

CS/B.Tech/AUE/odd/Sem-5th/AUE-503/2014-15**AUE-503****DESIGN OF MACHINE ELEMENTS**

Time Allotted: 3 Hours

Full Marks: 100

*The questions are of equal value.
The figures in the margin indicate full marks.*

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

GROUP A
(Multiple Choice Type Questions)

- I. Answer all questions. 10 × 1 = 10
- (i) In a unilateral system of tolerance, the tolerance is allowed on
 (A) one side of the actual size (B) one side of the nominal size
 (C) both sides of the actual size (D) both sides of the nominal size
- (ii) When a helical compression spring is subjected to an axial compressive load, the stress induced in the wire is
 (A) tensile stress (B) compressive stress
 (C) shear stress (D) bending stress
- (iii) In a leaf spring, the longest leaf is known as
 (A) lower leaf (B) master leaf (C) upper leaf (D) none of these
- (iv) The power transmitted by means of belt depends on
 (A) velocity of belt
 (B) tension under which the belt is placed on pulley
 (C) arc of contact between the belt and the smaller pulley
 (D) all of these
- (v) The cumulative fatigue life of a component can be determined by
 (A) Goodman diagram (B) Miner's equation
 (C) Buckingham's equation (D) Euler's equation
- (vi) When a helical compression spring is subjected to an axial compressive load, the stress induced in the wire is
 (A) tensile stresses (B) compressive stresses
 (C) shear stresses (D) bending stresses

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- (vii) Spring index is
 (A) ratio of coil diameter to wire diameter
 (B) load required to produce unit deflection
 (C) its capability of storing energy
 (D) indication of quality of spring
- (viii) A leaf spring in automobile is used
 (A) to apply forces (B) to absorb shocks
 (C) to measure forces (D) to store energy
- (ix) Fluctuating stresses
 (A) are static in nature
 (B) cause fatigue failure
 (C) are combination of mean and alternating stress
 (D) both (A) and (C)
- (x) Splined shafts have
 (A) keys made integral with the shaft
 (B) lesser strength than shaft with keyways
 (C) characteristics of a taper key
 (D) similar function as rectangular key

GROUP B
(Short Answer Type Questions)

Answer any *three* questions.

- What is notch sensitivity? What are the factors that affect endurance limit of a machine part?
- Establish the condition for transmission of max power in a belt drive. Hence derive the relation between the velocity and max tension of the belt under such condition.
- A plate 100 mm wide and 12.5 mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that the maximum stress does not exceed 60 MPa. Consider the joint first under static loading and then under fatigue loading.
- A hollow circular shaft is being designed to transmit 120 kW at 105 rpm. The inside diameter of the shaft is to be one-half of the outside diameter. Assuming that the allowable shear stress is 45 MPa, calculate the minimum required outside diameter.

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6. Explain what is meant by Factor of Safety used for design of machine elements. Explain its relation with mechanical properties of the material. Also indicate various factors on which the value of factor of safety depends.

2 × 3

GROUP C
(Long Answer Type Questions)

Answer any three questions.

3 × 15 = 45

7. It is required to design a helical compression spring subjected to a maximum force of 1150 N. The deflection of the spring corresponding to the maximum force should be approximately 25 mm. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire. The ultimate tensile strength and modulus of rigidity of the spring material are 1090 and 81370 MPa respectively. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate
- Wire diameter
 - Mean coil diameter
 - Number of active coil
 - Total no of coils
 - Free length of the spring
 - Pitch of the coil.

15

8. A fillet welded joint shown in Figure 1 is subjected to an eccentric load of 60 kN in the plane of the welds. Determine the size of the fillet, if the permissible shear stress for the weld is 100 MPa. The load is static in nature.

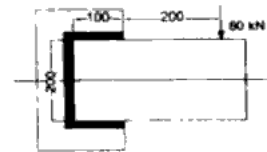
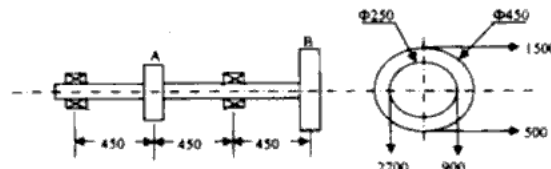


Figure 1

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9. A line shaft supporting two pulleys A and B is shown in Figure 2. Power is supplied to the shaft by means of a vertical belt on pulley A, which is then transmitted to pulley B carrying a horizontal belt. The ratio of belt tensions on tight and loose sides is 3 : 1 and the maximum tension in either belt is limited to 2.7 kN. The shaft is made of plain carbon steel 40C8 ($\sigma_u = 650$ MPa and $\tau_y = 380$ MPa). The pulleys are keyed to the shaft. Determine the shaft diameter according to A.S.M.E. code if $k_s = 1.5$ and $k_t = 1.0$.

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Lengths and forces indicated are in mm and N respectively.

Figure 2

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- 10.(a) The standard cross section for a flat key which is fitted on a 50 mm diameter shaft, is 16×10 . The key is transmitting 475 Nm torque from the shaft to the hub. The key is made of commercial steel ($S_u = S_{yc} = 230$ N/mm²). Determine the length of the key if the factor of safety is 3.
- (b) Design the cotter joint shown in Figure 3 to support 28 kN in tension and 28 kN in compression. The material for all components of the joint is steel with the allowable stresses in tension, compression and shear as 50 N/mm², 60 N/mm² and 35 N/mm² respectively.

Calculate the values of

- diameter of rod, d
- diameter of spigot, d_1
- thickness of cotter, t
- width of the cotter, b
- length of the cotter, l
- diameter of the socket, d_2

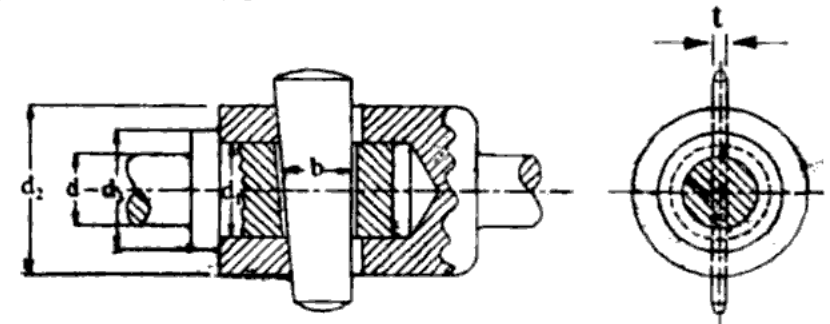


Figure 3

11. A protected type rigid coupling is used to transmit 37.5 kW at 180 rpm from the output shaft of an electric motor to input shaft of a hydraulic pump. The design torque is 1.5 times the rated torque. The shafts, keys and bolts are made of plain carbon steel 30C8 ($S_u = 400$ N/mm²) and the factor of safety is 2.5. The yield strength in compression can be assumed as 1.5 times the tensile yield strength. The flanges are made of Grey cast iron FG200 ($S_u = 200$ N/mm²). Assume that the ultimate shear strength to be 50% of the ultimate tensile strength and the factor of safety as 6. The number of bolts is 4. Design the coupling and specify the dimensions of its components.