## Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
## Design of Machine Elements – I

Time: 3 hrs.                                                      Max. Marks:100

**Note:** *1. Answer any FIVE full questions, selecting*
*atleast TWO questions from each part.*
*2. Use of Design data handbook is permitted.*

### PART – A

1  a. Write brief note on general procedure used in design. **(06 Marks)**
   b. Explain mechanical properties of materials. **(04 Marks)**
   c. A point in a structural member subjected to plane stress is shown in the Fig.Q1(c). Determine the following :
      (i) Normal and tangential stress intensities on plane MN inclined at an angle of 45°.
      (ii) Principal stresses and their direction.
      (iii) Maximum shear stress and the direction of the planes on which it occurs. **(10 Marks)**
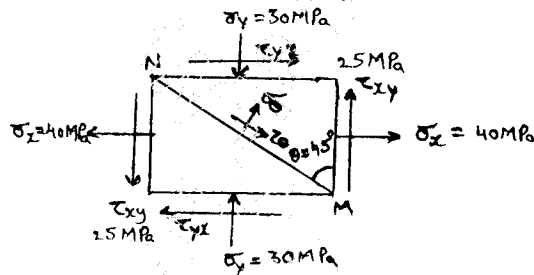


Fig.Q1(c)

2  a. Define factor of safety and discuss factors influencing selection of appropriate value for the factor of safety. **(04 Marks)**
   b. Explain the theories of failure. **(06 Marks)**
   c. A circular rod of 60 mm diameter is subjected to loads as shown in Fig.Q2(c). Determine the nature and magnitude of stresses at the critical points. **(10 Marks)**
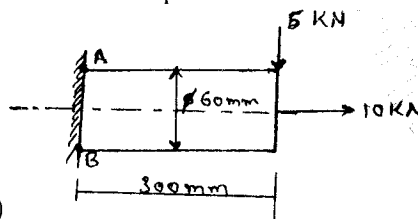


Fig.Q2(c)

3  a. Derive the equation for Soderberg criterion. **(05 Marks)**
   b. A cantilever beam mode of cold drawn carbon steel $\sigma_u$ = 550 MPa ; $\sigma_v$ = 470 MPa ; $\sigma_{-1}$ = 275 MPa of circular cross-section is subjected to load which varies from – F to 3F. Determine the maximum load that this member can withstand for an infinite life, using a factor of safety of 2. **(15 Marks)**
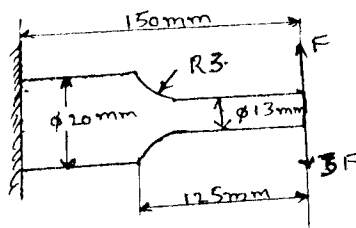


Fig.Q3(b)

4  a.  Design a protected type cast iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and the allowable shear stress in the flange is 40 MPa.   (10 Marks)

   b.  A rectangular sunk key 14 mm wide × 10 mm thick × 75 mm long is required to transmit 1200 N-m torque from a 50 mm diameter solid shaft. Determine whether the length is sufficient or not of the permissible shear stress and crushing stress are limited to 56 MPa and 168 MPa respectively.   (10 Marks)

## PART – B

5  a.  A shaft is mounted between bearings located 9.5 m apart and transmits 10,000 kW at 90 rpm. The shaft weighs 66,000 N, has outside diameter = 450mm and inner diameter = 300 mm. Determine the stress induced in the shaft and the angular deflection between the bearings. Do not neglect the weight of shaft.   (10 Marks)

   b.  A hollow shaft 500 mm outside diameter and 300 mm inside diameter is used to drive a propeller of a marine vessel. The shaft is mounted on bearing 6 m apart and transmits 60,000 kW at 150 rpm. The maximum axial propeller thrust is 500 kN and the shaft weights 70 kN. Determine
   (i)  Maximum shear stress developed in the shaft
   (ii)  Angular twist between the bearings.
   Take G = 84 GPa.   (10 Marks)

6  a.  Explain screw thread terminology. What are its uses?   (06 Marks)

   b.  A cylinder head is fastened to the cylinder of an air compressor using 8 number of bolt. The cylinder core diameter is 300 mm. The pressure inside the cylinder varies from zero to a maximum pressure of 1.5 N/mm². The stresses of the bolt material may be taken as $\sigma_u$ = 500 N/mm², $\sigma_y$ = 300 N/mm² and $\sigma$ = 240 N/mm². The bolts are tightened with an initial preload of 1.5 times the steam load, A copper asbestos gasket is used to make the joint leak proof. Assuming a FOS – 2.5 find the size of bolt required. Neglect stress concentration affect on the bolt and size effect.   (14 Marks)

7  a.  Explain failure of rivetted joint.   (04 Marks)

   b.  Design a triple riveted lap joints zig-zag type, for a pressure vessel of 1.5m diameter. The maximum pressure inside the vessel is 1.5 MPa. The allowable stresses in tension, crushing and shear are 100, 125 and 75 MPa respectively.   (16 Marks)

8  a.  Explain overhauling of screws.   (06 Marks)

   b.  A triple threaded power screw is used in a screw jack, has a nominal diameter of 50 mm and a pitch of 8 mm. The threads are square shape and the length of the nut is 48mm. The screw jack is used to lift a load of 7.5 kN. The co-efficient of friction at the threads is 0.12 and the collar friction is negligible. Calculate
   (i)  Principle shear stress in the screw rod
   (ii)  Transverse shear stresses in the screw and nuts
   (iii)  Unit bearing pressure for threads and
   (iv)  State whether the screw is self locking.   (14 Marks)

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