Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 2020

Course Code: ME401

Course Name: DESIGN OF MACHINE ELEMENTS - I

Max. Marks: 100 Duration: 3 Hours

Use of Design Data Book is permitted

Missing data if any may be suitably assumed

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain the BIS system for designation of steels based on its composition? (2)

b) Define stress concentration. Give any three methods to reduce stress concentration caused by a notch on a flat plate. (7)

c) A steel column having square cross section of 90 mm side carries a load of 120 kN at an eccentricity of 12 mm in a plane bisecting the thickness. Find the maximum and minimum intensities of stress in the section. (6)

2 a) Taking stress concentration into account find the maximum stress induced in a shaft when a tensile load of 15 kN is applied to a stepped shaft of diameters 50 mm and 20 mm with a fillet of radius of 5 mm. (3)

b) A steel shaft is subjected to the following loads: the bending moment varying from -150 Nm to +400 Nm; The twisting moment varying from 70 Nm to 200 Nm and the axial force varying from -50 N to 150 N. Determine the dimension of the shaft using Von Mises Hencky theory. The frequency of variation of the loads is same as the shaft speed. The properties of the material of the shaft are yield strength = 400 MPa, endurance strength = 310 MPa, ultimate strength = 620 MPa. Take K_t = 1.85, Notch sensitivity factor (q) = 0.95, K_a= 0.75, K_b= 0.85, K_c= 0.9 and Factor of Safety (n) = 2. (12)

3 a) Explain how the strength and stiffness factors of machine elements affect the design. (3)

b) The bending stress in a machine part fluctuates between a tensile stress of 300MPa and compressive stress of 160 MPa. What should be the minimum ultimate tensile strength of this part to carry this fluctuation indefinitely according to (i) Goodman's formula (b) Soderberg relation and (c) Gerber relation? Take the yield point as 60% of ultimate tensile strength and Endurance limit as 50% of ultimate tensile strength and Factor of safety as 2. (12)

PART B

Answer any two full questions, each carries 15 marks.

4 a) A bolt M20 x 2.5 metric thread is subjected to a fluctuating load varying from zero load (0 N) to 14 kN. Endurance strength = 210 MPa. Bolt and part are of same material and length. Take σ_y=480 MPa, Stress concentration factor= 3.85, (12)

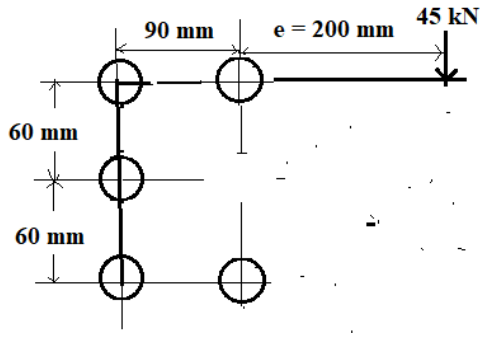
component area=365 mm^2. Calculate (i) Factor of Safety without preload (ii) minimum initial load to prevent joint opening, (iii) factor of safety with 11 kN preload and (iv) minimum force in the part for a given loading and a preload of 11 kN.

b) What do you mean by pre loading of bolts? What is its significance? (3)

5 a) A steel plate 90 mm wide and 10 mm thick is welded to another by means of single transverse and double parallel fillet weld such that the strength of the plate and the welded joint are equal. The welded plates are subjected to a static tensile force of 60 kN. Determine the length of the weld if the permissible shear stress is 80 MPa. (7)

b) A double riveted lap joint with zig-zag riveting is to be designed for 16 mm plates. The permissible stresses in tension, shear and crushing are 80MPa, 60 MPa and 120 MPa respectively. (i) State the mode in which the joint will fail. (ii) Find the efficiency of the joint. (8)

6 a) The structural connection consisting of five rivets of equal size and same material is of the form shown below (6)



The shear stress is 110 MPa and the crushing strength is 150 MPa. Find the diameter of the rivet.

b) A steam engine cylinder head of effective diameter 300 mm is subjected to a steam pressure of 1.5 MPa. The cylinder head is connected by 8 stud bolts having σ_y=320 MPa. Take 18% overload. Find the size of bolt required for the engine cylinder head and the approximate tightening torque. (9)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Design a semi elliptical leaf spring made of chrome vanadium steel having permissible bending stress 300 MPa, for the rear axle of a car subjected to a load of 12 kN. The span is 1 m long and width of the clamp is 110 mm. In all 12 leaves are used out of which two are main leaves and the remaining are graduated leaves. Take the width of the plate as 40 mm. (14)

b) Design a compressive helical spring for a maximum force of 800 N and subjected to a deflection of 22 mm. The spring index is 6. The permissible shear stress is 420 MPa and modulus of rigidity for the material is 80MPa. (6)

8 a) Design a uniform solid shaft supported on bearings (say A and B) 800 mm between centres. A 20° spur gear having 600 mm pitch diameter is located at C, 200 mm to the right of the left hand bearing A and a 700 mm diameter pulley is (12)

mounted at D, 250 mm to the left of the bearing B. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180° wrap angle. The pulley also serves as flywheel and weighs 2 kN. The maximum belt tension is 3.5 kN and the tension ratio is 3:1. Take the yield stress for the material as 380 MPa and factor of safety as 2.

b) What do you mean by critical speed of a shaft? (4)

c) Design a rectangular sunk key made of steel for a 90 mm diameter mild steel shaft to transmit a torque of 150 Nm. Assume shear stress =50 MPa and crushing stress= 120 MPa. (4)

9 a) Two helical springs of the same axial length but different diameters of coil are coaxially placed one inside the other. The axial load is 5 kN and the deflection is 32 mm. The maximum permissible shear stress in both the springs is 150MPa. The spring indices are 5 and 9. The wire diameters are being same, neglecting the effect of stress concentration; find the wire diameters and ratio of actual number of coils of the two springs. (10)

b) Design a flange coupling which connects a motor and a pump shaft made of steel. The flange and hub of the assembly are made of cast iron having shear strength 14 MPa. The power transmitted is 3 kW at a shaft speed of 960 rpm. Take the permissible shear stress and crushing stress for steel used as 50 MPa and 90 MPa respectively. (10)

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