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मठ - 040

Machine Design - I (1020)

P. Pages : 4

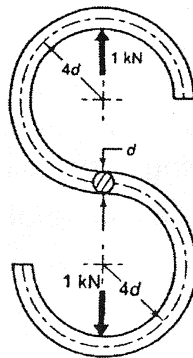
Time : Four Hours

Max. Marks : 100

Instructions to Candidates :

1. Do not write anything on question paper except Seat No.
2. Answersheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. All questions are compulsory, solve **any two** bits of a, b, c in each question.
5. Assume suitable data if necessary.
6. Draw neat sketches wherever necessary.
7. Use of PSG design data book is allowed.

1. a) Explain general procedure of machine design. Also write short note on standardization. 10
b) A mild steel shaft of 50mm dia. is subjected to a bending moment of 2KN-m & torque 'T'. If design stress of steel in tension is 200MPa. Find the value of 'T' according to
i) Max^m principal stress theory. 10
ii) Max^m distortion energy theory.
c) A link of S-shape made of a round steel bar is shown in fig. It is made of plain carbon steel 45 C₈ ($S_{yt} = 380\text{N/mm}^2$) & the factor of safety is 4.5. Calculate the dimensions of the link. 10

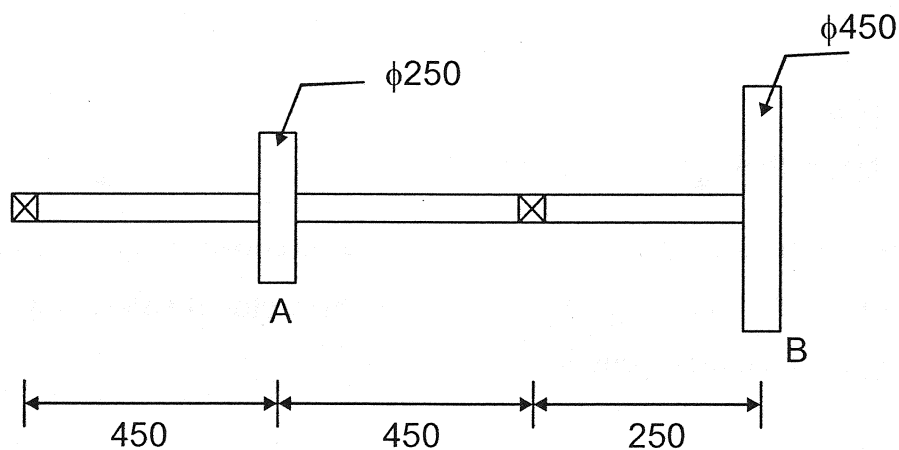


2. a i) Explain design of shaft as per ASME Code. 5

ii) A standard splined connection $8 \times 52 \times 60$ is used for the gear & the shaft assembly of a gear box. The splines transmit 20 kw power at 300 rpm. The dimensions of the splines are as follows :

Permissible normal pressure on splines is 6.5 N/mm^2 . The coefficient of friction is 0.06. Calculate (a) length of hub of the gear. (b) force required for shifting the gear. 5

b) A line shaft supporting two pulleys A & B is shown in fig. power is supplied to the shaft by means of a vertical belt on pulley A, that is then transmitted to pulley B carrying a horizontal belt. The ratio of belt tension on tight & loose sides is 3 : 1. The limiting value of tension in the belts is 2.7 kN. The shaft is made of plain carbon steel 40C₈ ($S_{ut} = 650 \text{ MPa}$ & $S_{yt} = 380 \text{ MPa}$). The pulleys are keyed to the shaft. Determine the diameter of the shaft according to ASME Code if $K_b = 1.5$ & $K_t = 1$. 10



c) Design a cast iron protective type flange coupling to transmit 15 kw at 900 rpm from an electric motor to a compressor. The service factor may be assumed as 1.35. The following permissible stresses may be used. Shear stress for shaft, bolt & key material = 40 MPa ; crushing stress for bolt & key = 80 MPa ; shear stress for C. I. = 8 MPa . 10

3. a) i) Explain bolt of uniform strength.

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ii) Prove that \max^m shear stresses developed in a solid shaft welded all around by a circular fillet weld & subjected to torsion is given by

$$\tau_{\max} = \frac{2.829T}{\pi S d^2}$$

where,

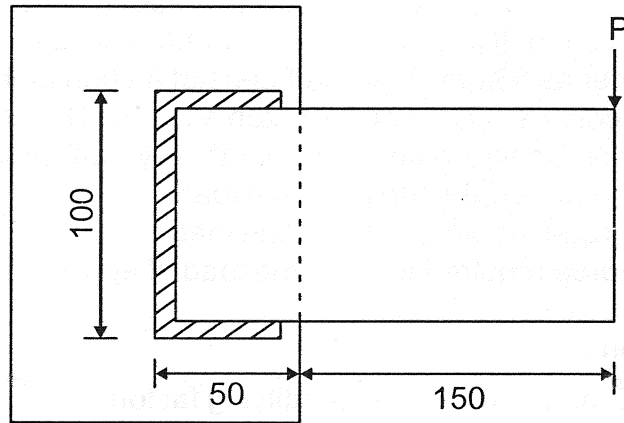
T - torque in N.mm

S - leg size of weld mm.

d - dia of shaft mm.

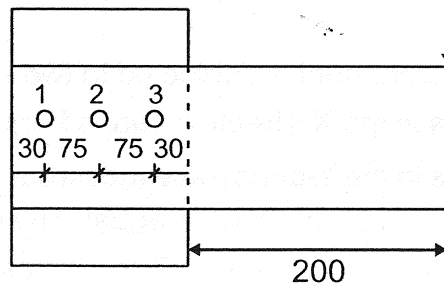
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b) A welded connection as shown in fig. is subjected to an eccentric force of 60 kN in the plane of the welds. Determine the size of the welds, if the permissible shear stress for the weld is 100 N/mm^2 . Assume static conditions. 10



c) A steel plate subjected to a force of 5 kN & fixed to a channel by means of three identical bolts. The bolts are made from plain carbon steel

$45\text{C}_8 (S_{yt} = 380 \text{ MPa})$ & the factor of safety is 3. specify the size of bolts. 10



4. a) i) Explain Recirculating ball screw. 5
 ii) Explain Nipping of leaf springs. 5
- b) A semi-elliptic leaf spring used for automobile suspension consists of three extra full length leaves & 15 graduated length leaves, including the master leaf. The centre to centre distance betⁿ two eyes of the spring is 1m. The max^m force that can act on the spring is 75KN for each leaf, the ratio of width to thickness is 9 : 1. The modulus of elasticity of the leaf material is 207000N/mm². The leaves are pre-stressed in such a way that when the force is max^m, the stresses induced in all leaves are same & equal to 450MP_a. Determine :
 i) width & thickness of the leaves.
 ii) initial nip.
 iii) initial pre-load required to close the gap. 10
- c) The nominal diameter of a triple - threaded square screw is 50mm, while the pitch is 8mm. It is used with a collar having outer diameter of 100mm & inner diameter as 65mm. The coefficient of friction at the thread surface as well as at the collar surface can be taken as 0.15. The screw is used to raise a load of 15 KN. Using the uniform wear theory, Calculate :
 i) torque required to raise the load
 ii) torque required to lower the load.
 iii) Force required to raise the load, if applied at the radius of 500mm. 10
5. a) Explain :
 i) Endurance strength modifying factors. 5
 ii) Design & Natural tolerances. 5
- b) A rod of a linkage mechanism made of steel 40C_r1(S_{ut} = 550MP_a) is subjected to completely reversed axial load of 100KN. The rod is machined on lathe & expected reliability is 95%. There is no stress concentration. Determine the diameter of the rod using factor of safety of 2 for an infinite life condition. 10
- c) A machine component is subjected to two - dimensional stresses. The tensile stress in the X-direction varies from 40 to 100 N/mm². while the tensile stress in the Y-direction varies from 10 to 80 N/mm². The frequency of variation of these stresses is equal. The corrected endurance limit of the component is 270 N/mm². The ultimate tensile strength of the material of component is 660 N/mm². Determine the factor of safety is used by the designer. 10