NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF COMMERCE

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

BACHELOR OF ENGINEERING (HONS) DEGREE INDUSTRIAL AND MANUFACTURING ENGINEERING

ENGINEERING DESIGN PRINCIPLES

TIE 2107

First Semester Main Examination Paper

December 2014

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

INSTRUCTIONS

1. Answer any five (5) questions
2. Each question carries 20 marks
3. This paper contains seven (7) questions

MARK ALLOCATION

QUESTION	**MARKS**
1.	**20**
2.	**20**
3.	**20**
4.	**20**
5.	**20**
6	**20**
7	**20**
TOTAL	**100**

Question 1

(a) State the purpose of the following machine components:

(i) Coupling [2]

(ii) Key [2]

(b) Write down a problem statement for a design of your choice. [2]

(c) Discuss the activities carried out during:

(i) Literature review [3]

(ii) Conceptualisation [4]

(iii) Project evaluation [4]

(d) What is factor of safety in design? [3]

Question 2

A steel shaft transmits 20 kW at 200 r.p.m. It carries a central load of 900 N and is simply supported between the bearings which are 2.5 m apart. Determine the size of the shaft if the allowable shear stress is 42 MPa and the maximum tensile or compressive stress is limited to 56 MPa. [20]

Question 3

A double square threaded power screw is to support a load of 60 kN. The power screw has a major diameter of 36 mm and a pitch of 6 mm. coefficient of friction, μ, may be as low as 0.1 and as high as 0.15.

(a) Will this screw always be self-locking? [6]

(b) If a single thread is used, will this screw always be self-locking? [4]

(c) What torque is necessary to raise the load when μ is 0.15? [5]

(d) If coefficient of friction is equal to the tangent of the lead angle, show that efficiency of the screw is always less than 50%. [5]

Question 4

A crossed belt is to transmit 7.5 kW at 1000 r.p.m of the smaller pulley. The smaller pulley has a diameter of 250 mm; the velocity ratio is 2; and centre distance is 1.25 m. A flat belt 6 mm thick with an expected coefficient of friction 0.3 is to be used. If the maximum allowable stress in the belt is 1.7 MPa, determine the belt width. The density of leather may be taken as 970 kg/m^3.

[20]

Question 5

(a) Derive the condition necessary to avoid interference in spur gearing. [12]

(b) A pair of mating spur gears has $14\frac{1}{2}^{o}$ full depth teeth of module 10. The pitch diameter of the smaller gear is 160 mm. If the transmission ratio is 1.5, calculate:

(i) The outside diameters [5]

(ii) The base circle diameters [3]

Question 6

(a) State the basic difference between helical and spur gears. [2]

(b) With aid of neat sketches, derive the relationship between the cone length and gear radii for a bevel gear. [5]

(c) A pair of bevel gears connects two shafts at right angles and transmits 2.75 kW. The pinion rotates at 1200 r.p.m and has 21 teeth. Given that the allowable static stress for the pinion and gear material is 85 MPa and 55 MPa respectively, calculate the torque on the weaker element for a velocity ratio of 3. The tooth form factor may be taken as $y = 0.124 - \frac{0.684}{T_f}$

[13]

Question 7

(a) A worm gear has 52 teeth and a diametral pitch of 6. It mates with a triple-threaded worm that rotates at 1750 r.p.m. The pitch diameter of the worm is 50 mm. Compute:

(i) The circular pitch [2]

(ii) The axial pitch [2]

(iii)The lead [2]

(iv)The pitch diameter of the worm gear [3]

(v) The rotational speed of the worm gear [2]

(b) A triple threaded worm of pitch 65 mm transmits 15 kW at 2000 r.p.m to a machine carriage at 75 r.p.m. The worm gear has 90 teeth of module 6. The tooth form is to be 20^{o} full depth involute. The coefficient of friction between the mating teeth may be taken as 0.1. Calculate:

(i) The tangential force acting on the worm [5]

(ii) The axial thrust on the worm [4]

End of Examination Paper