The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honors in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX5277 / MEX4231 Machine Design [Paper I]**
Academic Year	:	2016
Date	:	November 28, 2016
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

a. *The profession of engineering takes the knowledge of mathematics and natural sciences gained through the study, experience and practice. They apply this knowledge with judgment to develop ways to utilize the materials and forces of the nature for the benefit of all humans.*

Assume the above statement is correct and justify the statement quoting appropriate examples.

b. i. Following list consists with eight steps of a design process and they are not in order. Arrange them in order to have a complete design process.

Identification of a need, Specification and detailing, Problem Definition, Communication, Constrains, Decision, Alternative solutions, Analysis.

ii. Consider an appropriate problem which you need to find solutions and discuss the activities you conduct at each stage of the proposed design process under part b/i.

Question 02

a. It is very much important to understand the problem before trying to find solution/solutions. Explain four (04) techniques which can be used to clarify the issues in order to understand the problem.

b. What is the importance of incorporating a 'safety factor' in engineering design? Also state the factors which needed to be considered when determining the safety factor for a design exercise.

c. *Ergonomic considerations cannot be forgotten in designing engineering artifacts.* What do you understand by Ergonomics within the context of engineering design?

Select an appropriate example of a modern artifact and explain that the designer has given due consideration to ergonomic factors.

Question 03

Write short notes on the following.
Note: you may use neat sketches where ever necessary.

a. Plastics replaced many metal parts in machine components. Discuss the advantages and disadvantages of using plastics in engineering applications.

b. L_{10}, L_{10h} and L_{10s} life of bearings and the correlation of each other.

c. Fatigue failures in engineering components. Also discuss how to evaluate the fatigue endurance limit of a material.

d. Residual stress and stress concentration factor.

PART B

Question 04

a. Briefly describes followings,
   i. Positive clutch
   ii. Friction clutch

b. Write down two differences between a clutch and a coupling.

c. A single plate clutch, effective on both sides, is required to transmit 25 *kW* at 3000 *rev/min*. Determine the outer and inner diameters of frictional surface if the coefficient of friction is 0.255, ratio of diameters is 1.25 and the maximum pressure is not to exceed 0.1 N/mm^2.
   Also, determine the axial trust to be provided by springs. Assume the theory of uniform wear.

Question 05

Figure *Q*5 shows a rivet layout of an eccentrically loaded lap joint. The bracket plate is to be 25*mm* thick and all rivets are of the same size. The load on the bracket is 30*kN*. The spacing of the rivets and the eccentric load is as given in the figure. Determine the diameter of trivets if the allowable shear stress of the rivet material is 60 N/mm^2.

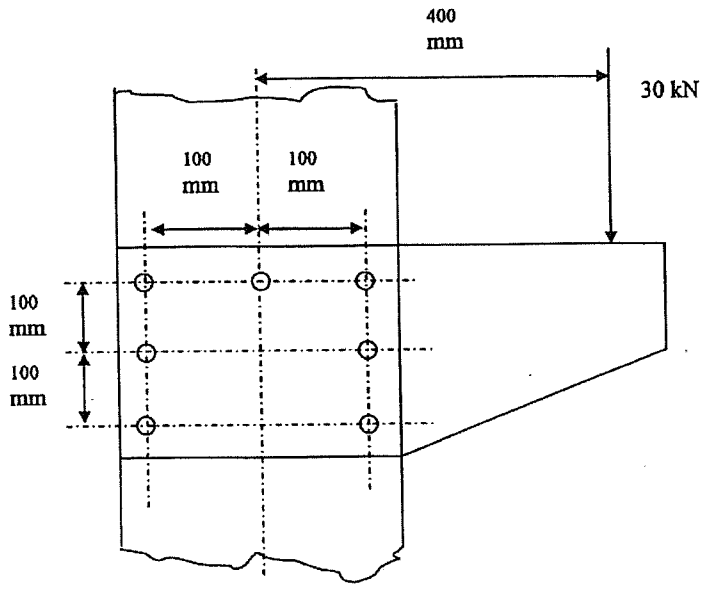


Figure *Q*5

Question 06

a. Show that the bending moment (M) of a shaft of diameter d subjected to a bending direct stress of σ, can be given by,

$$M = \frac{1}{32}\pi\, d^3\, \sigma$$

b.

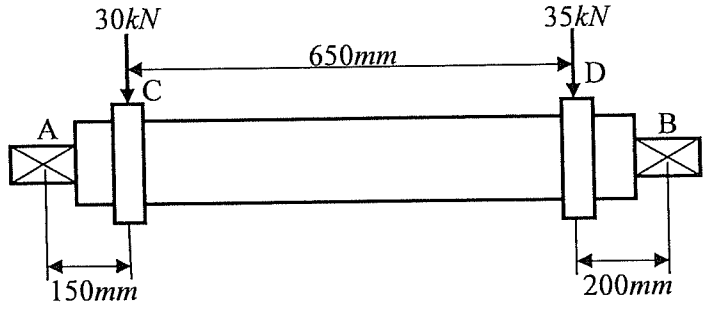


Figure.*Q*6

Rocking shaft of a pump lever is shown in the Figure.*Q*6. Find the minimum required diameter of the middle portion (between C and D) of the shaft, if the stress is not to exceed $100MN/m^2$. Loads of 30*kN* and 35*kN* acting at C and D respectively and the distances from the centres of the bearings located at A and B to the respective loads are given in the figure.

Question 07

a. Shaft couplings are used in joining two pieces of shafts. State three (03) requirements of good shaft couplings.

b. A Muff coupling is used to connect two shafts transmitting 40 *kW* at 350 *rpm*. The shaft and the key are made out of plain carbon steel where allowable shear and crushing stresses are 40 MN/m^2 and 80 MN/m^2 respectively. The muff is made with cast iron where the allowable shear stress is 15 MN/m^2. Design the muff coupling (Design should cover shaft, sleeve and key). Width and thickness of the appropriate key could be considered as 18*mm*.

Note: *If the diameter of the shaft is* **d** *the other related dimensions can be fixed empirically as;*

Outer diameter of the Sleeve, $D = 2\,\mathrm{d} + 13$ mm

Length of the Sleeve, $L = 3.5\,\mathrm{d}$

Question 08

a. Show that the torque required to lift a load by a screw and nut with square threads is given by,

$$T = W\frac{d}{2}\tan(\alpha+\phi)$$

Where,

T = Torque required to overcome friction between the screw and the nut

W= Load to be lifted vertically

a = Helix angle of the square thread and ϕ = Angle of friction

d = Mean diameter of the screw

b. A designer proposed a differential type screw jack using two right handed single start square screws, as shown in the Figure.Q8. Upper screw which supports the load has 16*mm* pitch and the lower screw which fixed to the base has 12*mm* pitch. In operation neither screw rotates. The outside screw diameter is 50mm and the Coefficient of thread friction is estimated to be 0.15.

i. What would be the efficiency of the screw jack?

ii. What load can be raised if the shear stress of the screws is limited to 28MN/m^2?

Note: *In square thread, Thread depth* $= \frac{1}{2}\cdot$ *Thread Pitch*

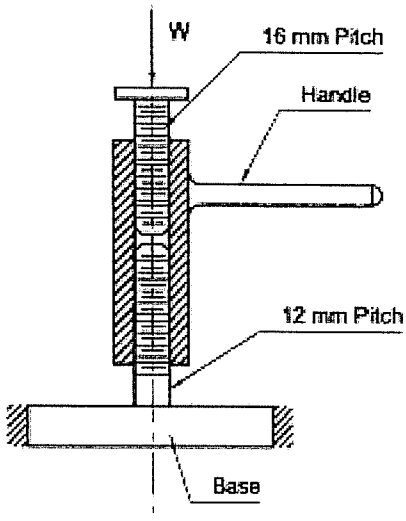


Figure.Q8

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