2013

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 valve rod in a steam engine is connected to an eccentric rod by

a) cotter joint b) bolted joint

c) knuckle joint d) universal coupling.

ii) The maximum energy that can be stored in a body due to external loading up to the elastic limit is called

a) resilience b) proof resilience

c) strain energy d) modulus of resilence.

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 ..... o shaft B.

a) twice b) four times

c) eight times d) sixteen times.

iv) The maximum shear stress theory is used for

a) brittle materials b) ductile materials

c) plastic materials d) non-ferrous material

v) A double strap butt joint (with equal straps) is

a) always in single shear

b) always in double shear

c) either in single shear or double shear

d) any one of these.

vi) Which of the following riveted butt joints with double straps should have the highest efficiency as per Indian Boiler Regulations ?

a) Single riveted b) Double riveted

c) Triple riveted d) Quadruple riveted.

vii) The taper on cotter varies from

a) 1 in 15 to 1 in 10 b) 1 in 24 to 1 in 20

c) 1 in 32 to 1 in 24 d) 1 in 48 to 1 in 24.

viii) The parallel fillet welded joint is designed for

a) tensile strength b) compressive strength

c) bending strength d) shear strength.

ix) According to IBR the type of joint in the boiler is preferred for circumferential join is

a) Lap joint b) Butt joint

c) Welded joint d) none of these.

x) The included angle in Acme thread is

a) 60° b) 55°

c) 475° d) 29°.

GROUP – B

(Short Answer Type Questions)

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

2. Explain with diagram the shear failure that occurs in any portion of a knuckle joint.
3. Discuss the type of load taken by a pin, axle and shaft.
4. A 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.
5. Find the equivalent twisting moment and equivalent bending moment. When is a shaft subjected to a bending moment and twisting moment ?
6. A shaft is transmitting 97·5 kW at 180 r.p.m. If the allowable shear stress in the material is 60 MPa, find the suitable diameter for the shaft. The shaft is not to twist more than 1° in a length of 3 metres. Take C = 80 GPa.

GROUP – C

(Long Answer Type Questions)

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

7. Two round rods are to be connected through a socket type cotter joint, which has to resist a tensile load of 55 kN between two steel rods.

   All parts of the joint are made of same material with the following stresses :

   Tension 90 N/mm^2, shear 60 N/mm^2, crushing 150 N/mm^2. You are required to find the dimension of all the components of the joint. Draw a sectional view of the cotter joint (freehand).

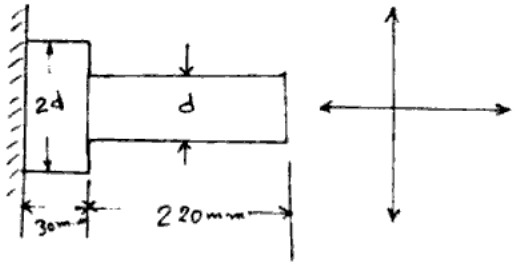
8. Design a cast iron protective type flange coupling to transmit 15 kW at 900 r.p.m. from an electric motor to a compressor. The service factor may be assumed as 1·5. The following permissible stresses may be used :

   Shear stress for shaft, bolt and key material = 40 MPa, Crushing stress for bolt and key = 80 MPa, Shear stress for cast iron = 8 MPa.

   Draw a neat sketch of the coupling.

9. A cantilever beam as shown in the figure below is subjected to a transverse load varying from 100 N compression to 400 N tension as the axial load varying from 350 N to 450 N. The maximum bending occurs at the same instant that the

axial load is maximum. Find the diameter of the load. Take the factor of safety to be 2, ultimate tensile strength to be 500 MPa, the yield point stress 425 MPa and endurance limit 300 MPa. Assume surface correction factor 0·82, size correction factor 0·85, reliability factor 0·95, stress concentration factor 1·4 and notch sensitivity factor 0·9.



10. A shaft is supported by two bearings placed 1 m apart. A 500 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 3 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu = 0{\cdot}3$. Determine the suitable diameter for a solid shaft, allowing working stress of 60 MPa in tension and 40 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.

11. a) Explain the following terms of the spring :

i) Free length

ii) Solid height

iii) Spring rate

iv) Active and inactive coils

v) Spring index.

b) Two plates of 10 mm thickness each are to be joined by means of a double riveted double strap butt joint. Determine the rivet diameter, rivet pitch, strap thickness and efficiency of the joint. Take the working stresses in tension shearing and crushing as 80 MPa, 50 MPa, and 110 MPa respectively. 5 + 10

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