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The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX5277 Machine Design [Paper I]**
Academic Year	:	2016/2017
Date	:	November 20, 2017
Time	:	1430 hrs. – 1630 hrs.
Duration	:	2 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions. All questions carry equal marks.
3. 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.
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

Question 01

Answer following questions.

a) Discuss the importance in giving due consideration to **Residual Stresses** and **Stress Concentration** when designing mechanical components.

b) Explain what **Over Hauling** and **Self Locking** of power screws.

c) Explain what **Self Energizing** and **Self Locking** in the context of brakes.

d) Explain the **Chordal Action** of a chain.

Question 02

a. *Gordon Clegg states that 'Sometimes the problem is to discover what the problem is'.*

In line with this statement explain the importance of identifying the problem clearly before proceeding with other stages in the design process. You may use appropriate examples if necessary.

b. Figure.Q3a, Figure.Q3b, Figure.Q3c and Figure.Q3d show different types of wheelchairs and there are considerable differences in the configurations and components of these wheelchairs. Quoting at least five (05) main features (example; difference in wheel design) explain why these wheelchairs are different from one to another.
Note: you may answer the question considering the design intent and rationale of each design.

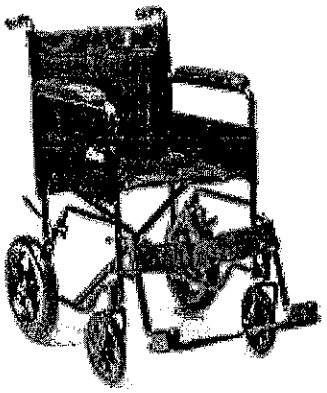


Figure.Q3a

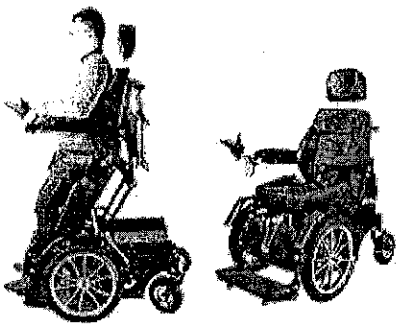


Figure.Q3b



Figure.Q3c



Figure.Q3d

Question 03

a) Discuss the primary objectives to be achieved in adhering to interchangeability in mass production of a particular component. Give a suitable example to explain how interchangeability is employed in design practice.

b) Explain the following systems of tolerances with illustrations.

i. Basic Hole
ii. Basic Shaft
iii. Unilateral
iv. Bilateral

c) In a hole and a shaft combination of 40 *mm* nominal size, H8 hole limits are + 0.039 *mm* and + 0.000 *mm* and F7 shaft limits are – 0.025 *mm* and - 0.050 *mm*
State the value of,

i. maximum and minimum clearance,
ii. allowance,
iii. tolerance on the hole and the shaft,
iv. type of fit.

PART B

Question 04

A crank built up from a cylindrical sections by welding, required a loading of 1 kN to overcome the resistance when in the position shown in the Figure.Q4.

a) Compute the maximum normal and shear stresses indicated in the section A-A.
b) Determine the maximum shear stresses indicated in the parts I, II and III.

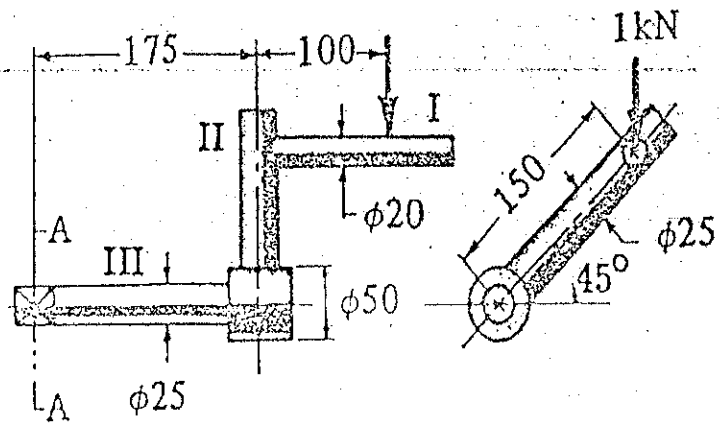


Figure.Q4 (all dimensions are in *mm*)

Question 05

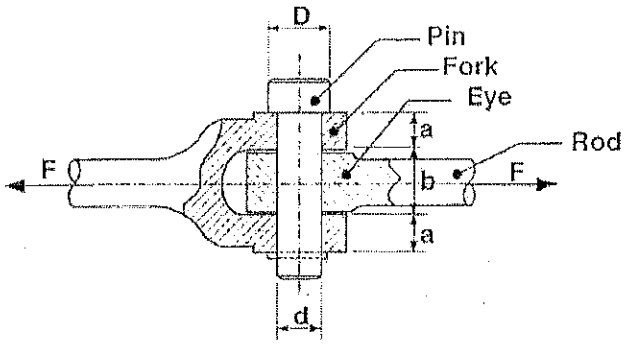


Figure.Q5

Figure.Q1 shows a Knuckle joint. Design a knuckle joint for transmitting a tensile load of 100 *kN*. The material used is carbon steel with a tensile stress of 50 MN/m^2, Shear stress of 35 MN/m^2 and crushing stress of 90 MN/m^2. The diameter of the rod b is 50 *mm*.

Note:
If the diameter of the Rod is ***b,*** *which is 50mm, as shown in the Figure.Q5 the other related dimensions can be fixed empirically as;*

Diameter of the pin d = b
Outer diameter of the eye = 2 b
Diameter of the Pin head and the collar = 1.5 b
Thickness of the eye (rod end) = 1.25 b
Thickness of the fork a = 0.75 b
Thickness of the pin head = 0.5 b

And you ***should check****, 1. for the shear of the knuckle pin, 2. bending of the knuckle pin, 3. the eye in tension, 4. the eye in shear, 5. the fork ends in tension, 6. the fork end in crushing.*

Question 6

Discuss the advantages and disadvantages of welded joints.

Figure.Q6 shows a plate 75 *mm* wide and 15 *mm* thick joined with another plate by a single transverse weld and a double parallel fillet weld. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading.

The maximum tensile and shear stresses are 70 MN/m^2 and 50 MN/m^2.

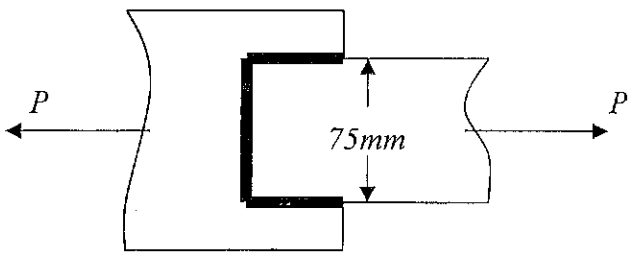


Figure.Q6

Question 7

The collet chuck in Figure.Q7 is operated by turning the hand wheel to draw the collet into the conical seat in the headstock. This tightness of four-piece collet against the work piece when clamped, is perfect.

Assume the following data;

Coefficient of friction between collet and conical seat = 0.20
Coefficient of friction at collar = 0.15
Coefficient of tread friction = 0.10
Effective radius of collar = 19 *mm*
Tread, 60^0 – V type, 25 mm outside diameter, 21 *mm* root diameter, and 16 tread per 25 *mm*.

If each collet piece is to exert a force of 450 *N* against the work piece, what torque is required on the hand wheel.

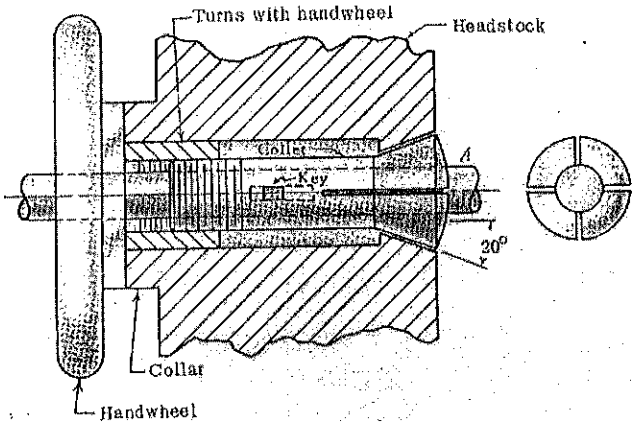
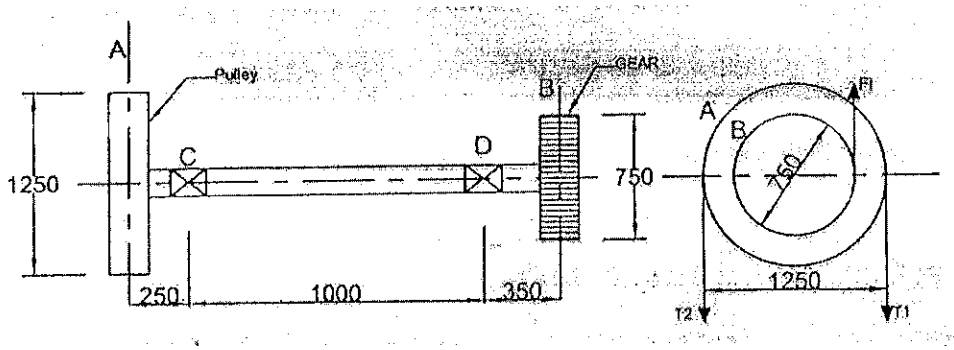


Figure.Q7

Question 8

Figure.Q8 shows a shaft which is used to transmit power. It consists of a pulley **A** and a gear **B** and is supported by two bearings at **C** and **D**. The pulley delivers power through a belt to another pulley of equal diameter vertically below the pulley **A**. The tangential force F_t on the gear **B** acts vertically upward as shown.

The shaft transmits 20 *kW* at 150 *rev/min*. The ratio of belt tensions, T_1/T_2, is equal to 2.5. The gear and the pulley weigh 900 *N* and 2700 *N* respectively. The permissible shear stress for the material of the shaft may be taken as 63 MN/m^2. Assume the weight of the shaft is negligible. Determine the minimum shaft diameter suitable for this application.



All Dimensions in mm

Figure.Q8

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