MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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V SEMESTER B.TECH. (MECHANICAL ENGINEERING)
END SEMESTER ONLINE EXAMINATION, JANUARY 2021
SUBJECT: MECHANICAL DESIGN - I [MME 3153]

REVISED CREDIT SYSTEM

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to the candidates

- Answer ALL the questions
- Missing data may be suitably be assumed stating it.
- Use of data handbook is permitted.

1A Define the following. (02)

i. Maximum strain energy theory of failure

ii. Distortion energy theory of failure

1B A hollow shaft of 40 mm outer diameter and 25 mm inner diameter fixed at one end is subjected to a twisting moment of 120 N-m. At the same time, it is subjected to an axial compressive force of 10 kN. Calculate the maximum compressive and shear stresses in the shaft. (04)

1C A round shaft made of a brittle material and subjected to a bending moment of 15 Nm is shown in the figure Q1C. The stress concentration factor at the fillet is 1.5 and the fillet radius is 2 mm. The ultimate tensile strength of the shaft material is 200 N/mm^2. Determine the diameter d, the magnitude of stress at the fillet and the factor of safety. (04)

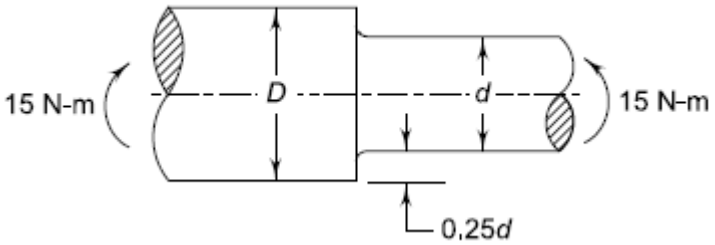

Figure Q1C
All dimensions are in mm

2A A pulley mounted on a shaft is subjected to torque varying between 200 Nm and 100 Nm and bending moment fluctuating from -150 Nm and 250 Nm. The ultimate stress and yield stress of the shaft material are 650 MPa and 460 MPa respectively. The stress concentration for the shaft is 1.85 and 1.25 in bending and torsion respectively. The factor of safety is 1.9. The load correction factor for bending and torsion are 1 and 0.5 respectively, while the surface correction factor is 0.89. Calculate the shaft diameter if the notch sensitivity factor is 0.94. (05)

2B A crane hook has trapezoidal cross-section of sides 125 mm, 65 mm and depth of 95 mm. The inner radius of curvature is 125 mm and the load acts at a distance of 20 mm away from the centre of curvature of crane hook. Calculate the maximum load that the crane hook can carry if the permissible stress of crane hook material is 92 MPa. (05)

3A A horizontal piece of commercial shafting is suspended by two bearings 1.5 m apart. A keyed gear, 20º involute and 175 mm diameter, is located 400 mm to the left of the right bearing and driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and drives a pulley with a horizontal belt drive directly behind it. The tension ratio of the belt is 3 to 1. The drive transmits 45 kW at 330 rpm. Assume C_m= C_t= 1.5. Shafting material is commercial cold rolled steel with σ_u= 482 MPa and σ_e=241 MPa. Assume the shaft rotation as clockwise when seen from left hand side. (08)

3B Mention any two differences between the sunk key and saddle key. (02)

4A A plate is welded to a vertical support using two 10 mm fillet welds as shown in figure Q4A. Determine the safe load P if the allowable shear stress in the weld is 100 MPa. (05)

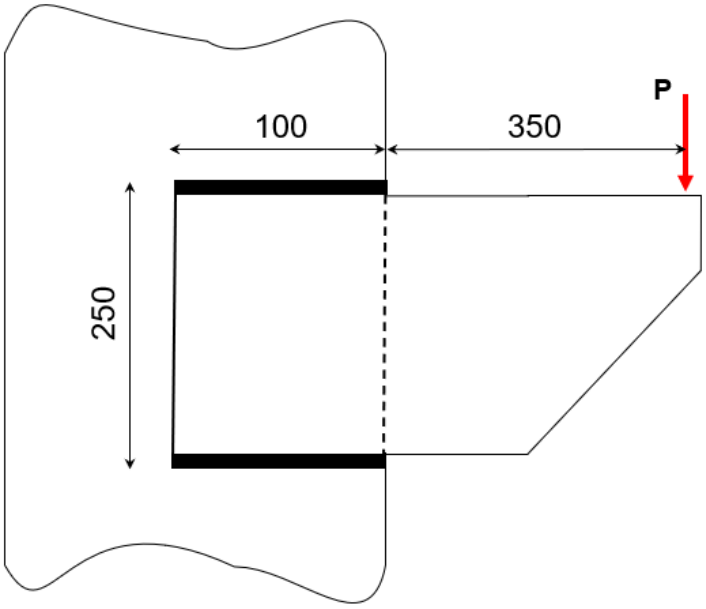

Figure Q4A
All dimensions are in mm

4B A triple riveted lap joint of zig-zag type is used to join two plates of 10 mm thick. The allowable stress in shear and crushing for rivet material are 85 MPa and 170 MPa respectively. The allowable tensile stress for the plate is 120 MPa. Sketch the joint and determine (05)

i) Longitudinal pitch

ii) Length of overlap

5A Determine the maximum tensile stress produced in the M16x2 bolts used in fastening the bracket as shown in fig. Q5A. The load acting on the bracket is 21 kN. (05)

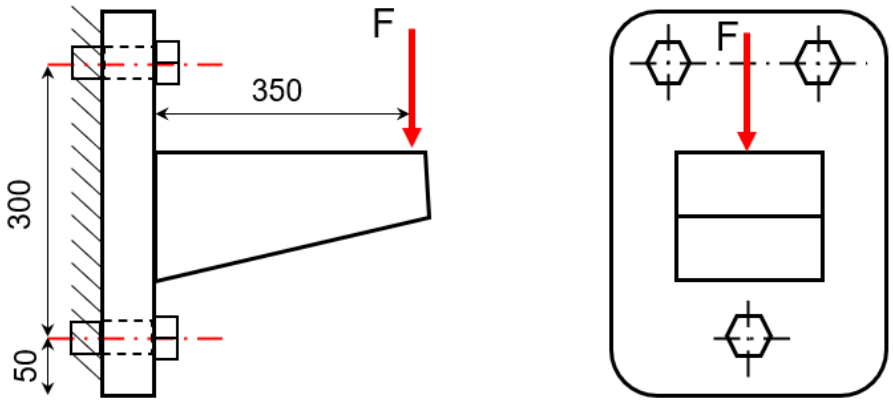

Figure Q5A
All dimensions are in mm

5B A power screw has double-start square thread of 36 mm nominal diameter and 6 mm pitch. The load on the screw is 8 kN and mean diameter of thrust collar is 40 mm. Assuming the friction coefficient for both screw and collar as 0.15, determine (05)

i. Torque required to raise the load.

ii. Efficiency of the screw

iii. Is the screw self-locking?