B.E.(with Credits)-Regular-Semester 2012-Mechanical Engineering Sem V

ME501 - Design of Machine Elements

P. Pages : 3 **GUG/W/16/3794**

Time : Three Hours * 3 9 8 4 * Max. Marks : 80

Notes : 1. All questions carry equal marks.
2. Answer Q. 1 or 2, Q. 3 or 4, Q. 5 or 6 and Q. 7 and 8.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of DDB by Prof. B. D. Shiwalkar is permitted.

1. a) What is stress concentration ? What are the methods of reducing stress concentration ? **5**

b) What is factor of safety ? Why is it necessary to use factor of safety. **5**

c) Design a cotter joint to transmit a load of 100 kN in tension or compression. Assume the following stresses for socket, spigot and cotter. **10**

Allowable tensile stress = $90\ N/mm^2$

Allowable crushing stress = $170\ N/mm^2$

Allowable shear stress = $60\ N/mm^2$

OR

2. a) Discuss the factors governing the selection of a material to design machine components. Explain in brief important properties also. **5**

b) Discuss the general procedure in designing a machine element. **5**

c) A simply supported beam has a concentrated load at the centre which fluctuates from a value P to 4P. The span of the beam is 500 mm and its cross-section is circular with a diameter of 60 mm. Taking for the beam material an ultimate stress of 700 MPa, a yield stress of 500 MPa, endurance limit of 300 MPa for reversed bending, and a factor of safety of 1.3, calculate the maximum value of P. Take a size factor of 0.85 and a surface finish factor of 0.9. **10**

3. a) A cylindrical pressure vessel with 1m inner diameter is subjected to internal steam pressure of 1.5 MPa. The permissible stresses for the cylinder plate and the rivets in tension, shear and compression are 80 MPa, 60 MPa and 120 MPa respectively. The efficiency of longitudinal joint can be taken as 80% for the purpose of calculating the plate thickness. The efficiency of circumferential lap joint should be at least 62%. Design the circumferential lap joint and calculate, thickness of the plate, diameter of the rivets, number of rivets, pitch of rivets, number of rows of rivets, and overlap of the plates. **10**

b) A rectangular cross-section bar is welded to a support by means of fillet welds as shown in figure (1). Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 MPa. **10**

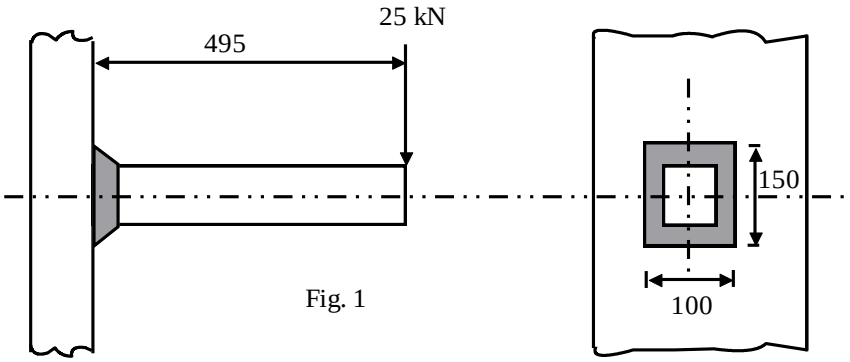

Fig. 1

OR

4. a) What is bolt of uniform strength ? **5**

b) Explain with neat sketches, different strength equations related to riveted joint. **5**

c) Design a double riveted butt joint with two cover plates for the longitudinal seam of boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume joint efficiency as 75% allowable tensile stress in the plate 90 MPa. Compressive stress 140 MPa, and shear stress in the rivet 56 MPa. **10**

5. a) What is 'overhauling' and 'self locking' of power screw ? What is the condition for 'overhauling' and 'self locking' ? **5**

b) A power screw having double start square threads of 25 mm nominal diameter and 5 mm pitch is acted upon by an axial load of 10 kN. The outer and inner diameters of screw collar are 50 mm and 20 mm respectively. The coefficient of thread friction and collar friction may be assumed as 0.2 and 0.15 respectively. The screw rotates at 12 rpm. Assuming uniform wear condition at the collar and permissible thread bearing pressure of 5.8 N/mm^2. Find the torque required to rotate the screw, the stress in the screw, and the number of threads of nut in engagement with screw. **15**

OR

6. a) Explain the following terms related to spring. **5**

i) free length ii) solid height
iii) spring rate iv) active and inactive coils
v) spring index

b) Design a helical compression spring for a maximum load of 1000N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm^2. **10**

Take Wahl's factor $K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$, where C is spring index.

c) Explain the design procedure for the Bell-Crank lever. **5**

7. a) Define equivalent torsional moment and equivalent bending moment. State when these two terms are used in the design of shafts. **5**

b) A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180^{o} and $\mu = 0.24$. Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley. **15**

OR

8. a) Give the expression for circumferential stress and longitudinal stress in case of thin cylindrical shell. **5**

b) A pressure vessel of 250 mm inner diameter is subjected to an internal pressure of $2.5\ N/mm^2$. Material of cylinder is SAE 1020. The top cover plate is flat circular while bottom cover plate is hemispherical and integral. Determine : **15**

i) Thickness of shell

ii) Thickness of bottom cover plate

iii) Size and number of bolts required for top cover plate.

iv) Gasket for leak proof

v) Thickness of top cover plate

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