

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

**DEPARTMENT OF INDUSTRIAL AND MANUFACTURING
ENGINEERING**

**BACHELOR OF ENGINEERING (HONOURS) DEGREE IN INDUSTRIAL AND
MANUFACTURING ENGINEERING**

1ST SEMESTER EXAMINATION - DECEMBER 2011

ENGINEERING DESIGN APPLICATIONS I COURSE CODE TIE 2107

EXAMINATION DURATION 3 HOURS

INSTRUCTIONS TO CANDIDATE

Answer any FIVE questions

All questions carry equal marks (20 marks each)

QUESTION 1

- (a) Explain your understanding of Factor of Safety as applied to design [10]
(b) Discuss any five factors considered when carrying out engineering design [10]

QUESTION 2

- (a) A solid steel shaft is to transmit 20kW at 200 r.p.m. Given that the ultimate shear stress for the steel is 360MPa, with a factor of safety of 8, find the required shaft diameter. [14]
(b) If a hollow shaft is to be used in place of the solid shaft in (a), find the inside and outside diameters when the ratio of the inside and outside diameters 0.5 [6]

QUESTION 3

A solid shaft is subjected to a bending moment of 3000Nm and a torque of 10kNm. The shaft is made of steel having ultimate tensile stress of 700MPa and ultimate shear stress of 500MPa. Assuming a factor of safety of 6, determine the diameter of the shaft [20]

QUESTION 4

Derive the expression for the torque required to lower a load using a square-threaded power screw. Explain how you would determine the efficiency of the screw. [20]

QUESTION 5

- (a) A triple threaded worm has teeth of 6mm module and pitch circle diameter of 50mm. If the worm gear has 30 teeth of $14\frac{1}{2}^\circ$ and the coefficient of friction of the worm gearing is 0.05, find
- The lead angle of the worm [3]
 - Velocity ratio [2]
 - Centre distance [2]
 - The efficiency of the worm gearing [3]
- (b) A worm drive transmits 15kW at 2000 r.p.m. to a machine carriage at 75 r.p.m. The worm is triple threaded and has 65mm pitch diameter. The worm gear has 90 teeth of 6mm module. The tooth form is to be 20° full depth involute. The coefficient of friction between the mating teeth may be taken as 0.1. Calculate
- The tangential force acting on the worm [4]
 - Axial thrust and separating force on the worm [6]

QUESTION 6

A pair of mating spur gears has $14\frac{1}{2}^\circ$ full depth teeth of module 10mm. The pitch diameter of the smaller gear is 160mm. If the transmission ratio is 3 to 2, calculate:

- a) number of teeth of each gear [4]
- b) addendum [2]
- c) whole depth [3]
- d) clearance [3]
- e) outside diameters [2]
- f) root diameters [3]
- g) base circle diameters [3]

QUESTION 7

- (a) What are the advantages of V-belts over flat belts? [6]
- (b) A belt drive consists of two V-belts in parallel, on grooved pulleys of the same size. The angle of the groove is 30° . The cross-sectional area of each belt is 750mm^2 and coefficient of friction is 0.12. The density of the belt material is 1200kg/m^3 and the maximum safe stress for the belt material is 7MPa. Calculate the power that can be transmitted between pulleys of 300mm diameter rotating at 1500 r.p.m. [14]

End of Examination