

# The Open University of Sri Lanka Faculty of Engineering Technology Department of Mechanical Engineering



Study Programme

: Bachelor of Technology Honours in Engineering

Name of the Examination: Final Examination

Course Code and Title : DMX5577/MEX5277 Machine Design-Paper I

Academic Year

: 2017/18

Date

: February 20, 2019

Time

: 1430 -1630hrs

Duration

: 2 hours

## **General Instructions:**

1. Read all instructions carefully before answering the questions.

- 2. This question paper consists of 8 questions in Two Parts, Part A and Part B. All questions carry equal marks.
- 3. 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.
- 4. Assume any missing dimensions or design data. All such assumptions shall be clearly stated appropriately in the relevant answers.
- 5. Any sketches that you provide to explain your answer shall be neatly drawn and labeled.

# PART A

#### Ouestion 01.

- a. Outline the basic design requirements, that should be given due consideration when designing a machine or a machine component. Give a brief account on each of the requirements that you have outlined.
- b. Given below are three pairs of terms, and each pair has two terms. Define or briefly explain in your own words each term of a pair distinctly from the other.
  - i. Reliability and safety factor
  - ii. Accessibility and maintainability
  - iii. Ergonomics conditions and operator comfort/safety.
- c. Discuss the effects of vibration on machines. Quote relevant examples to justify your answer.

### Question 02

- a. Write short notes on the following in the context of rolling element bearings. *Note: you may use neat sketches wherever necessary.* 
  - i. Load carrying capacity of bearings.
  - ii. L<sub>10</sub>, L<sub>10h</sub> and L<sub>10s</sub> life of bearings and the correlation of each other.
  - iii. Radial internal clearance and axial internal clearance of a bearing.
  - iv. Methods of oil lubrication and selection of oil for lubricating bearings.
- b. Fatigue failures are critical and important in designing machine elements.
  - i. Explain why consideration of fatigue failure is important at the designing stage of machine elements.
  - ii. State four (4) factors to be considered when designing to avoid fatigue failures.

## Question 03

- a. Explain what 'Self-energizing' and 'Self-locking' within the context mechanical brakes. You may use relevant equations to justify the explanation.
- b. Briefly discuss each of the following within the context of limits and fits.
  - i. 'Dimensional tolerance' and the importance of indicating tolerances in design drawings.
  - ii. Allowance of a fit.
  - iii. Unilateral and Bilateral systems of tolerance.
  - iv. 'Hole basis system' and 'Shaft basis system'.
- c. What is Surge in springs?

# PART B

## Question 04

- a. Write down two differences between a clutch and a coupling.
- b. A clutch with one driving plate with both sides active was designed to transmit 110 kW at 1250 rpm. The coefficient of friction between contact surfaces is 0.4.
  - i. If the outer diameter of contact surfaces is 300 mm determine the internal diameter of the friction surfaces. Assume a uniform pressure of  $0.17 N/m^2$ .
  - ii. Determine the maximum torque that can be transmitted and the maximum intensity of pressure when uniform wear condition has been reached. Assume same dimensions and the same axial force.

# Ouestion 05

Figure Q5 shows a hoisting drum of diameter 500 mm is keyed to a shaft which is supported by two bearings to the housing. The shaft is driven by an electric motor through a 12:1 reduction ratio. The drum should be capable of hoisting a maximum load of 8 kN at a speed of 50 m/min. The efficiency of the drive is 80%.

The shaft is made out of steel with a tensile stress of  $115 \, MN/m^2$  and shear stress of  $50 \, MN/m^2$ . The diameter of the gear which drives the drum is  $450 \, mm$  and this gear is mounted at the end of the drum shaft in such a way that it overhangs the nearest bearing by  $150 \, mm$ . The combined shock and fatigue factors can be taken as 2 and  $1.5 \, mm$  respectively.

## Determine,

- a. Required power of the driving motor.
- b. Torque on the drum shaft.
- c. Speed of the motor.
- d. Diameter of the shaft if the shaft has a maximum bending moment at the location of left bearing.

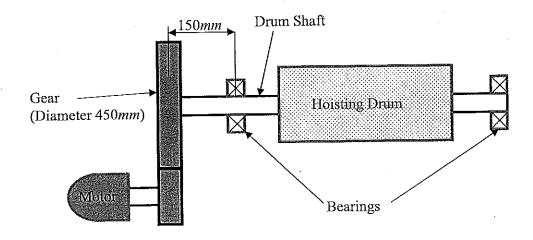


Figure Q5 (not to scale)

## Ouestion 06

A V-belt drive connects two shafts whose centres are 1 m apart. The driving pulley which has an effective diameter of 300 mm is supplied with 95 kW power and runs at 1000 rpm. The driven pulley runs at 375 rpm. The angle of groove on the pulleys is 40°. Permissible tension in a belt with a cross sectional area of 400  $mm^2$  is 2.1  $MN/m^2$ . The material of the belt has a density of 1100  $kg/m^3$ . The driven pulley is overhung with a distance of the centre to the nearest bearing being 200 mm. The coefficient of friction between the belt and the pulley rim is 0.28. If the permissible stress of the belt material is  $42MN/m^2$ , Determine,

- a. The number of belts required to transmit the power.
- b. Diameter of the driven pulley.

a. For a square thread operating with a thrust collar, show that the screwing-up torque (T<sub>su</sub>) is given by;

$$T_{su} = F \cdot \frac{d}{2} \left[ \tan(\Psi + \phi) + \mu \frac{dm}{2} \right]$$

Where:

F = axial load on screw

d = pitch diameter of the thread

 $\phi$  = angle of friction

 $\psi$  = helix angle

 $\mu$  = friction coefficient of nut on thrust collar

 $d_m$  = mean diameter of the thrust collar

b. A 60 mm square threaded steel screw is used in a common screw jack, where a maximum load of 25 kN needed to be lifted. There are 2 threads per 24 mm. The body of the jack is made out of cast iron. The coefficient of friction on the thread is 0.2. The thrust collar of the top has an inside diameter of 40 mm and an outer diameter of 70 mm. The coefficient of friction for the collar is 0.9.

Determine,

(i) the efficiency of the screw and thrust collar.

(ii) the pull at the end of a 500 mm lever to operate this screw jack.

## Question 08

A rectangular plate shown in Figure Q8 made out of steel is of 200 mm length and 100 mm in deep. The plate is welded as a cantilever to a vertical column and supports a single concentrated load of 60 kN acting at the edge of the plate. Determine the minimum weld size needed to hold the load. The maximum shear stress of the weld material 140  $MN/m^2$ .

Hint: To answer this problem, calculate primary shear stress, secondary shear stress and the resultant of the two. To calculate the secondary shear stress, find polar moment of area of the entire weld length about the point at which the turning tends to take place.

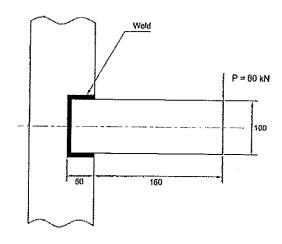


Figure. 08

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