

MACHINE DESIGN – I

(MECH 3101)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group - A

1. Answer any twelve:

$$12 \times 1 = 12$$

Choose the correct alternative for the following

- (i) Series Factor of R20 series is
 - (a) $\sqrt[10]{20}$
 - (b) $\sqrt[20]{20}$
 - (c) $\sqrt[20]{10}$
 - (d) 10^{20}
- (ii) Maximum principal stress theory of failure is best applicable to
 - (a) components made of plain carbon steel
 - (b) components made of aluminium alloy
 - (c) components made of cast iron
 - (d) components made of brass
- (iii) According to Indian standard specifications, a plain carbon steel designated by 40C8 means that
 - (a) carbon content is 0.04 per cent and manganese is 0.08 per cent
 - (b) carbon content is 0.4 per cent and manganese is 0.8 per cent
 - (c) carbon content is 0.35 to 0.45 per cent and manganese is 0.70 to 0.90 per cent
 - (d) carbon content is 0.60 to 0.80 per cent and manganese is 0.8 to 1.2 per cent
- (iv) The endurance or fatigue limit is defined as the maximum value of the stress which a polished standard specimen can withstand without failure, for infinite number of cycles, when subjected to
 - (a) static load
 - (b) dynamic load
 - (c) static as well as dynamic load
 - (d) completely reversed load
- (v) In cyclic loading, stress concentration is more serious in
 - (a) brittle materials
 - (b) ductile materials
 - (c) brittle as well as ductile materials
 - (d) elastic materials
- (vi) The size of the weld in butt welded joint is equal to
 - (a) $0.5 \times$ Throat of weld
 - (b) Throat of weld
 - (c) $2 \times$ Throat of weld
 - (d) $2 \times$ Throat of weld
- (vii) A bolt of M 24 $\times$ 2 means that
 - (a) the pitch of the thread is 24 mm and depth is 2 mm
 - (b) the cross-sectional area of the threads is 24 mm^2
 - (c) the nominal diameter of bolt is 24 mm and the pitch is 2 mm
 - (d) the effective diameter of the bolt is 24 mm and there are two threads per cm
- (viii) Which of the following screw thread is used for jacks, vices and clamps?
 - (a) square threads
 - (b) trapezoidal threads
 - (c) buttress threads
 - (d) acme threads.
- (ix) A bushed-pin type flange coupling is used
 - (a) for intersecting shafts
 - (b) when the shafts are not in exact alignment
 - (c) for small shafts rotating at slow speeds
 - (d) for parallel shafts
- (x) When a belt drive is transmitting maximum power,
 - (a) effective tension is equal to the centrifugal tension
 - (b) effective tension is half of the centrifugal tension
 - (c) driving tension in slack side is equal to the centrifugal tension
 - (d) driving tension in tight side is twice the centrifugal tension

Fill in the blanks with the correct word

- (xi) Series factor of the Derived Series R20/4(100.....1000) is _____.
- (xii) According to Distorsion Energy theory of failure, the relationship between yield strength in shear (S_{sy}) and tensile yield strength (S_{yt}) is $S_{sy} = \frac{1}{\sqrt{3}} S_{yt}$

- (xiii) Two shafts A and B are made of the same material. The diameter of the shaft A is twice as that of shaft B. The power transmitted by the shaft A will be _____ of shaft B.
- (xiv) A screw is said to be self-locking if its efficiency is _____
- (xv) The maximum efficiency of square threaded power screw with friction angle of 30° is _____

Group - B

2. (a) Draw Stress-Strain curve of a brittle material showing all essential points on it. Explain offset method and proof stress. [[CO1](Remember/LOCQ)]
- (b) What do understand by (i) Elasticity and Modulus of Elasticity, (ii) Resilience and Modulus of resilience and (iii) Toughness and Modulus of toughness? [[CO1](Understand/IOCQ)]
- (2 + 2 + 2) + (2 + 2 + 2) = 12**
3. (a) What is mode of failure? How many modes of failures are there? [[CO2](Remember/LOCQ)]
- (b) The stress state in a machine member is given as follows, $\sigma_x = 25$ MPa; $\sigma_y = 9$ MPa and $\tau_{xy} = \tau_{yx} = 5$ MPa as shown in Fig. 2. Using Mohr circle, find the principal stresses and directions. Also solve the problem using the transformation equation.

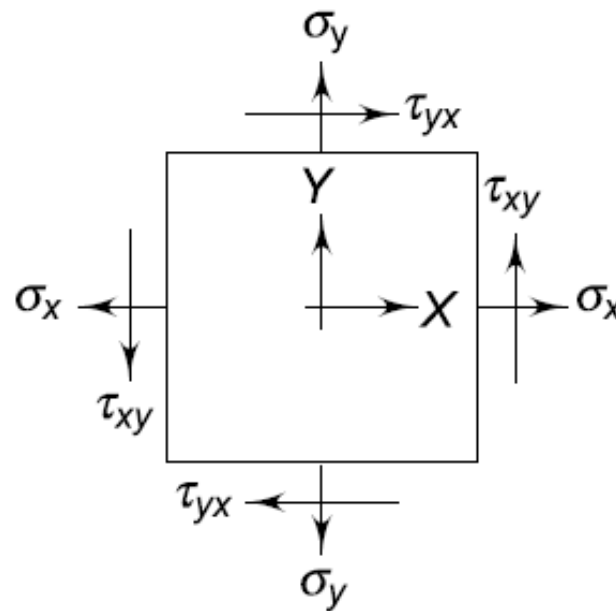
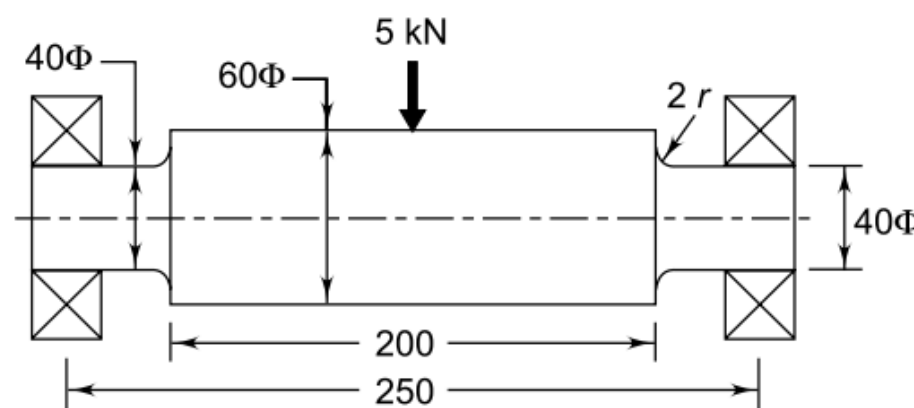


Fig. 2

[[CO2](Understand/IOCQ)]
(2 + 2) + (5 + 3) = 12

Group - C

4. (a) What are the methods of reducing stress concentration? [[CO3](Remember/LOCQ)]
- (b) A shaft carrying a load of 5 kN midway between two bearings is shown in Fig. 3. Determine the maximum bending stress at the fillet section. Assume the shaft material to be brittle. [[CO3](Apply/IOCQ)]

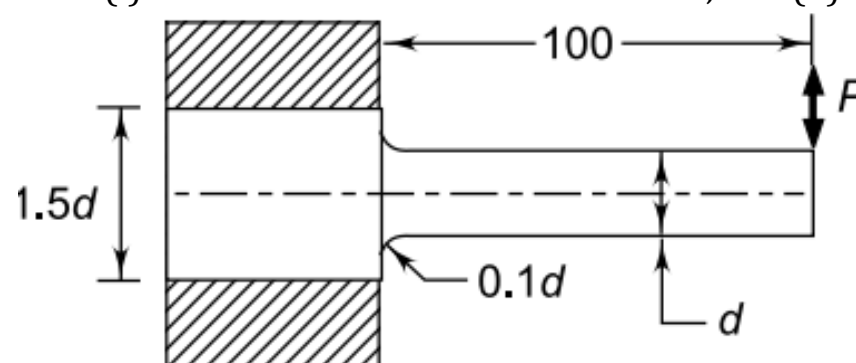


All Dimensions are in mm

Fig. 3

5 + 7 = 12

5. (a) What is the difference between failure due to static load and fatigue failure? [[CO4](Remember/LOCQ)]
- (b) A cantilever beam made of steel Fe 540 ($S_{ut} = 540$ N/mm² and $S_{yt} = 320$ N/mm²) and subjected to a completely reversed load (P) of 5 kN is shown in Fig. 4. The beam is machined and the reliability is 50%. The factor of safety is 2 and the notch sensitivity factor is 0.9. Calculate (i) endurance limit at the fillet section; and (ii) diameter d of the beam for infinite life.



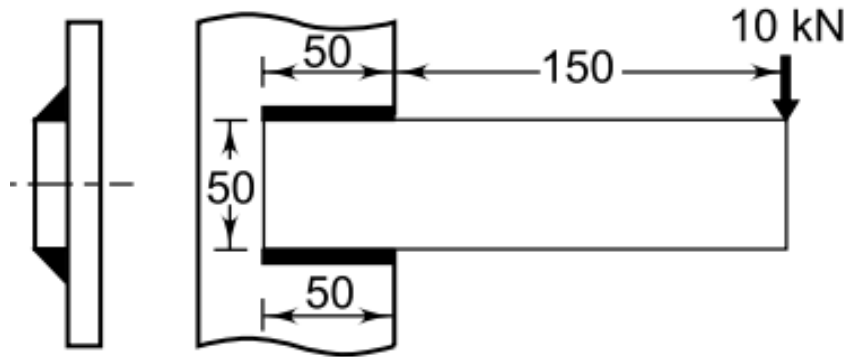
All Dimensions are in mm

Fig. 4

[[CO4](Analyse/HOCQ)]
4 + (4 + 4) = 12

Group - D

6. (a) What are permanent joints? Give their examples. [[CO5](Remember/LOCQ)]
 (b) A welded connection of steel plates, as shown in Fig. 5, is subjected to an eccentric force of 10 kN. Determine the throat dimension of the welds, if the permissible shear stress is limited to 95 N/mm². Assume static conditions. [[CO5](Apply/IOCQ)]

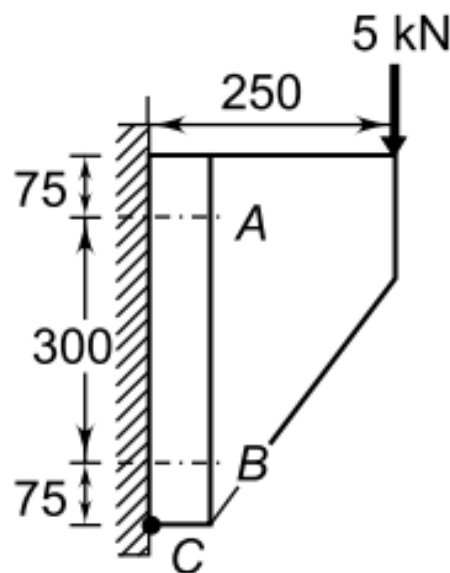


All Dimensions are in mm

Fig. 5

(2 + 2) + 8 = 12

7. (a) What are the advantages and disadvantages of threaded joints? [[CO5](Remember/LOCQ)]
 (b) A bracket for supporting the travelling crane is shown in Fig. 6. The bracket is fixed to the steel column by means of four identical bolts, two at A and two at B. The maximum load that comes on the bracket is 5 kN acting vertically downward at a distance of 250 mm from the face of the column. The bolts are made of steel 40C8 ($S_{yt} = 380$ N/mm²) and the factor of safety is 5. Determine the major diameter of the bolts on the basis of maximum principal stress. [[CO5](Apply/IOCQ)]



All Dimensions are in mm

Fig. 6

5 + 7 = 12

Group - E

8. A semi-elliptic leaf spring used for automobile suspension consists of three extra full-length leaves and 15 graduated-length leaves, including the master leaf. The centre-to-centre distance between two eyes of the spring is 1 m. The maximum force that can act on the spring is 75 kN. For each leaf, the ratio of width to thickness is 9:1. The modulus of elasticity of the leaf material is 207 000 N/mm². The leaves are pre-stressed in such a way that when the force is maximum, the stresses induced in all leaves are same and equal to 450 N/mm². Determine (i) the width and thickness of the leaves; (ii) the initial nip; and (iii) the initial pre-load required to close the gap C between extra full-length leaves and graduated-length leaves. [[CO6](Analyse/HOCQ)]

12

9. (a) The layout of a leather belt drive transmitting 15 kW of power is shown in Fig. 7. The centre distance between the pulleys is twice the diameter of the bigger pulley. The belt should operate at a velocity of 20 m/s approximately and the stresses in the belt should not exceed 2.25 N/mm². The density of leather is 0.95 g/cc and the coefficient of friction is 0.35. The thickness of the belt is 5 mm. Calculate: (i) the diameter of pulleys; (ii) the length and width of the belt; and (iii) the belt tensions. [[CO6](Apply/IOCQ)]

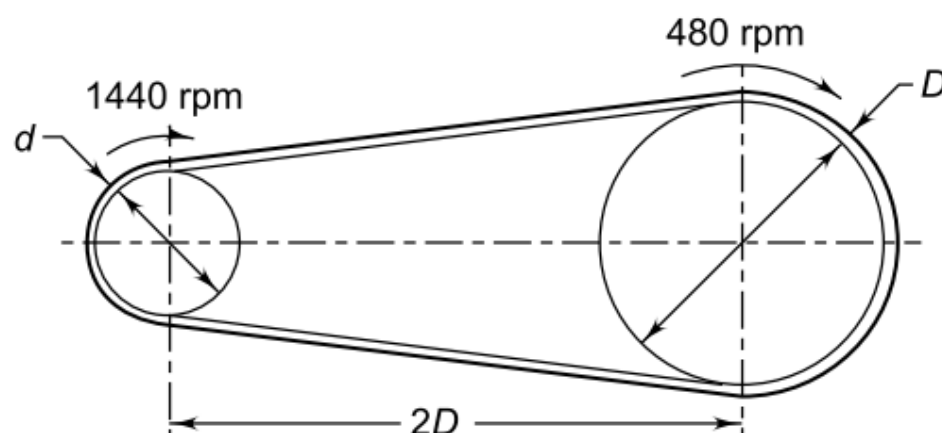


Fig. 7

(b) State the law of belting.

[[CO6](Remember/LOCQ)]
9 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	32.29	46.88	20.83