spring is, $\sigma_b = 6Pl/nbt^2$.
A semi-elliptical multi-leaf spring is used for rear axle suspension of a truck. It consists of two extra full length leaves and ten graduated length leaves including master leaf. The centre to centre distance of spring eye is 1.2 metre. The leaves are made of steel 55SiMo90 of $S_{yt} = 1500$ N/mm², $E = 207$ GPa and factor of safety is 2.5. The spring is to be designed for a maximum force of 30 kN. The leaves are pre-stressed so as to equalize stress in all leaves. Determine, i) cross-section of the leaves and ii) deflection at the end of spring. 8 + 7
10. A rotating shaft subjected to a non-rotating force of 5kN and simply supported between two bearings A & E as shown in fig. 1. The shaft is machined from plain

carbon steel 30C8 ($S_{ut} = 500 \text{ N/mm}^2$) and expected reliability 90%. The equivalent notch radius at the fillet section can be taken as 3mm. What is the life of shaft?

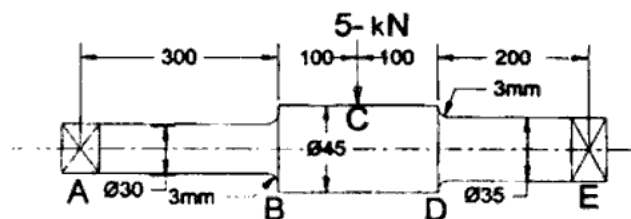


Fig. 1

11. a) A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity 84 kN/mm², find the axial load which the spring can carry and the deflection per active turn.
- b) A bracket is riveted to a column by six rivets of equal size as shown in figure 2. Shear stress in the rivet is limited to 15 MPa. Determine the diameter of the rivet.

6 + 9

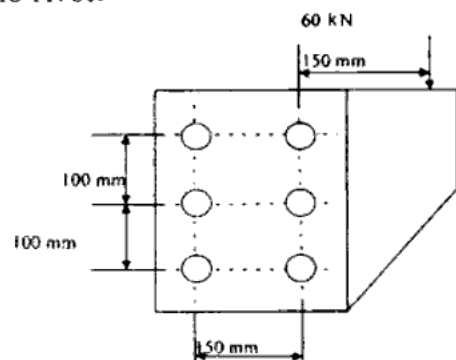


Fig. 2

12. A steel cantilever is 200 mm long (Fig. 3). It is subjected to an axial load which varies from 150 N in compression to 450 N in tension and also transverse load at its free end which varies from 80 N up to 120 N down. The cantilever is of circular cross-section. It is of diameter 2d for first 50 mm and of diameter d for the remaining length. Determine its diameter at the fillet cross-section taking a factor of safety of 2. Assume the following :

Yield strength = 330 N/mm²

Ultimate strength = 600 N/mm²

Stress concentration factor = 1.44 for bending

& 1.64 for axial loading

Surface finish factor = 0.9

Size factor = 0.85

Reliability factor = 0.897

Notch sensitivity factor = 0.9

Endurance limit of standard specimen in axial loading = 0.8 times the endurance limit of the standard rotating beam specimen in reversed bending.

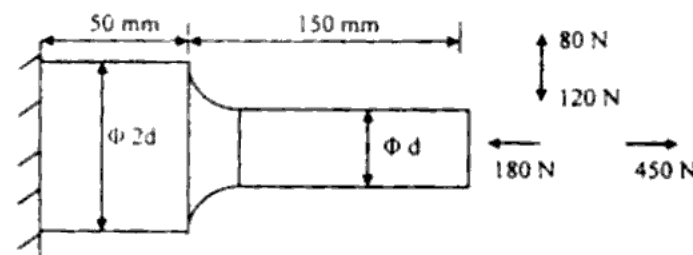


Fig. 3