CBCS SCHEME

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17ME54

# Fifth Semester B.E. Degree Examination, July/August 2022
## Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 100

***Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.***
***2. Use of design data hand book is permitted.***
***3. Any missing data may be suitably assumed.***



### Module-1

1 a. Define Machine design. Briefly explain steps involved in design procedure. **(08 Marks)**

b. Consider a machine member 50mm diameter and 250mm long. It is supported at one end and other end as a cantilever beam. Calculate the principle stress and maximum shear stress for the given load condition. **(12 Marks)**

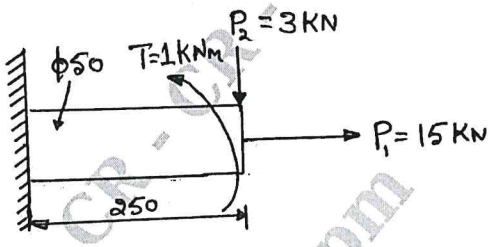


Fig.Q.1(b)

**OR**

2 a. State and briefly explain four theories of failure. **(04 Marks)**

b. Define stress concentration. Mention any two methods of identifying stress concentration in the components. **(06 Marks)**

c. A stepped shaft of circular cross-section is as shown in figure is made of 20Mn2 steel having $\sigma_y$ = 432MPa. Determine the value of 'd' and the fillet radius so that the maximum stress will be limited to ratio corresponding to factor of safety 2.5. **(10 Marks)**

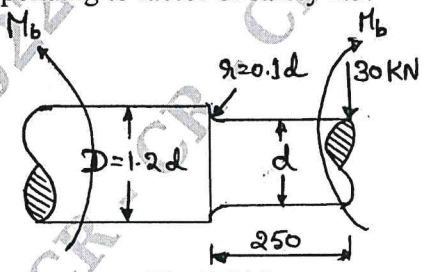


Fig.Q.2(c)

### Module-2

3 a. Define impact energy. Derive the equation for impact stress in axial load. **(08 Marks)**

b. A cantilever beam of width 50mm, depth 150mm is 1.5m long. It is struck by a weight of 1000N that falls from a height of 10mm at its free end. Take E = 206.8 × $10^3$MPa. Determine impact factor, instaneous deflection, instaneous stress and instaneous load. **(12 Marks)**

**OR**

4 a. Derive Soderberg equation for designing members subjected to fatigue loads. **(06 Marks)**

b. A steel member of circular cross-section is subjected to a torsional stress that varies from 0 to 35MPa and at the same time, it is subjected to an axial stress that varies from -14MPa to +28MPa. Neglect stress concentration and column effect. Assuming that maximum stress in torsion and axial load occurs at the same time. The material has $\sigma_{on}$ = 206MPa, $\sigma_y$ = 480MPa, assume diameter of member is less than 12mm, take load and surface correction as 1. Determine maximum equivalent stress and factor of safety based upon yield in shear. **(14 Marks)**

## Module-3

5 A shaft is supported by two bearing placed 1m apart. A 500mm diameter pulley is mounted at a distance of 200mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 3000N. The pulley weighs 1000N. Another pulley 300mm diameter is placed 300mm to the left of right hand bearing is driven with the help of electric motor and the belt is placed horizontally to the right when viewed from the left bearing. This pulley weigh 500N. The angle of contact for both the pulley is 180° and $\mu$ = 0.24. Determine suitable diameter for solid shaft, assuming torque on one pulley is equal to torque on other pulley. Choose C15 steel having $\sigma_y$ = 235.4MPa, $\sigma_u$ = 425MPa as shaft material. Assume minor shock, use ASME code for design. Take key way effect as 0.75. **(20 Marks)**

**OR**

6 a. Design and sketch a Spigot and Socket joint to connect two rods of 30C8 steel to carry axial tensile and compressive load of 100kN. Take allowable stresses as $\sigma_t$ = 90MPa, $\sigma_c$ = 100MPa, $\tau$ = 50MPa. **(12 Marks)**

b. Design a parallel key for a gear shaft of diameter 25mm. 20kW power at 1000rpm is transmitted from the shaft to the gear. The yield strength of key material in tension is 450MPa and factor of safety is 3. The yield strength in compression can be assumed to be equal to yield strength in tension. Determine the dimension of the key. Assume shear stress as 50% of yield stress in tension. **(08 Marks)**



## Module-4

7 a. Design a double riveted butt joint with two cover plate for the longitudinal seam of boiler having 12mm plate thickness. Assume an efficiency of 75%, allowable tensile stress in the plate of 83N/mm$^2$, allowable crushing stress of 138N/mm$^2$ and allowable shear stress of 55N/mm$^2$ in rivet. **(13 Marks)**

b. Determine the diameter of rivet for the bracket as shown in Fig.Q.7(b). The allowable normal and shear stress are 120N/mm$^2$ and 60N/mm$^2$. **(07 Marks)**

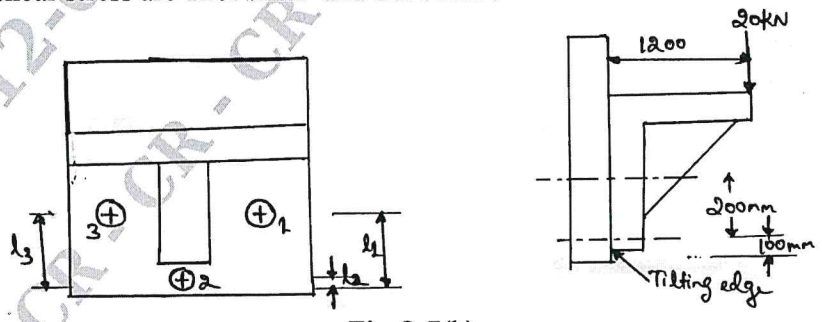


Fig.Q.7(b)

**OR**

8 a. Determine the size of weld for a eccentrically loaded weld as shown in Fig.Q.8(a). The allowable stress in weld is 75N/mm$^2$. Take $h_t$ = 1mm. **(12 Marks)**

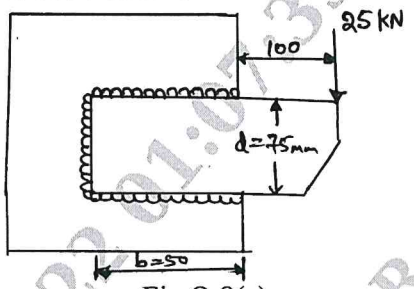


Fig.Q.8(a)

b. A plate of 80mm wide and 15mm thick is joined with another plate by a single transverse weld and a double parallel weld. Determine the length of parallel fillet weld if the joint is subjected to static loading. Take $\sigma_t$ = 90MPa, $\tau$ = 55MPa. **(08 Marks)**

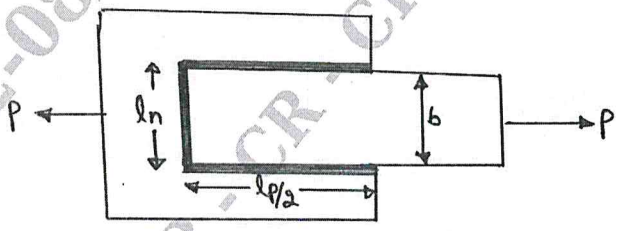


Fig.Q.8(b)



## Module-5

9 a. A bolt in a steel structure is subjected to a tensile load of 9kN. The initial tightening load on the bolt is 5kN. Determine the size of bolt taking allowable stresses for the bolt material to be 80MPa and K = 0.05. **(06 Marks)**

b. The structural connection is as shown in Fig.Q.9(b) is subjected to an eccentric load P of 10kN with an eccentricity of 500mm. The centre distance between bolts at 1 and 3 is 150mm and the centre distance between bolt at 1 and 2 is 200mm. All bolts are identical. The bolts are made of plain carbon steel having yield strength in tension of 400MPa and factor of safety is 2.5. Determine size of bolts. **(14 Marks)**

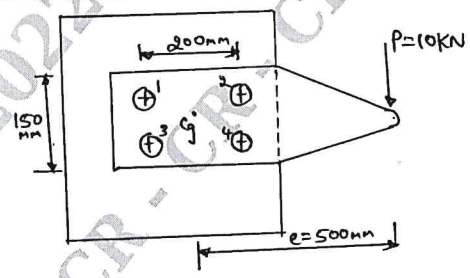


Fig.Q.9(b)

**OR**

10 Design a screw jack with a lift of 300mm to lift a load of 50kN. Select C40 steel [$\sigma_y$ = 328.6MPa] for the screw and soft phosphor bronze [$\sigma_{ut}$ = 345MPa and $\sigma_y$ = 138MPa] for nut. Take overload = 25%, shear stress as 50% of yield stress. Assume heavy machine oil is used. Assumed factor of safety as 3 for yield, 6 for ultimate strength. **(20 Marks)**

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