    (2) In the analysis of flexible coupling, it is assumed that the power is transmitted by the shear resistance of pins.

    (3) Rubber bushes with brass lining are provided to absorb misalignment between the two shafts.

    Which of the above given statements are correct?

    (a) 1, 2 and 3   (b) only 1 and 3

    (c) only 2 and 3   (d) only 1 and 2.

(viii) Lead of a triple start square thread having pitch of 4 mm and major diameter 30 mm is

    (a) 4 mm   (b) 12 mm   (c) 7 mm   (d) 30 mm.

(ix) The maximum efficiency of square threaded power screw having helix angle ϕ is

    (a) $\dfrac{1-\sin}{1+\sin\phi}$ (b) $\dfrac{1+\sin}{1-\sin\phi}$ (c) $\dfrac{1-\tan\phi}{1+\tan\phi}$ (d) $\dfrac{1+\tan}{1-\tan\phi}$

(x) When a helical spring is cut into halves, the stiffness of the spring will be

    (a) same   (b) one-half   (c) doubled   (d) one-fourth.

Group – B

2. Calculate factors of safety, based upon the distortion energy theory, for stress elements at A and B of the member shown in the figure 1. This bar is made of AISI 1006 cold-drawn steel having minimum yield strength of 370 MPa and is loaded by the forces F = 0.55 kN, P = 4.0 kN, and T = 25 N-m.
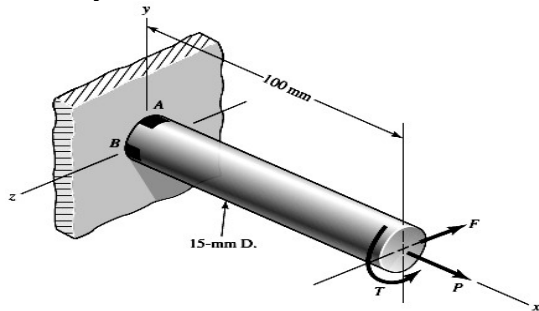
Figure 1

12

3. It is required to design a knuckle joint to connect two circular rods subjected to an axial tensile force of 50kN. The rods are co-axial and a small amount of angular movement between their axes is permissible. Design the joint and specify the dimensions of its components as shown in figure 2. Consider plain carbon steel of Grade 30C8 having yield strength of 400MPa. Take factor of safety for different components as per convenience.

Calculate (i) diameter of the rivets

(ii) width of the plate

(iii) efficiency of the joint

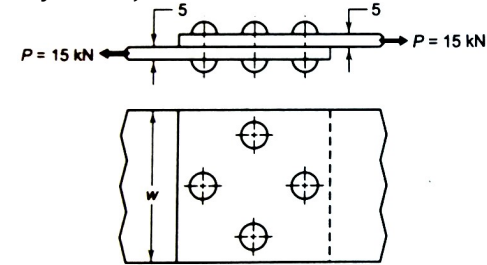*Figure 6*

6 + (2 + 2 + 2

Group – E

8. A belt driven shaft is shown schematically in Fig. 7

  (i) Construct load, torsional and bending moment diagrams for the in both the horizontal and vertical plane.

  (ii) Develop an expression for the resultant bending moment on the segment between the left pulley and the right bearing.

  (iii) Find the location and magnitude of the minimum value of bending m on the shaft segment between the left pulley and the right bearing.

  (iv) Calculate the torque in the segment between pulleys.

  (v) If the shaft is to be made of plain carbon steel 40C8 (S_{yt} = 380 N/ and a design safety factor of 3 is desired, what is the diameter of the W_B & W_D are the weights of pulley B and D respectively. Assume S_{sy} = 0.5 S_{yt}
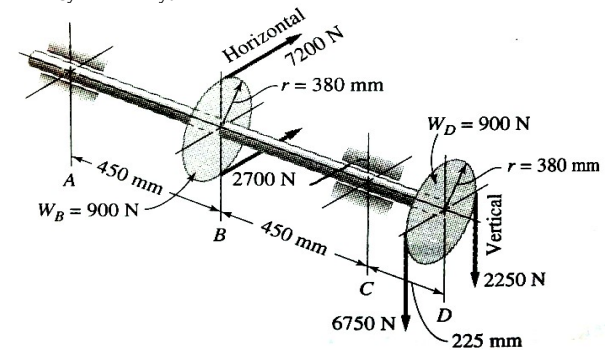
Figure 7

(4 + 2 + 2 + 2 + 2

9. (a) What is nip of leaf-spring? What is the objective of nipping of leaf spring?

(b) A semi-elliptic leaf spring consists of two extra full-length and eight graduated-length leaves, including master leaf. The centre-to-centre distance between the two eyes of the spring is 1 m. The maximum force acting on the spring is 10 kN and the width of each leaf is 50 mm. The spring is initially pre-loaded in such a way that when the load is maximum, the stresses induced in all the leaves are equal to 350 N/mm². The modulus of elasticity of the leaf material is 207000 N/mm². Determine
(i) the thickness of leaves
(ii) the deflection of the spring at maximum load

(1 + 1) + 10 = 12

DESIGN OF MECHANICAL SYSTEMS - I
(MECH 3103)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

[N.B.: ONE PAGE DESIGN DATA SHEET IS PROVIDED WITH QP]

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i)   Series factor for R20 series is:
         (a) $\sqrt[10]{20}$ (b) $\sqrt{20}$ (c) $\sqrt[20]{10}$ (d) $\sqrt[3]{20}$.

   (ii) Hardness of steel is increased by adding:
         (a) Nickel   (b) Molybdenum
         (c) Sulphur   (d) None of these.

   (iii) Notch sensitivity factor takes account of
         (a) sensitivity to material composition
         (b) sensitivity to stress concentration
         (c) sensitivity to loading
         (d) all of the above.

   (iv) ASME code equation for shaft design is based on
         (a) maximum shear stress theory   (b) Von Mises theory
         (c) Goodman diagram   (d) Soderberg criterion.

   (v)   Plain carbon steel designated by 40C8 means
         (a) Plain carbon steel with ultimate tensile strength of 400 N/mm2 and 0.8% carbon
         (b) Plain carbon steel with 0.35 to 0.45% carbon and 0.7 to 0.9% manganese
         (c) Plain carbon steel with 0.8% carbon and 4 % manganese
         (d) Plain carbon steel with 0.4% carbon and 8% manganese.

   (vi) If Yield strength under shear is Ssy and Yield strength under tension is Syt then according to Distortion Energy theory
         (a) Ssy = 0.568 Syt   (b) Ssy = 0.755 Syt
         (c) Ssy = 0.577 Syt   (d) None of These.

   (vii) Consider the following statements in respect of flexible couplings:
         (1) The flanges of flexible coupling are usually made of grey cast iron FG200.
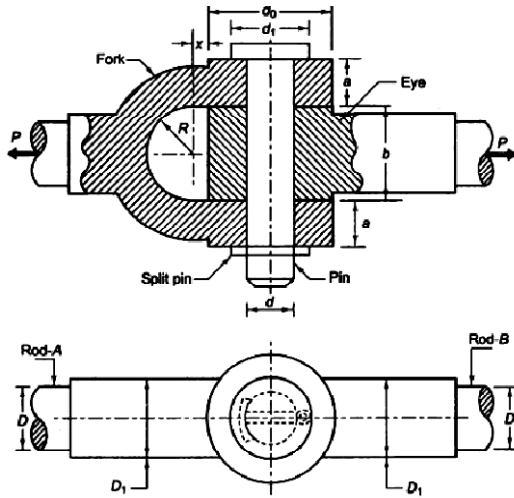
Figure 2

12

Group – C

4. (a) Explain in detail about Rotating Bam Experiment and construction of S-N curve.

(b) A rotating shaft subjected to non-rotating force of 5kN and simply supported between two bearings A and E as shown in figure 3. The shaft is machined from plain carbon steel 30C8 (Yield stress 500 N/mm2) and the expected reliability is 90%. The equivalent notch radius at the fillet section can be taken as 3mm. What is the life of the shaft?
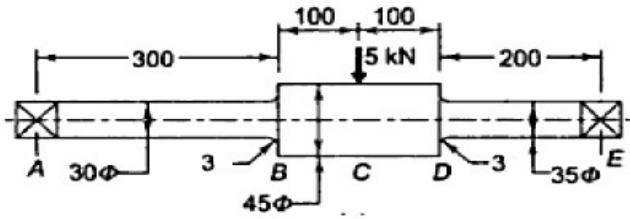(Refer design data sheet for all the required constant values)

Figure 3

5 + 7 = 12

5. A polished steel is subjected to axial force that varies from zero to P_{max}. It has a groove which is 2 mm deep. The radius of the groove is 3 mm. The theoretical stress concentration factor and notch sensitivity factor at the groove are 1.8 and 0.95 respectively. The outer diameter of the bar is 30 mm. The ultimate strength

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of bar is 1250 MPa. The endurance limit in reversed bending is 600 MPa. Fi maximum force that the bar can carry for 10^5 cycles with 90% reliability. Take $K_a = 1$, $K_b = 0.85$, $K_c = 0.897$ $K_d = 1/K_f$ and a load factor of 0.8.

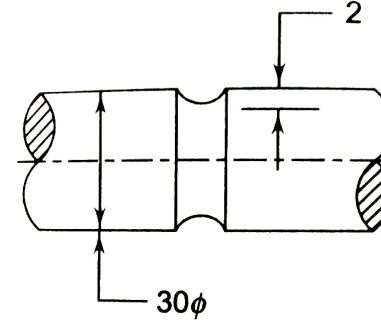30ϕ

Figure 4

Group – D

6. A wall bracket is attached to the wall by means of four identical bolts, t A and two at B as shown in figure 5. Assuming that the bracket is against the wall and prevented from tipping about point C by all four and using an allowable tensile stress in the bolts as 35 N/mm², dete the size of the bolts on the basis of distortion energy theory.
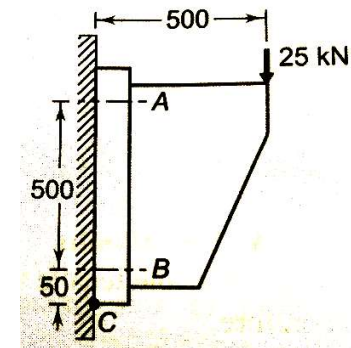

Figure 5

7. (a) Derive the expression for maximum efficiency of square thr power screw.

(b) Two loaded plates each 5 mm thick are connected by means o rivets as shown in Fig. 6. The permissible stresses for rivets and in tension, shear and compression are 80, 60, 120 N/mm² respect