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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Fifth Semester, B. E. - Mechanical Engineering

Semester End Examination, Dec. - 2014

Design of Machine Elements - I

Time: 3 hrs *Max. Marks: 100*

Note: *i) Answer any **FIVE** full questions, selecting at least **TWO** full questions from each part.*
ii) *Use of DDH book is permitted. iii) Missing data if any may be suitably assumed.*

PART - A

1. a. State the difference between physical properties and mechanical properties. Give two examples for each. 4

   b. An off set link subjected to a force of 25 kN is shown in Fig. 1(b) which is made of grey cast iron FG 300. Determine the dimensions of the cross –section of the link, assuming a factor of safety 3. 6

   c. For the steel rod shown in Fig. 1(c) Determine; (i) Max. and Min. Principal stresses (ii) Maximum shear stress. 10

2 a. Write the statements of maximum normal stress theory and maximum shear stress theory; sketch the design space/ boundary; and state the difference between the two theories. 6

   b. A overhanging shaft is subjected to a maximum bending moment of 250 N-m and a torque of 500 N-m. If the shaft is made of 45 C8 steel determine the diameter of the shaft based on maximum shear stress theory and distortion energy theory. Use a factor of safety of 2. 8

   c. A Mass of 50 kg drops through a height of 25 mm at the centre of 250 mm along simply supported beam. The beam is having a square section of 70 mm x 70 mm. Determine the impact stress induced, assuming $E = 2x10^5 N/mm^2$. 6

3 a. State Miner's rule with necessary equation. 4

   b. Explain how Goodman line is constructed from S-N curves. Derive Goodman's equation. 8

   c. A cantilever stepped circular shaft is supported at the larger diameter, which is 1.5 times the smaller diameter. Fillet radius is 0.1 times the smaller diameter. If the smaller diameter is 10 mm and subjected to axial stress that varies from -15 to +30 N/mm^2 and torsion shear stress that varies from 0 to 30 N/mm^2, determine the factor of safety, if $\sigma_y = 400 N/mm^2$, $\sigma_{en} = 250 N/mm^2$, B = 0.85, C = 0.8, q = 0.9, A = 0.9 for axial and 0.6 for torsional load. 8

4 Design and draw two views of a knuckle joint to connect two circular rods subjected to axial tensile force of 50 kN. Permissible stress values are 80 N/mm^2. In tension and compression and 40 N/mm^2 in shear. 20

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PART – B

5 A transmission shaft supporting two pulleys A and B mounted between bearings C and D is shown in Fig. Q 5. If the material is strengths are σ_u = 600 MPa and σ_y = 380 MPa, determine the shaft diameter, assuming C_m = 1.5, C_t = 1.0 and FOS = 2. Also determine the angle of twist of shaft between pulleys A and B if G = 80x10^3 MPa. 20

6 a. Two circular plates of outer dia '2d'and inner dia 'd' are clamped together by bolt as shown in Fig. 6(a) The bolt is made of plain carbon steel with σ_y =380 N/mm^2 and E = 2x10^5 N/mm^2, while the plates are made of aluminium with E = 0.7x10^5 N/mm^2. The initial preload in the bolt is 5 kN and external force on the bolted joint is 10 kN. Determine the size of the bolt, if the factor of safety is 2.5. 8

b. A bracket fixed to the wall by means of four identical bolts two at 'A' and two at 'B' are shown in Fig. 6(b). Assuming the allowable tensile stress in the bolts as 35 N/mm^2, determine the size of the bolts based on maximum principal stress theory. 12

7 Design longitudinal and circumferential joint for a boiler, whose inner diameter is 1.7 m and pressure of steam is 2.0 N/mm^2. Permissible stresses in tension, shear and crushing are 80 N/mm^2, 60 N/mm^2 and 120 N/mm^2 respectively. Sketch the joints. 20

8 a. For the welded joint shown in Fig. 8(a) determine the weld size, if the permissible shear stress in the weld is 100 N/mm^2. 10

b. The nominal diameter of a triple threaded square screw is 50mm, while the pitch is 8mm. It is used with collar of outer diameter 100mm and inner diameter 60mm. 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 15kN. Using uniform wear theory for collar friction. 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 a radius of 500 mm. 10

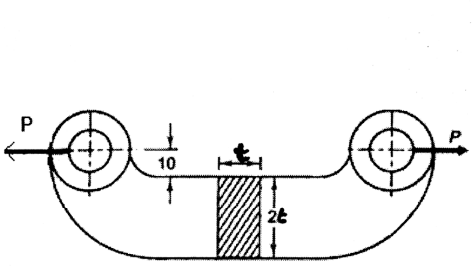

Fig Q 1(b)

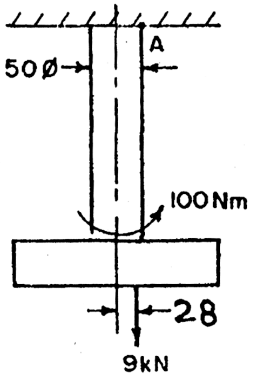

Fig Q 1(c)

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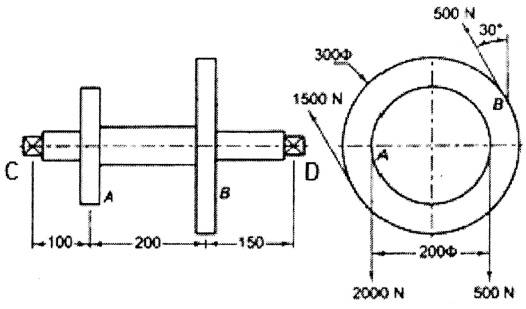

Fig Q 5

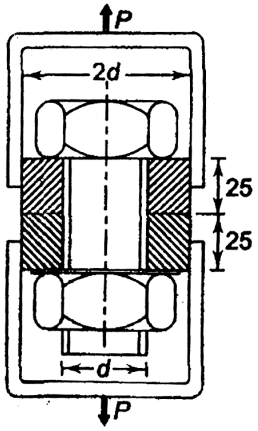

Fig Q 6(a)

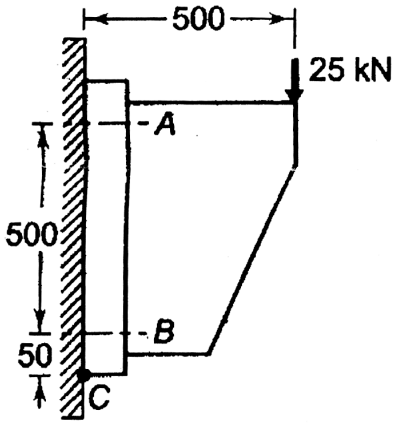

Fig Q 6(b)

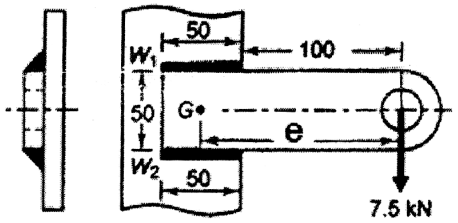

Fig Q 8(a)

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