THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY

045

DIPLOMA IN TECHNOLOGY – LEVEL 04

FINAL EXAMINATION 2008/2009

MEX4231 / MED2202 – ELEMENTARY MACHINE DESIGN – PAPER I

DATE : 12th March 2009
TIME : 1430 hours to 1630 hours
DURATION : Two hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE ANSWERING THE QUESTION PAPER

---

1. *This question paper has two parts. Part A and Part B. Part A has three (03) questions and Part B has five (05) questions. Answer only four (04) questions selecting at least one (01) question from Part A and not more than Three (03) questions from Part B.*

2. *All questions carry equal marks.*

3. *Read the questions carefully before you start answering each question.*

4. *Write the relevant question number at the beginning of the answer.*

5. *Before submitting your answer script, fill the relevant cage on the front page by writing the question numbers for which you have already answered.*

6. *Some questions require design data. They are provided to you separately as charts, catalogues, data sheets and tables. Do not write anything on these data books. At the end of the examination return them to the supervisor.*

7. *Assume any missing dimensions or design data. All such assumptions shall be clearly stated appropriately in the relevant answers.*

8. *Any sketches that you provide to explain your answer shall be neatly drawn and labelled.*

PART A

Question 1

(a) What does "Safety Factor" measure in an analytical model?

(b) On what factors does the magnitude of safety factor depend?

(c) What are design codes? State at least two design codes that you are familiar with.

(d) What is "Fracture Toughness?"

Question 2

(a) Why are free body diagrammes important in design exercises?

(b) Figure Q2 shows a handbrake lever assembly, which consists of three subassemblies, the handle (1), the lever (2), and the cable (3). The lever is pivoted to the handlebar and the cable is connected to the lever. The cable runs within a plastic-lined sheath (for low friction) down to the brake caliper assembly at the bicycle's wheel rim. The sheath provides a compressive force to balance the tension in the cable ($F_{sheath} = - F_{cable}$). The user's hand applies equal and opposite forces at some point on the lever and handgrip. These forces are transmitted to a larger force in the cable by the lever ratio. The configuration shown in the figure provides the free body diagramme for the entire assembly. With the help of separate sketches show the free body diagramme of each part and all three parts.

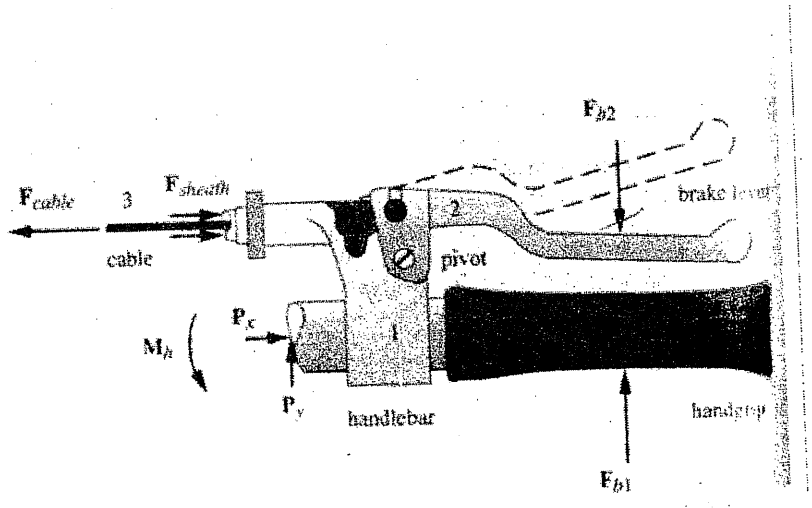


Figure Q1

Question 3

(a) With schematic diagrammes present the meaning of Hole-basis and Shaft-basis assembly systems.

(b) Explain why Hole-basis system is mostly preferred over the Shaft-basis system.

(c) State an instance where Shaft-basis assembly system is mostly used.

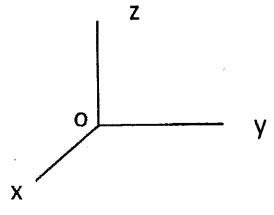
(d) A medium force fit on a 75 mm shaft requires a hole tolerance of 0.225mm, a shaft tolerance of 0.223 mm and an average interference of 0.0375 mm. Determine the proper hole and shaft dimensions with the basic hole standard. Present the results in a diagramme meaningfully.

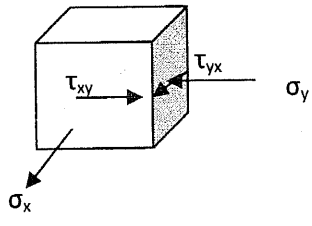
PART B

Question 4

(a) Explain why the consideration of principal stresses (normal) and maximum shear stress is important from the point of view of designing machine elements.

(b) A biaxial stress element as shown in the Figure Q3 has σ_x = 40 MPa, σ_y = (-)20 MPa and τ_{xy} = 30 MPa ccw. Use Mohr's circle to determine the principal stresses. Check the result with the numerical method.





Question 5

(a) Illustrate the layout of "chain riveting" and "zigzag riveting" methods with respect to double riveted butt joint.

(b) Identify pitch, transverse pitch, diagonal pitch and margin pitch in the above layouts.

(c) Two steel plates, each 6 mm thick, are to be joined by a double riveted zigzag lap joint. Design the joint using following allowable strengths of mild steel.

Tensile – 100 N/mm^2

Shear – 70 N/mm^2

Crushing – 130 N/mm^2

Your answer should include rivet diameter, pitch, transverse pitch, margin pitch, tearing efficiency, shearing efficiency and crushing efficiency.

What would be the acceptable efficiency of the joint?

Assume: Transverse Pitch >= 0.33p + 0.67D

Margin pitch = 1.5D

Where p is the pitch and D is the rivet diameter.

Both rivets and plates are of same material

Question 6

(a) 'By increasing the helix angle of a power screw above 30^0 not much is gained.' Do you agree? Why?

(b) Explain the condition of overhauling of a power screw.

(c) A screw press is required to exert a force of 40 kN. The maximum unsupported length of the screw is 400 mm. The screw is made of steel and the nut of cast iron and has single start square threads. Design the nut and screw pair if the allowable strengths are as follows.

For Steel:

Yield in tension – 100 N/mm^2

Yield in shear – 60 N/mm^2

Bearing pressure between steel and cast iron – 12 N/mm^2

For Cast Iron:

Shear – 40 N/mm^2

Assume the force applied by the operator be 600 N and the Rankine formula for crippling stress.

$$P_{cr} = \frac{\sigma_c A}{1 + a\left[\frac{l}{k}\right]^2}$$

in usual notations; a = (1/25,000) for steel when both ends are fixed.

Coefficient of friction between steel and cast iron is 0.13

Your answer should contain dimensions of power screw, nut and hand wheel.

UNIVERSITY OF GUELPH LIBRARY

Recommended Dimensions for a few Selected Square Threads

Nominal Diameter (mm)	Major Diameter for Bolt (mm)	Major Diameter for Nut (mm)	Minor diameter (mm)	Pitch (mm)
24	24	24.5	16	8
26	26	26.5	18	8
28	28	28.5	20	8
30	30	30.5	20	10
32	32	32.5	22	10
36	36	36.5	26	10
40	40	40.5	28	12

Question 7

(a) Why is the section of an arm of a pulley elliptical? In which plane major axis of the arm section is placed and why?

(b) A 7.5 kW, 1,200 rev/min motor is arranged in such a way that the motor base is pivoted for tension adjustment as shown in Figure Q7. The weight of the motor provides to maintain the necessary belt tension. The motor weighs 1,600 N and its pulley diameter is 0.20 m. The distance 'b' is 0.40 m and that 'c' is 0.45 m.

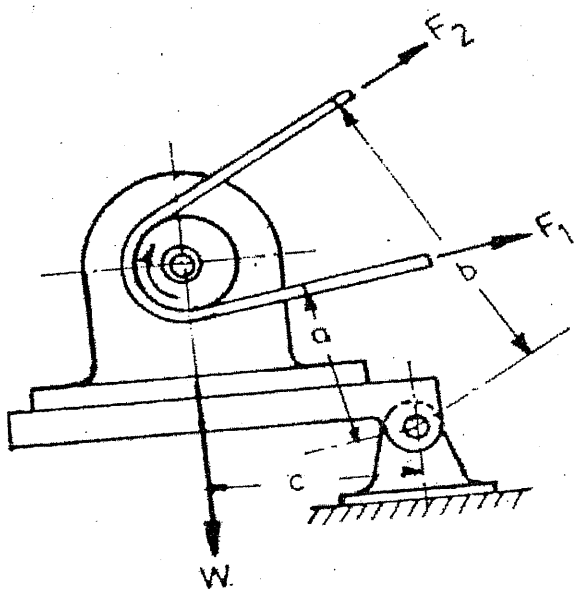


Figure Q7

The starting torsional moment on the motor is 250% of rating. Arc of contact of the driver pulley is 165^0, angle of V-belt 40^0. Coefficient of friction between the pulley and belt material is 0.13. Determine:

I. The effective tension required for starting the drive and the two tensions of the belt.

II. The distance 'a' from the hinge point to the motor centre line.

III. The tensions in the belt at the rated load.

IV. The tension at the zero load.

Comment on the results.

Question 8

(a) Explain how you will control tooth failure on gears at the design stage of gear wheels. Refer to spur gears only.

(b) Design a pair of spur gears required to drive an air compressor with the following data. Consider the static condition only. Show that the spur gear pair that you designed is safe under static conditions.

Power transmission: 15 kW at 1400 rpm of the motor speed.

Compressor speed: 500 rpm

Pressure angle: 20^0

Pinion teeth: 25

Both wheels are made of cast iron having allowable strength of 55 MPa.

A steady load is applied 24 hours/day, thus the service factor: 1.25

Velocity factor (C_v) can be considered as 0.35 for initial trial run of calculations. Use information given in the handout for gear designs.
