



UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 4 Examination in Engineering (Old Curriculum): November 2014

Module Number: ME4311

Module Name: Design of Machine Elements

[Two Hours]

[Answer all questions, each question carries 5 marks]

- Q1 (i) Explain why impact stresses should be avoided in machine components. [1 Marks]
- (ii) A simply supported shaft AD transmits torque between two pulleys with one pulley at its mid span B and the other close to one support at C as shown in Figure Q1. The belt drives pull the shaft with tensions T_1 and T_2 . With the aid of sketches, indicate all possible stresses induced in the shaft AB . [2.5 Marks]
- (iii) A shaft of diameter 30mm transmits a torque of 1000Nm under an axial tensile load of 15kN. A filleted shoulder of the shaft experiences a bending moment of 750Nm. Find the maximum direct $\sigma_{l(max)}$ stress and the maximum shear stress τ_{max} at the particular critical location of the shaft.

Note: with usual notation, $\sigma_{l(max)} = \frac{\sigma_l}{2} + \frac{1}{2} \left[\sqrt{(\sigma_l)^2 + 4\tau^2} \right]$ $\tau_{max} = \frac{1}{2} \left[\sqrt{(\sigma_l)^2 + 4\tau^2} \right]$

Sectional module Z of the shaft $Z = \frac{\pi}{32} \times d^3$ Bending Stress $\sigma_b = \frac{M}{Z}$

[1.5 Marks]

- Q2 (i) Explain the advantages and disadvantages of threaded fasteners. [1Mark]
- (ii) Through bolts, Tapped Bolts and Studs are used in machineries. How would you justify the use of the three types of bolts in your designs? [1.5 Marks]
- (iii) The wall bracket shown in Figure Q2 is supported by four bolts at a distance of L_1 and L_2 from the point A . Explain the calculation steps required to determine the diameter of the bolts.

[2.5 Marks]

- Q3 a) With the aid of a suitable diagram, explain the term "Endurance limit of fatigue" (σ_e) of a material. Give the relationship between "design stress" (σ'_e) and the endurance limit of fatigue (σ_e), including important factors affecting the fatigue life of a machine component. [1.5 Marks]
- b) Draw the graphical relationship between variable stress (σ_v) and Mean stress (σ_m) for the Sorderberg method of combination stress. Show that a safe design point satisfies the relationship $(\sigma_m/\sigma_y) + (\sigma_v/\sigma_e) = 1/\text{Factor of safety}$

[1.5 Marks]

- c) The maximum and minimum bending stresses acting on a grooved shaft are 88 N/mm^2 and 12 N/mm^2 respectively. Fatigue stress concentration factor K_f at the groove is 1.65. According to the Soderberg criteria, estimate the factor of safety in terms of endurance limit of the shaft material under the given working conditions. You may assume the endurance limit of the shaft material to be equal to half of the yield strength.

[2.0 Marks]

- Q4 a) State advantages of riveted joints against bolted joints.

[1 Mark]

- b) A double riveted double cover butt joint in plates of 20 mm thickness is made with 25 mm diameter rivets at 100 mm pitch. The permissible direct stress σ_t , shear stress τ and crushing stresses σ_{cr} are as follows:

$$\sigma_t = 120 \text{ MPa}, \tau = 100 \text{ MPa}, \sigma_{cr} = 150 \text{ MPa}$$

Sketch the riveted joint and find the following.

- Tearing resistance of the plates
- Shear resistance of the rivets
- Crushing resistance of the rivets

[2.0 Marks]

- c) Find the efficiency of the joint, assuming that the strength of the rivet in double shear is twice that of single shear.

[2.0 Marks]

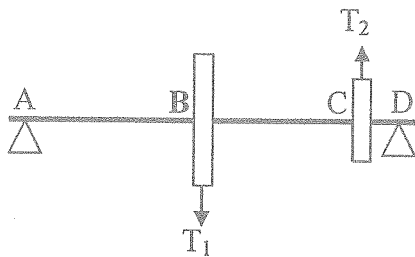


Figure Q1

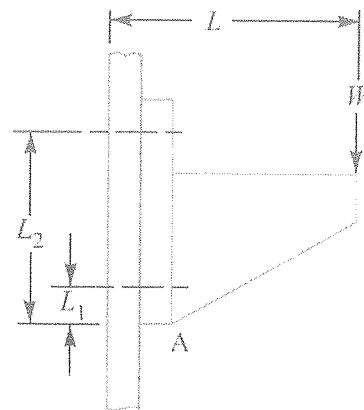


Figure Q2