The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX5277 / MEX4231 Machine Design [Paper I]**
Academic Year	:	2014/15
Date	:	September 05, 2015
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 the following in the context of Fatigue failures of engineering components. *Note: you may use equations and neat sketches where ever necessary.*

i. Explain what **fatigue endurance limit** is, and also how to assess the Fatigue endurance limit of a material experimentally.

ii. Explain the **mean stress effect** on fatigue performance of a component. Also explain how to incorporate the mean stress in fatigue designing.

iii. **Residual stresses** and **stress concentrations** are two important aspects in machine design specially when evaluating the fatigue performance. Explain what you understand by residual stresses and stress concentrations and also discuss how do you take residual stresses and stress concentrations into consideration in designing components under dynamic loading.

Question 02

a. Engineering product development and design is a challenging tasks faced by modern engineers. Explain such challenges and briefly discuss how to overcome the mentioned challenges.

b. *New designs/artifacts as a result of advancement of technology do not always uplift the social standards, but destroy the society.*
Justify the above statement using suitable examples of such designs/artifacts.

Question 03

a. Write answers to the following which are related to fastening devices.

   i. Illustrate the various ways in which a riveted joint may fail.

   ii. Illustrate an axially loaded unsymmetrical welded joint and explain the procedure of designing such a joint.

   iii. List advantages and disadvantages of the screwed joints.

b. Explain as to why the designer should specify an optimum surface finish in a design. *Note: You may quote appropriate examples to justify your answer.*

PART B

Question 04

A shaft is supported on bearings A and B as shown in the Figure $Q4$. The spur gear (C) located $200mm$ to the right of bearing A has 20^0 straight tooth and $600mm$ pitch diameter. Pulley (D) with a diameter of $700mm$ is mounted $250mm$ to the left of bearing B. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180^0 wrap angle. The pulley weights $2000N$ and also serves as a flywheel. The maximum tension of the belt is $3000N$ and the tension ratio is 3:1. The allowable shear stress of the shaft material is $40MN/m^2$.

Determine,

i. maximum bending moment acting on the shaft
ii. minimum diameter of the shaft

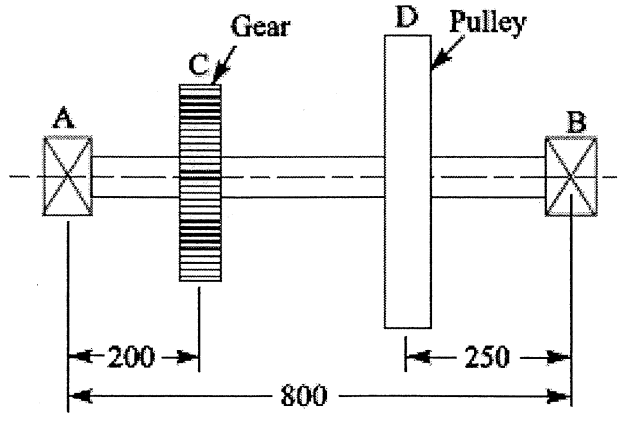

Figure $Q4$

Question 05

a. Show that the bending moment (M) of a shaft of diameter d can be expressed as,

$$M = \frac{1}{32}\pi d^3 \sigma$$, where σ is maximum direct stress.

b. Show that the Torque (T) of a shaft of diameter d subjected to torsion can be expressed as,

$$T = \frac{1}{32}\pi d^3 \tau$$, where τ is maximum shear stress.

c. Figure $Q5$ shows an overhang crank with pin and shaft. Diameter of the crank is $80mm$. A tangential load (W) of $15kN$ acts on the crank pin. The crank shaft axis and crank pin axis is situated $140mm$ apart. The centre of the crank shaft bearing is at $120mm$ to the point which the load applies.
Determine the,
   i. maximum principal stress,
   ii. maximum shear stress, at the centre of the crank shaft bearing.

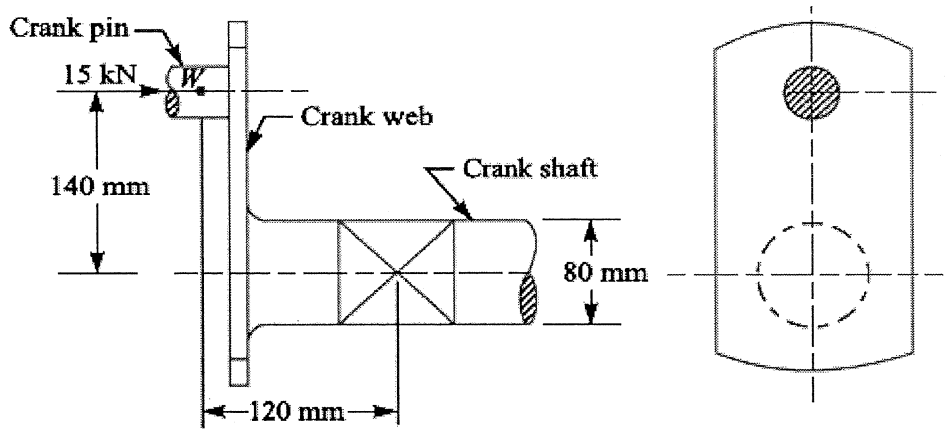

Figure $Q5$

Question 06

A helical gear made out of cast iron has to transmit $35kW$ at $1500rpm$. The gear has 24 teeth and a helix angle of 30^o. The allowable static stresses for the cast iron is 56 MN/m^2. The face width may be taken as 3 times the normal pitch.

Determine,

i. The module of the gear (*Note: if you obtain a third degree equation of module, use trial and error method to solve*).
ii. Face width
iii. Pitch circle diameters
iv. End thrust on the gear.

Use the following equations for calculations;

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

The velocity factor (C_v): $C_v = \frac{15}{15+v}$, *where v is expressed in m/s*

Tangential tooth load: $W_T = S\, C_v\, b\, \pi\, m\, y$

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

Question 07

A motor is directly coupled to a gear box by means of a flange coupling. Both shafts, with a diameter (d) $35mm$, which connect the motor and gear box, are made of steel having allowable stress of $63MN/m^2$. The flanges are fitted with 6 bolts on $125mm$ bolt circle. Safe stress for bolt material is $56MN/m^2$. The shaft transmits a toque of $800Nm$ at $350rpm$. The coupling is made out of cast iron with a shear stress of $10MN/m^2$. The safe stress for key material is $46MN/m^2$.

Determine,

i. diameter of bolts.
ii. thickness of flanges
iii. length of the key
iv. length of the hub

Given that,
Outer diameter of the hub = 2 d
Length of the hub = 1.5 d
*Width and Thickness of the key are 12*mm *and 8*mm *respectively*

Question 08

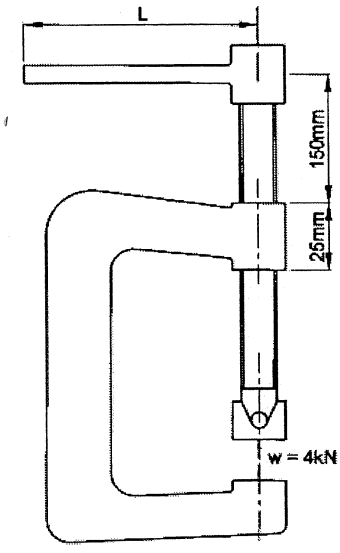

Figure $Q8$

Figure $Q8$ shows a C–clamp, which has square threads with $12mm$ outside diameter and $2mm$ pitch. The coefficient of friction for collar and the screw thread are 0.12 and 0.25 respectively and the collar has a mean radius of $7mm$. The load on the jaws is $4kN$. If the force exerted by the operator at the end of the handle is $90N$, determine,

a. The length of the handle.
b. The magnitude and the location of the maximum shear stress in the body of the screw.
   Note: to find the location, consider two sections just below the nut and just above the nut
c. The bearing pressure on the threads.