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Paper Code : AUE-503

DESIGN OF MACHINE ELEMENTS

Time Allotted : 3 Hours | *Full Marks* : 70

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)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) The maximum shear stress theory is used for
   a) brittle materials
   b) ductile materials
   c) plastic materials
   d) non-ferrous materials.

ii) The maximum energy that can be stored in a body due to external loading upto the elastic limit is called
   a) resilience
   b) proof resilience
   c) strain energy
   d) modulus of resilience.

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iii) 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*.
   a) twice b) four times
   c) eight times d) sixteen times.

iv) A basic shaft is one whose
   a) lower deviation is zero
   b) upper deviation is zero
   c) lower and upper deviations are zero
   d) none of these.

v) Failure of a material is called fatigue when it fails
   a) at the elastic limit
   b) below the elastic limit
   c) at the yield point
   d) below the yield point.

vi) The taper on cotter varies from
   a) 1in 32 to 1 in 24 b) 1 in 24 to 1 in 20
   c) 1 in 48 to 1 in 24 d) 1 in 15 to 1 in 10.

vii) In leaf springs, the longest leaf is known as

a) master leaf b) lower leaf

c) upper leaf d) none of these.

viii) The maximum normal stress theory is used for

a) brittle materials

b) ductile materials

c) non-ferrous materials

d) plastic materials

ix) Stress concentration is caused due to

a) abrupt change of cross-section

b) variations in load acting on a member

c) variations in properties of materials in a member

d) all of these.

x) Which one of the following is a positive drive ?

a) Chain drive

b) Crossed flat belt drive

c) Rope drive

d) V-belt drive.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Establish the condition for transmission of maximum power in a belt drive. Hence derive the relation between the velocity and maximum tension of the belt under such condition.

3. What is the difference between caulking and fullering ? Explain with the help of neat sketches.

4. Design a rectangular key (16 × 10 am) for a shaft of 50 mm diameter. The shearing and crushing stresses for the key material are 40 MPa and 75 MPa.

5. A solid shaft is transmitting 1 MW at 240 r.p.m. Determine the diameter of the shaft if the maximum torque transmitted exceeds the mean torque by 20%. Take the maximum allowable shear stress as 60 MPa.

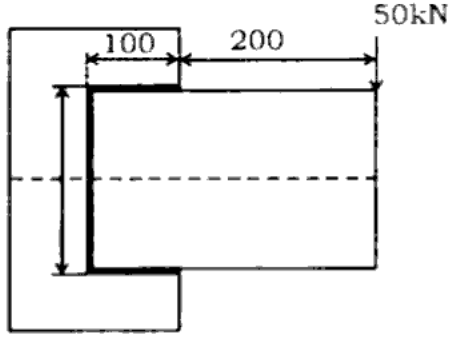
6. Explain what is meant by factor of safety used for design of machine elements. Explain its relation with mechanical properties of the material. Also indicate various factors on which the value of factor of safety depends.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. A welded connection of steel plates is shown in figure 1. It is subjected to an eccentric force of 50 kN. Determine the size of the weld, if the permissible shear stress in the weld is not to exceed 70 N/nm^2.



8. A hot rolled steel shaft is subject to a torsional moment that varies from 330 N-m clockwise to 110 N-m counterclockwise and an applied bending moment at a critical section varies from 440 N-m to 220 N-m. The shaft is of uniform cross-section and no keyway is present at the critical section, determine the required shaft diameter. The material has an ultimate strength of 550 MN/m^2 and yield strength of 410 MN/m^2. Take the endurance limit as half of the ultimate strength, factor of safety of 2, size factor of 0·85 and a surface finish factor of 0·62.

9. Design a knuckle joint for a tie rod of a circular section to sustain a maximum pull of 70 kN. The ultimate strength of the material of the rod against tearing is 420 MPa. The ultimate tensile and shearing strength of the pin material are 510 MPa and 396 MPa respectively. Determine the tie rod section and pin section. Take factor of safety = 6. Draw the freehand drawing and give all the dimensions.

10. Design and draw a protective type of cast iron flange coupling for a steel shaft transmitting 15 kW at 200 r.p.m. and having an allowable shear stress of 40 MPa. The working stress in the bolts should not exceed 30 MPa. Assume that the same material is used for shaft and key and that the crushing stress is twice the value of its shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for cast iron is 14 MPa.

11. Design a close coiled helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm. Assume a spring index of 5. The permissible shear intensity is 420 MPa and modulus of rigidity, $G = 84\ kN/mm^2$. Neglect the effect of stress concentration. Draw a fully dimensioned sketch of the spring.