

**THE OPEN UNIVERSITY OF SRI LANKA****FACULTY OF ENGINEERING TECHNOLOGY****BACHELOR OF TECHNOLOGY – LEVEL 04****FINAL EXAMINATION – 2011/2012****MEX4231 – ELEMENTARY MACHINE DESIGN – PAPER I****DATE : FEBRUARY 24, 2012****TIME : 1430 HRS. – 1630 HRS.****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, but **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 box on the front page by writing the question numbers for which you have already answered.
6. Data books, design catalogs or any type of additional information will not be provided with this paper.
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 labeled.

**PART A****Question 01**

Write a short note on fatigue failures of engineering components.

*Note: Your answer should clearly explain;*

- *the importance of investigating fatigue failures of engineering materials,*
- *causes of fatigue failures,*
- *fatigue failure initiation,*
- *world famous accidents, where fatigue mechanism was responsible for causing failure of the material of engineering components (provide sufficient evidence).*

Also clearly explain how to evaluate the fatigue endurance limit of a material.

**Question 02**

- a. How do you identify /define a society?  
'Technology can change the society'. Do you agree or disagree? Clearly explain your opinion using relevant examples.
- b. Consider a latest engineering product development and explain the factors that the designer of the product has considered in aspects of environment, ergonomics, sustainability and economics during the design process and product's life cycle.

**Question 03**

- a. What are the basic considerations when selecting a bearing for a given application?
- b. Identify two practical applications where each of the following rolling element bearings is in use.
  - i. Cylindrical roller bearings.
  - ii. Spherical roller bearings.
- b. Explain clearly the following parameters within the context of rolling element bearings.
  - i.  $L_{10}$  life.
  - ii. Static Load Rating.
  - iii. Equivalent Dynamic Load.

**PART B****Question 04**

Sketch the view/s to illustrate the design features of a standard cotter joint.

List and illustrate all stresses induced in the cotter joint when a tensile load is applied on it.

**Question 05.**

- a. What is preloading of a bolt?
- b. For a screw and nut with square threads, show that torque required to lift a load is given by,

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

Where,

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

$W$  = Load to be lifted vertically

$\alpha$  = Helix angle of the square thread

$\phi$  = Angle of friction

$d$  = Mean diameter of the screw

- c. A power screw driven by an electric motor moves a nut in a horizontal plane against a force of 75 kN at a speed of 300 mm/min. The screw has a single square thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at screw threads is 0.1. Find the power of the motor.

**Question 06**

- a. Briefly describes following:
  - 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 3,000 rev/min. Determine the outer and inner diameters of frictional surface if the coefficient of friction is 0.25, ratio of diameters is 1.25 and the maximum pressure is not to exceed 0.1 N/mm<sup>2</sup>.  
Also, determine the axial thrust to be provided by springs. Assume the condition of uniform wear.

**Question 07**

Find the width of a leather belt to drive a motor of 20 kW at 2,250 rev/min and fitted with a pulley 200 mm diameter. Density of different belt materials is given in Table.Q7.

Material of belt	Mass density in $kg/m^3$
Leather	1,000
Rubber	1,140
Single woven belt	1,170
Double woven belt	1,250

Table.Q7

Following information are also provided,

Motor efficiency = 85%

Allowable stress for belt = 2.1 MPa

Angle of contact for motor pulley =  $165^\circ$

Coefficient of friction between belt and pulley = 0.3

Thickness of the belt = 10 mm

**Question 08**

- a. A mild steel rod of 12 mm diameter was tested for tensile strength with the gauge length of 60 mm. Following observations were recorded.

Final length = 80 mm

Final diameter = 7 mm

Yield load = 3.4 kN

Ultimate load = 6.1 kN

Calculate the,

- i. Yield stress
  - ii. Ultimate tensile stress
  - iii. Percentage reduction in area
  - iv. Percentage elongation
- b. A shaft is transmitting 100 kW at 160 rev/min. Find a suitable diameter for the shaft, if the maximum torque transmitted exceeds the mean value by 25%. Take maximum allowable shear stress for shaft material as 70 MPa.

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