UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: February 2020

Module Number: ME 4303 **Module Name: Design of Machine Elements**

[Three Hours]

[Answer **all questions**, each question carries **ten** marks]

All assumptions must be stated clearly. Sketches and diagrams are to be provided where required. Symbols stated herein denote standard parameters.

Q1 a) Various material properties are considered in design of machine elements. Give one example application that each of the following material property becomes significant. Describe how the performance of the particular machine element would affect if the respective material property was "low".

i) Thermal conductivity
ii) Tensile strength
iii) Hardness
v) Resilience

[4.0 Marks]

b) Manufacturability and assembly are two out of many concerns in machine design. You are required to design a 250mm long, simply supported shaft of average diameter 25 mm, with 30mm diameter section at the midspan on which a gear wheel is fixed. Explain two different shaft designs (no calculations are required) considering manufactureability and assembly if it is used in;

i) A prototype machine
ii) Mass produced machine

[2.0 Marks]

c) Explain with the aid of sketches how a cam shaft would undergo variable stresses. [2.0 Marks]

d) Briefly explain how fatigue life of machine elements can be improved by;

i) Increasing surface finish
ii) Reducing stress concentration

[2.0 Marks]

Q2 a) Categorize the riverted joints depending upon the way in which the plates are connected and briefly describe each category.

[2.0 Marks]

b) i) A double riveted joint is made between 15 mm thick plates. The rivet diameter and pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension, 320 MPa in shear and 640 MPa in crushing, find the minimum force per pitch for tearing, shearing, and crushing which will rupture the joint.

[3.0 Marks]

ii) If the above joint is subjected to a load such that the factor of safety is 4, find out the actual stresses for tearing, shearing, and crushing which developed in the plates and the rivets.

[3.0 Marks]

c) Find the efficiency of the joint.

[2.0 Marks]

Q3 a) Write down four important factors which depend on the selection of a belt drive.

[2.0 Marks]

b) An engine running at 150 r.p.m. drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft is 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Fine the speed of dynamo shaft, when

i) there is no slip

[1.0 Mark]

ii) there is a slip of 2% at each drive

[1.0 Mark]

c) i) Above engine pulley and pulley on the line shaft, on parallel shafts 1.95 m apart are connected by a crossed belt. Find the length of the belt required.

[4.0 Marks]

ii) Find the angle of contact between the belt and each pulley.

[2.0 Marks]

Q4 a) Define a spring with suitable parameters and give various applications of it.

[1.0 Mark]

b) i. What are the types of springs, which classified according to their shape and purpose?

ii. Briefly discuss 2 types of springs with suitable sketches.

[2.0 Marks]

c) Consider a part of the compression spring shown in **Figure Q4 (c)**.

i) Show that torsional shear is $\tau_1 = \frac{8WD}{\pi d^3}$ and direct shear is $\tau_2 = \frac{4W}{\pi d^2}$

ii) Using those relations, find the total shear stress (minimum and maximum).

Hint: $\frac{T}{j} = \frac{\tau}{r} = \frac{G\theta}{L}$ *is given with usual notations*

[3.0 Marks]

d) A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity 84 kN/mm^2. Neglecting the effect of curvature find,

i) Axial load which the spring can stand

[2.0 Marks]

ii) Deflection per active turn

[2.0 Marks]

Q5 a) What are the two main types of clutches commonly used in engineering practice? Discuss them briefly with suitable sketches.

[2.0 Marks]

b) Discuss five characteristics of the material which used for lining of friction surfaces of a clutch.

[1.0 Mark]

c) Discuss the designing considerations of friction clutch.

[2.0 Marks]

d) A plate clutch having a single driving plate with contact surfaces on each side is required to transmit 110 kW at 1250 r.p.m. The outer diameter of the contact surface is to be 300 mm. The coefficient of friction is 0.4.

i) Assuming a uniform pressure of 0.17 N/mm²; determine the inner diameter of the friction surfaces.

$$Take, R = \frac{2}{3}\left[\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}\right] \; for\ a\ uniform\ pressure\ condition$$

ii) Assuming the same dimensions and the same total axial thrust, determine the maximum torque that can be transmitted and the maximum intensity of pressure when uniform wear conditions have been reached

[5.0 Marks]

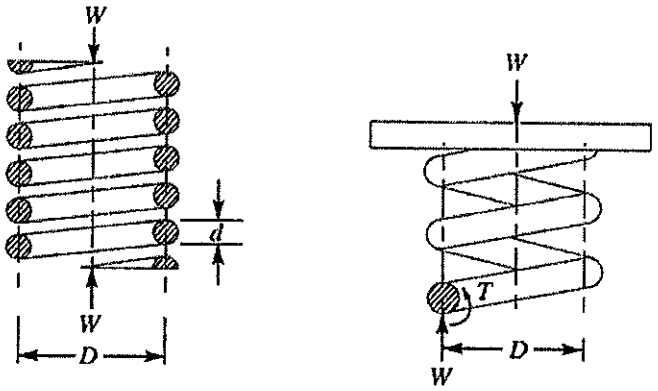

Figure Q4(c) Free body diagram of axial loaded helical spring