THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA OF TECHNOLOGY – LEVEL 04
FINAL EXAMINATION – 2005

MEX4231/MED2202 – ELEMENTARY MACHINE DESIGN – PAPER I

DATE : MARCH 11, 2006
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 Two (02)*** *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. *Some questions require design data. They are provided to you separately. Do not write anything on these data books.*
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.*
9. *Use the charts, catalogues, data sheets and tables available and return them to the supervisor at the end of the examination.*

PART A

Question 01

a) What are the factors, which influence the designer in deciding a value for a safety factor?

b) Illustrate the difference between "Single riveted double strap butt joint" and "Double riveted lap joint"

c) With a suitable sketch state the meaning of circular pitch, addendum, dedendum, face width, working depth and pressure angle with reference to spur gears.

Question 02

a) Why are tolerances specified in designing machine parts?

b) Using a neatly drawn sketch and assuming a basic size explain:

1. Maximum limit of size
2. Minimum limit of size
3. Tolerance zone

c) Cold drawn shafts up to $\pm 0.01\ mm$ tolerance are available, and an interference fit is to be designed for a 50 mm nominal size of hole. Determine the tolerances for hole and shaft if maximum and minimum interferences are to be 0.001 mm and 0.07 mm respectively. Assume basic shaft system.

Question 03

a) Design of a product/machine/component needs consideration of several requirements. What are the major requirements that a designer should consider in design process?

b) Discuss the changes in the traditional design process with the introduction of computer-aided design.

c) Explain the primary steps that you consider when selecting rolling element bearings to support a power transmission shaft.

PART B

Question 04

A beam with 15 mm x 200 mm section is cantilevered to a 250 mm steel channel using four bolts as shown in the Figure Q4. Based on the external load of 16 kN applied at the free end of the cantilever beam, determine the following:

a) The resultant load on each bolt.

b) The maximum bolt shear stress.

c) The maximum bearing stress.

d) The critical bending stress in the beam.

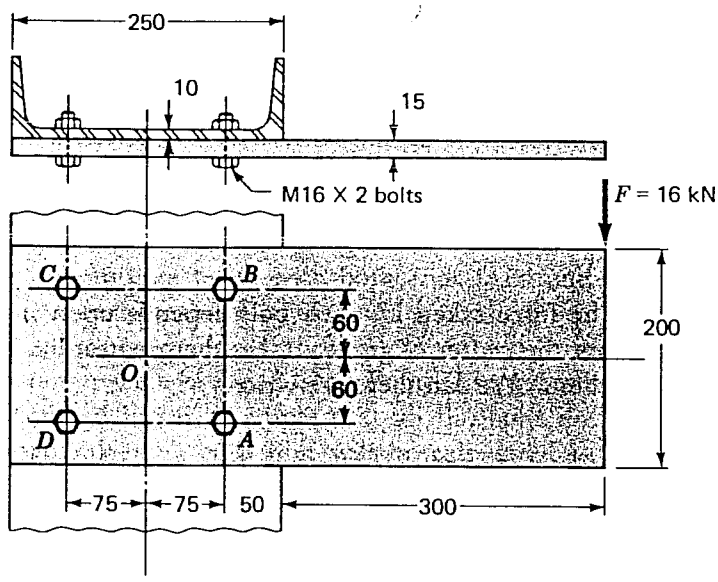

Figure Q-4

Question 05

A flat belt drive is used to transmit power between two horizontal parallel shafts. The angle of lap of the small pulley is 165 degrees. The cross section and density of the belt are 300mm^2 and 1400 kg/m^3 respectively. Maximum allowable strength of the belt material is $1.8N/mm^2$. Coefficient of friction between pulley and belt is 0.25. The initial tension of the belt has been adjusted to 425 N. Find the maximum power transmission possible from the above belt drive.

Question 06

State five (05) advantages and three (03) disadvantages of welded joints over riveted joints.

FigureQ-6 shows the front and end elevations of a welded joint, where an angle is welded to a flange. Both materials are steel. The dimensions of the angle are $200\times150\times10mm$ and it is subjected to an axial load of 200 kN as shown in the figure. The allowable shear stress for the welding material is $75N/mm^2$. Determine the two weld lengths a and b, if the two lengths are such that the sum of the resisting moments of the weld about the gravity axis is zero.

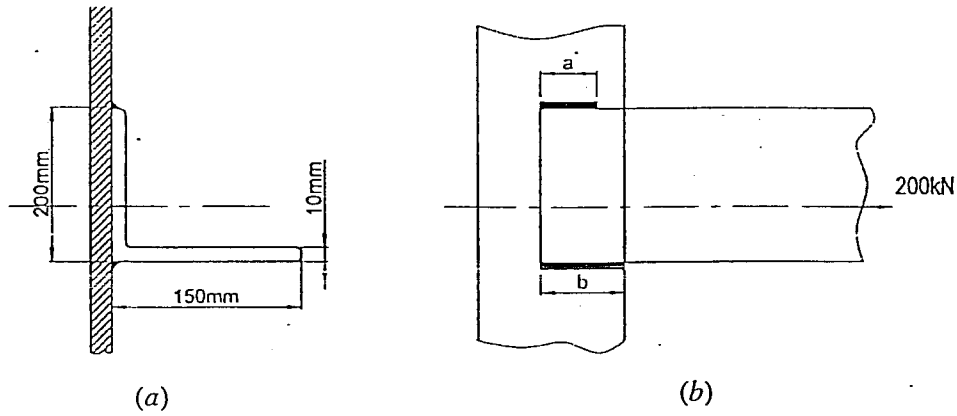

Figure Q-6

Question 07

Figure Q-7 illustrates a double reduction gear train. Shaft A is driven by a 1.5 kW power source at 1,720 rev/min. The speed reduction between shaft A and B is 3.5:1 and that between shafts B and C is 4:1. The pinion wheel on shaft A has 24 teeth and the gear wheel on shaft C has 160 teeth.

a) Find the tooth numbers for the gears on shaft B.

b) Find the speeds of shafts B and C.

c) If the power loss at each mesh is 4%, find the torque on each shaft.

d) Using the following information design the pair of gears involved in the second reduction stage, and check the pair you have designed for the dynamic wear loads stating whether the gears are safe.

All pinion wheels of the gear train are to be made of forged steel ($S_o = 100MPa$) and the gear wheels are of semi-steel $(S_o = 60MPa)$. The pairs are 20 degree full depth involute and are to be carefully cut. C factor for dynamic loading is 160 kNm, and the K factor for wear is $1100kN/mm^2$. E $(Young's\ \ Modulus) = 21N/mm^2$.

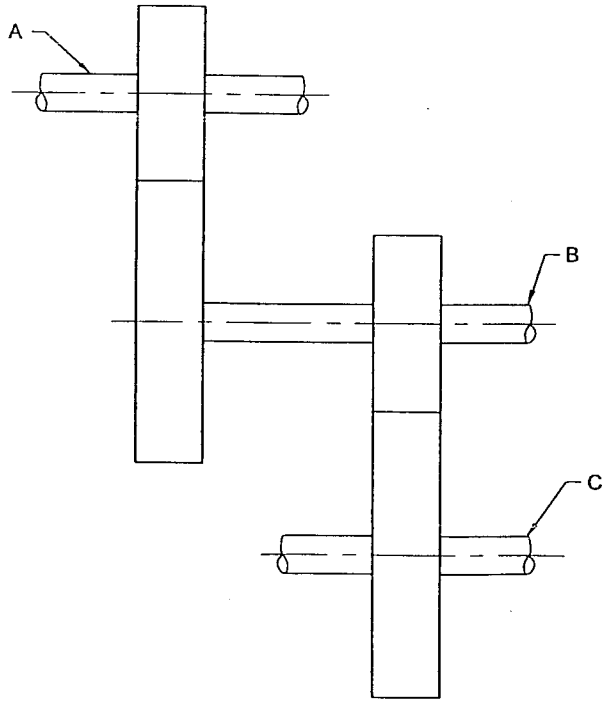

Figure Q-7

Question 08

a) For a Acme thread show that screwing-up torque (T_{su}) is given by,

$$T = W\frac{d}{2}\left[\frac{\tan\alpha + \mu\tan\beta}{1-\mu\sec\beta\tan\alpha} + \frac{\mu d_m}{d}\right]$$

where W - Axial load on the screw
d - Pitch diameter of the screw
α -Helix angle
μ -Friction coefficient for both threads and thrust collar
d_m -Mean diameter of nut or thrust collar
β - Angle of Acme thread

b) Determine the maximum wrench torque that can be applied in tightening a bolt having acme threads of normal series 30mm major diameter, 19.58mm minor diameter, area of core 301 mm^2, pitch 6 mm and acme angle of thread 30 degrees. Thread and collar friction may be taken as 0.15. The maximum shear stress in the bolt should not exceed $140N/mm^2$.