CS/B.TECH/AUE(N)/SEM-5/AUE-503/2012-13

2012
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.*

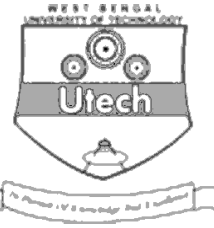## GROUP – A
(Multiple Choice Type Questions)

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

   i)   Rankine's theory of failure is applicable for......... type of materials.

   a)   brittle   b)   ductile

   c)   elastic   d)   plastic

   e)   tough.

   ii) If d is the diameter of bolt hole then for a flanged pipe joint to be leak proof, the circumferential pitch of the bolts should be

   a) $10\sqrt{d}$ b) $10\sqrt{d}$ to $15\sqrt{d}$

   c) $15\sqrt{d}$ to $20\sqrt{d}$ d) $20\sqrt{d}$ to $30\sqrt{d}$

   e) $30\sqrt{d}$ to $40\sqrt{d}$

5237(N)   [Turn over

iii) A stud

    a) has a head on one end and a nut fitted to the other

    b) has head at one end and other end fits into a tapped hole in the other part to be joined

    c) has both ends threaded

    d) has pointed threads

    e) requires locking nut.

iv) The included angle in Acme threads is

    a) 60°   b) 55°

    c) 47·5°   d) 29°.

v) The designation M 33 × 2 of a bolt means

    a) metric threads of 33 nos. in 2 cm

    b) metric threads with cross-section of 33 nm^2

    c) metric threads of 33 mm pitch diameter and 2 mm pitch

    d) bolt of 33 mm nominal diameter having 2 threads per cm

    e) none of these.

vi) 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

    e) Oldham coupling.
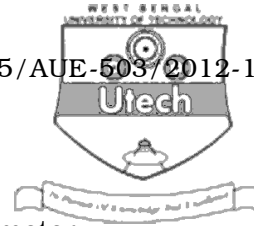
vii) Spring index is

    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

    e)   nothing.

viii) If two springs are in parallel then their overall stiffness will be

    a)   half   b)   same

    c)   double   d)   unpredictable

    e)   none of these.

ix) According to I.B.R., the........... type of joint is preferred for circumferential joint.

    a)   lap joint   b)   butt joint

    c)   welded joint   d)   any one of these

    e)   none of these.

x) Which key transmits power through frictional resistance only ?

    a)   Wood-ruff key   b)   Kennedy key

    c)   Sunk key   d)   Saddle key

    e)   Feather key.

GROUP – B

(Short Answer Type Questions)

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

2. The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of the bolt required according to

    (i) maximum principal stress theory

    (ii) maximum shear stress theory.

3. Distinguish clearly, giving examples between pin, axle and shaft.

4. A semi-elliptical leaf spring consists of 1 master leaf, 2 extra full-length leaves and 15 graduated-length leaves. The centre-to-centre distance between two eyes is 1 m. The maximum force that can act on the spring is 75 kN. For each leaf, the ratio of width to thickness is 9 : 1. The modulus of elasticity of the leaf material is 207 kN/mm^2. The leaves are pre-stressed in such a way that when the force is maximum, the stresses induced in all leaves are same and equal to 450 N/mm^2. Determine :

    (i) the width and thickness of the leaves

    (ii) the initial nip (*C*)

    (iii) the initial pre-load required to close the gap (*C*) between extra full-length leaves and graduated-length leaves.

5. Two mild steel tie bars, for a bridge structure, 250 mm wide and 20 mm thick, are to be joined by means of a butt joint with double straps. The allowable stresses in tension, shear and compression are 80, 60 and 120 N/mm^2 respectively. Determine :

    (i) diameter of the rivet

    (ii) number of rivets

    (iii) show the arrangement of the rivets

    (iv) efficiency of the joint.

6. A spherical pressure vessel, with a 500 mm inner diameter is welded from steel plates. The welded joints are sufficiently strong and do not weaken the vessel. The plates are made from cold drawn steel 20C8 (σ_{ut} = 440N/mm^2 and σ_{yt} = 242 N/mm^2). The vessel is subjected to internal pressure which varies from zero to 6 N/mm^2. The expected reliability as 50% and the factor of safety is of 3·5. The surface finish factor is 0·82 and size factor is 0·85. The reliability factor at 50% reliability is 1. Assume endurance limit as 50% of σ_{ut}. The vessel is expected to withstand infinite number of stress cycles. Calculate the thickness of the plates.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.   3 × 15 = 45

7. A bracket, subjected to a force of 5 kN inclined at an angle of 60° with the vertical, is shown in the Fig 1. The bracket is fastened by means of four identical bolts to the structure. The bolts are made of plain carbon steel 30C8 (σ_{yt} = 400 N/mm^2) and the factor of safety is 5 based on maximum shear stress. Assume maximum shear stress theory and determine the size of the bolts.
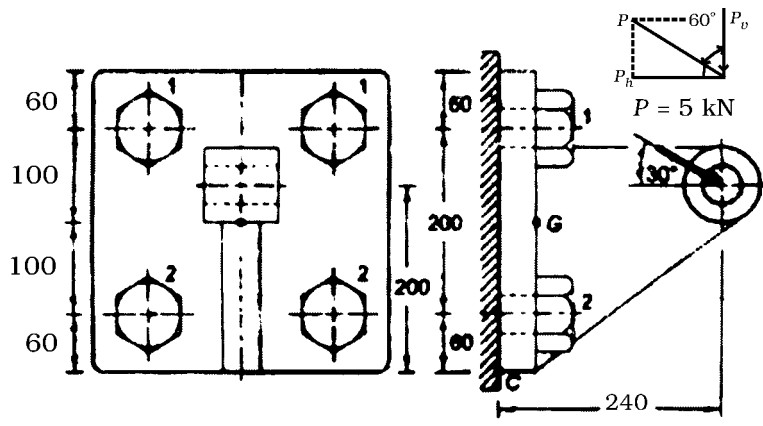

Fig. -1

8. An eccentrically loaded bracket is welded to the support, as shown in the Fig 2. The permissible shear stress for the weld material is 55 N/mm^2 and the load is static. Determine the throat and leg dimensions for the welds.
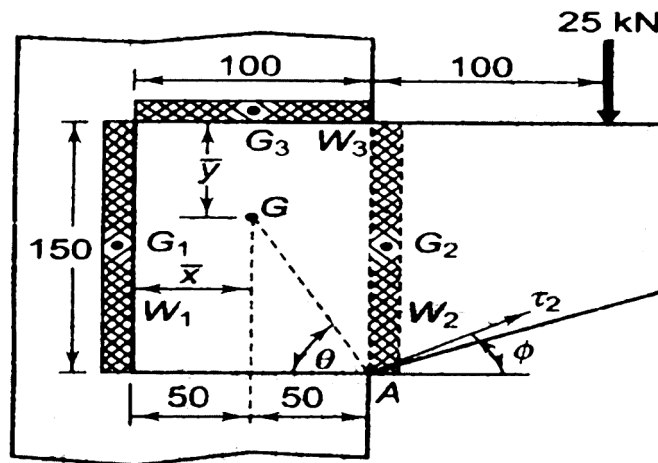

Fig. - 2

9. a) Design a gib and cotter joint to resist a safe tensile load of 50 kN. The material of the gibs, cotter and rods is same for which the allowable safe stresses are : f_c = 60 N/mm^2, f_t = 25 N/mm^2 and f_s = 20 N/mm^2.

    b) Two round tie rods of a roof truss are connected by means of a coupling joint (Turnbuckle). The maximum pull in the rod is 50 kN. Assuming that the allowable stress in tension, compression and shear as 70 N/mm^2; 80 N/mm^2 and 30 N/mm^2 respectively, design and draw the joint. How much would be the rods drawn together for one turn of the coupler ?   9 + 6

10. It is required to design a bushed-pin type flexible coupling to connect the output shaft of an electric motor to the shaft of a centrifugal pump. The motor delivers 20 kW at 720 r.p.m. The starting torque of the motor can be assumed to be 150% of the rated torque. Design the coupling and specify the dimensions of its components.

11. A railway wagon moving at a velocity of 1·5 m/s is brough to rest by a bumper consisting of two helical springs arranged in parallel. The mass of the wagon is 1500 kg. The springs are compressed by 150 mm in bringing the wagon to rest. The spring index can be taken as 6. The springs are made of oil-hardened and tempered steel wire of ultimate tensile strength 1250 N/mm^2 and modulus of rigidity of 81370 N/mm^2. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength. Calculate :

    (i)   wire diameter

    (ii)   mean coil diameter

    (iii)   number of active coils

    (iv)   total number of coils

    (v)   solid length

    (vi)   free length

    (vii)   pitch of the coil

    (viii)   required spring rate

    (ix)   actual spring rate.

12. A line shaft supporting two pulleys A and B is shown in the Fig.-3. Power is supplied to the shaft by means of vertical belt on the pulley A, which is then transmitted to the Pulley B carrying a horizontal belt. The ratio of belt tension on tight and lose sides is 3 : 1. The limiting value of tension in the belts is 2·7 kN. The shaft is made of plain carbon steel 40C8 (σ_{ut} = 650N/mm^2 and σ_{yt} = 380 N/mm^2). The pulleys are keyed to the shaft. Determine the shaft diameter according to the ASME code if, k_b (combined shock and fatigue factor applied to bending moment) = 1·5 and k_t(combined shock and fatigue factor applied to torsional moment) = 1·0.
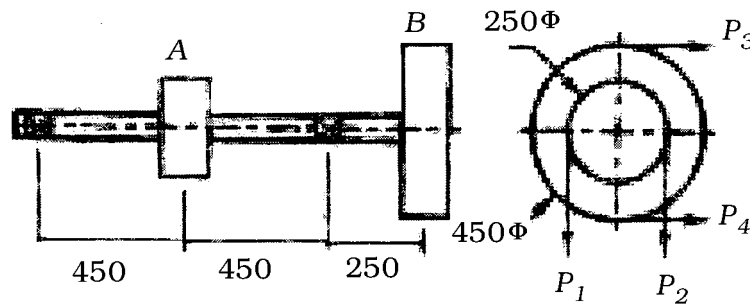

Fig.3