00038

The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX4231 Elementary Machine Design [Paper I]**
Academic Year	:	2012/13
Date	:	July 26, 2013
Time	:	1430 hrs. – 1830 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 professional designers say that the modern design is a group effort.*

Assuming the above statement is correct, select an appropriate engineering product and clearly state the different kind of specialized groups involved in designing and manufacturing of the product. You should also clearly state the key duties of each group.

b. Efficient communication is essential to carry out designing and manufacturing.
   i. Explain the need to have reliable communication methods in a modern manufacturing facility.
   ii. Briefly discuss the use of drawings in communicating and evaluating a design.

a. *Fatigue failures are critical and important in designing machine elements.*
   i. Explain why is it important to give due consideration to fatigue failures at the designing stage of machine elements.
   ii. State four (4) factors to be considered while designing to avoid fatigue failures.

b. Explain what endurance limit is, and state how do you find the endurance limit experimentally.

c. Explain the stress concentration on machine elements stating three (3) methods of reducing stress concentration.

Question 03

a. i. What is ergonomics?
   ii. State the importance of considering ergonomic factors in machine design.

b. The shafts of machine tools should be designed in such a way that the operational speeds are far away from shaft's natural frequency. Explain the consequences in not doing so.

c. Explain what is self-locking of screws.

d. Explain clearly the following parameters within the context of rolling element bearings.

   i. L_2 life.
   ii. Static Load Rating.
   iii. Equivalent Dynamic Load.

PART B

Question 04

a. Shaft couplings are used to join two or more pieces of shafts.
   i. State four (04) requirements of good shaft couplings.
   ii. Describe the applications of rigid type couplings and flexible type couplings, and give two (02) examples for each of rigid and flexible coupling types.

b. A shaft with a diameter of $45mm$ is made of steel having yield strength of $400MPa$. A parallel key of size $14mm$ wide and $9mm$ thick made of steel with yield strength of $340MPa$ is to be used to secure the torque transmission. If the shaft is loaded to transmit the maximum permissible torque, determine required length of the key. Use maximum shear stress theory for calculation and also assume a factor of safety of 2.

Question 05

The cantilevered shaft is subjected to vertical load of $3kN$ at C, an axial pulling force of $15kN$ and a pure torque of $1000Nm$ as shown in Figure.Q5. The diameter of the shaft is $50mm$ and the length is $250mm$. Calculate the maximum and minimum principle stresses and maximum shear stresses at points A and B.

The maximum and minimum principle stresses and maximum shear stress of a member subjected to direct stresses of σ_1 and σ_2 and shear stress of τ, is given respectively by,

$$\sigma_{max} = \frac{\sigma_1 + \sigma_2}{2} + \frac{1}{2}\sqrt{(\sigma_1 - \sigma_2) + 4\tau^2}\ ,\ \sigma_{min} = \frac{\sigma_1 + \sigma_2}{2} - \frac{1}{2}\sqrt{(\sigma_1 - \sigma_2) + 4\tau^2} \text{ and}$$

$$\tau_{max} = \frac{1}{2}\sqrt{(\sigma_1 - \sigma_2) + 4\tau^2}$$

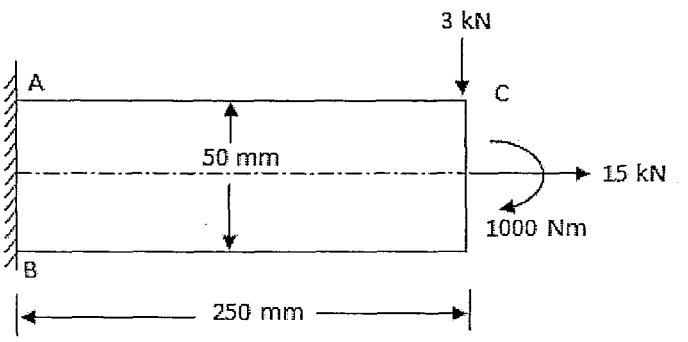

Figure.Q5

Question 06

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 nut
W = Load to be lifted vertically
a = Helix angle of the square thread
ϕ = Angle of friction
d = Mean diameter of the screw

b. A square threaded screw of $55mm$ external diameter and $10mm$ pitch is used to pull the cutter of a broaching machine. The operating nut takes the axial load of $400N$ on the top flat surface of the nut with $60mm$ and $90mm$ internal and external diameters respectively. If the coefficient of friction is 0.15 for all contact surfaces of the nut, determine;

i. The power required to rotate the operating nut when the cutting speed is 6m/min.
ii. The efficiency of the screw.

Question 07

Figure.Q7 shows a band break which consists of a straight arm 750*mm* long pivoted at *O*. The arm *OC* is placed perpendicular to the vertical centre line going through *D*. The break band has a contact of 270°, where one end of the band is fastened to the fixed pin *O* and the other end is fixed to break arm at *B*, 125*mm* away from pin *O*. Diameter of the drum is 600*mm* and which is running at 200*rpm*. The coefficient of friction is 0.25.

a. Calculate the minimum pulling force (*P*) necessary on the end of the break arm to stop the wheel if 35*kW* is to be absorbed. Clearly state the direction of the pull.

b. If the thickness of the band is 2.5*mm*, calculate the required width of the band, if the maximum tensile stress is 50*MPa*.

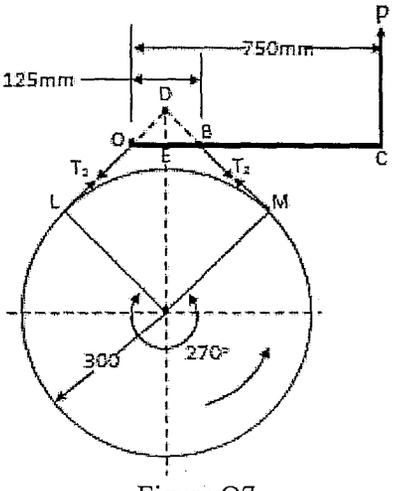

Figure.Q7

Question 08

A pair of straight teeth spur gears is to transmit 20*kW* when the pinion rotates at 300*rpm*. The pinion has 15 teeth and its face width is 14 times the module. Pinion and the gear has a velocity ratio of 1:3. The allowable static stresses for the pinion and the gear materials are 120*MPa* and 100*MPa* respectively.
Determine,

a. The module of the gear wheel (*Note: if you obtain a third degree equation of module, use trial and error method to solve*).
b. Face width
c. Pitch circle diameters of the pinion and the gear from the standpoint of strength only, taking into consideration the effect of the dynamic loading.

Use the following equations for calculations;

The tooth form factor (y): $y = 0.154 - \frac{0.912}{\text{No. of teeth}}$

The velocity factor (C_v): $C_v = \frac{3}{3+v}$, *where v is expressed in m/s and service factor* (Cs)=*1*

Beam strength of the tooth: $W_T = S\, C_v\, b\, \pi\, m\, y$

Where, S- *allowable stress,* b-*face width,* m- *module and* y- *tooth form factor.*