USN ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Design of Machine Elements – I

Time: 3 hrs.   Max. Marks:100

Note: *1. Answer FIVE full questions, selecting atleast TWO questions from each part.*
2. Use of design data handbook is permitted.
3. Missing data, if any, may be suitably assumed.

PART – A

1   a. Explain biaxial and triaxial stresses with neat sketches.   **(04 Marks)**
     b. What are factors to be considered for selection of material for machine component? **(06 Marks)**
     c. A hollow shaft of 40mm outs diameters and 25mm inns diameter is subjected to a twisting moment of 120N-m, an axial thrust of 10000N and a bending moment of 80N-m. Calculate the maximum compressive and shear stresses.   **(10 Marks)**

2   a. Explain the following theories of failure :
         i) Maximum normal stress theory
         ii) Maximum shear stress theory.   **(06 Marks)**
     b. Explain with a neat sketch, stress concentration.   **(04 Marks)**
     c. Determine the maximum stress induced in the following cases tasking stress concentration into account.
         i) A rectangular plate 60mm wide, 10mm thick and with a central hole of 12mm is loaded in axial tension of 12kN
         ii) A stepped shaft, stepped down from 50mm to 25mm with a fillet radius of 5mm is subjected to a tensile load of 12kN.   **(10 Marks)**

3   a. Derive Goodman's equation.   **(05 Marks)**
     b. A circular bar of 500mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20kN and a maximum value of 50kN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by Ultimate strength of 650 MPa, Yield strength of 500MPa and endurance strength of 350MPa.   **(15 Marks)**

4   a. A stream engine of effective diameter 300mm is subjected to a stream pressure of $1.5N/m^2$. The cylinder head is connected by 8 bolts having yield point stress 330MPa and endurance limit at 240MPa. The bolts are tightened with an initial preload of 1.5 times the stream load. A soft copper gasket is used to make the joint leak-proof. Assuming a factor of safety 2, find the size of bolt required. The stiffness factor for copper gasket may be taken as 0.5.**(10 Marks)**
     b. For supporting the travelling crane in a workshop, the brackets are fixed on steel columns as shown in Fig.Q4(b). The maximum load that comes on the bracket is 12kN acting vertically at a distance of 400mm from the face of the column. The vertical face of the bracket is secured to a column by four bolts, in two rows (two in each row) at a distance of 50mm from the lower edge of the bracket. Determine the size of the bolts if the permissible value of the tensile stress for the bolt material is 84MPa.
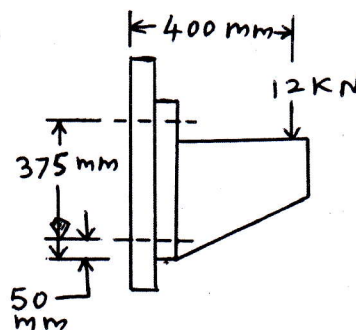

Fig.Q4(b)   **(10 Marks)**

PART – B

5   A steel solid shaft transmitting 15kN at 200rpm is supported on two bearings 750mm apart and has two gears keyed to it. The pinion has 30 teeth of 5mm module is located 100mm to the left of right hand bearing and delivers powers horizontally to the right. The gear having 100 teeth of 5mm module is located 150mm to the right of the left hand bearing and receives from in a vertical direction from below. Using an allowable stress of 54MPa in shear, determine the diameter of the shaft.   **(20 Marks)**

6   a.   Design a sleeve and cotter joint to resist a tensile load of 60kN. All parts of the joint are made of the same material with the following allowable stresses :
$\sigma_t = 60$ MPa ; $\sigma_c = 125$MPa ; $\tau = 70$ MPa.   **(10 Marks)**

    b.   Design a cast iron flange coupling for a mild steel shaft transmitting 90kN at 250 rpm. The allowable shear stress in the shaft is 40MPa and the angle of twist is not to exceed 1° in a length of 20 diameters. The allowable shear stress in the coupling bolts is 30MPa. **(10 Marks)**

7   a.   A double riveted lap join with zig – zag riveting is to be designed for 13mm thick plates. Assume $\sigma_t = 80$MPa ; $\tau = 60$MPa and $\sigma_c = 120$ MPa.   **(10 Marks)**

    b.   A rectangular steel plate is welded as a cantilever to a vertical column and supports a single concentrated load P, as shown in Fig.Q7(b). Determine the weld size if shear stress in the same is not to exceed 140MPa.
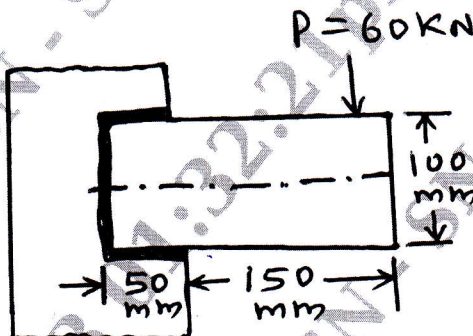

Fig.Q7(b)   **(10 Marks)**

8   a.   The cutter of a broaching machine is pulled by square threaded screw of 55mm external diameter and 10mm pitch. The operating nest takes the axial load of 400N on a flat surface of 60mm and 90mm internal and external diameters respectively. If the coefficient of friction is 0.15 for all contact surfaces on the nut, determine the power required to rotate the operating nut when the cutting speed is 6m/min. Also find the efficiency of the screw.
     (10 Marks)

    b.   A vertical two start square threaded screw of 100mm mean diameter and 20mm pitch supports a vertical load of 18kN. The nut of the screw is fitted in the hub of a gear wheel having 80 teeth which meshes with a pinion of 20 teeth. The mechanical efficiency of the pinion and gear wheel drive is 90%. The axial thrust on the screw is taken by a collar bearing 250mm outside diameter and 100mm inside diameter. Assuming uniform pressure conditions, find the diameter of pinion shaft and height of nut, when coefficient of friction for the vertical screw and nut is 0.15 and that of collar bearing is 0.20. The shear stress in the shaft material is 56MPa and allowable bearing pressure is 1.4MPa.   **(10 Marks)**

* * * * *