ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA

DEPARTMENT OF
MECHANICAL, AUTOMOTIVE AND PRODUCTION ENGINEERING

SECOND SEMESTER EXAMINATIONS

2016/2017 ACADEMIC SESSION

HOD'S SIGNATURE

COURSE: MEE 312- Mechanical Engineering Design I (3 Units)

CLASS: 300 Level Mechanical Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer ANY FIVE questions of your choice

Date: July/August, 2017

Question 1

(a) (i) What is the application of countersunk rivet head?

(ii) What is the difference between the minor diameter and pitch diameter of a screw thread?

(iii) List three types of screw threads.

(b) A triple riveted lap joint is made between two 15 mm thick plates. The rivet diameter and pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension, 300 MPa in shear and 600 MPa in crushing, find the minimum force per pitch which will rupture the joint. If the above joint is subjected to a load such that the factor of safety is 6, find the actual stresses developed in the plates and the rivets. Find the efficiency.

Question 2

(a) Design the rectangular key for a shaft of 50 mm diameter. The shearing and crushing stresses for the key material are 42 MPa and 70 MPa.

(b) (i) Two shafts are connected by means of a flange coupling to transmit torque of 35 N/m. The flanges of the coupling are fastened by four bolts of the same material at a radius of 30 mm. Find the size of the bolts if the allowable shear stress for the bolt material is 45 MPa.

(ii) What is the major difference between keys and splines?

(iii) List the types of shaft with examples.

Question 3

(a) A solid circular shaft is subjected to a bending moment of 3000 Nm and a torque of 10,000 Nm. The shaft is made of 45 C 8 steel having ultimate tensile stress of 700 MPa and an ultimate shear stress of 500 MPa. Assuming a factor of safety as 5, determine the diameter of the shaft. (equivalent twisting moment $T_e = \sqrt{M^2 + T^2}$, equivalent bending moment $M_e = \frac{1}{2}(M + \sqrt{M^2 + T^2})$

(b)(i) Derive the equivalent bending moment equation for hollow shaft subjected to combined bending and twisting moments. (Put your final answer in terms of k)

(ii) List three types of lubricants.

(iii) What is a journal?

Question 4

(a) Calculate the heat generated and dissipated by a journal bearing for a centrifugal pump from the following data: Load on the journal = 25,000 N; Speed of the journal = 900 rpm; type of oil is SAE 20, for which the absolute viscosity at 65°C = 0.019 kg/ms; Ambient temperature of oil = 15.5°C; Maximum bearing pressure for the pump = 1.6 N/mm^2. (Assume Heat dissipation coefficient = 1233 W/m2/°C, journal diameter (d) is 100 mm, l/d for centrifugal pump is 1.5, standard ZN/p = 28, the clearance ratio (c/d) = 0.0013, k = 0.002, the minimum value of the bearing modulus at which the oil film will break should be taken as $3K = \frac{Z.N}{p}$,

Coefficient of friction $\mu = \frac{33}{10^8}\left(\frac{ZN}{p}\right)\left(\frac{d}{c}\right) + k)$

(b)(i) List two types of belts.

(ii) List three materials used for belts.

Question 5

(a)(i) List the procedures in the design of a cast iron pulley.

(ii) List five types of flat belt pulleys.

(b) A compressor, requiring 80 kW, is to run at about 350 rpm. The drive is by V-belts from an electric motor running at 750 rpm. The diameter of the pulley on the compressor shaft must not be greater than 2 metres while the centre distance between the pulleys is limited to 1.75metre. The belt speed should not exceed 1500 m/min. Determine the number of V-belts required to transmit the power if each belt has a cross-sectional area of 350 mm2, density 1000 kg/m3 and an allowable tensile stress of 2.5 MPa. The groove angle of the pulleys is 35°. The coefficient of friction between the belt and the pulley is 0.15. Calculate also the length required of each belt. $(2.3 \log\left(\frac{T_1}{T_2}\right) = \mu.\theta cosec\beta)$

Question 6

An overhung pulley transmits 35 kW at 240 rpm. The belt drive is vertical and the angle of wrap may be taken as 180°. The distance of the pulley centre line from the nearest bearing is 350 mm. $\mu = 0.25$.

Determine:

(a) Diameter of the pulley.

(b) Width of the belt, assuming thickness of 10 mm.

(c) Diameter of the shaft.

(d) Dimensions of the key for securing the pulley on to the shaft.

The following stresses may be taken for design purposes: Shaft Tension and compression is 80 MPa, Key Shear is 50 MPa, Belt Tension is 2.5 MPa, Pulley rim Tension is 4.5 MPa and pulley arm's tension is 15 MPa. (Density of the pulley material, cast iron should be taken as 7200 kg/m^3, section modulus $Z = \frac{\pi}{32} \times b_1(a_1)^2$, Width of key should be taken as 20 mm and Thickness of key should be taken as 12 mm)

Question 7

(a)(i) List any four advantages of advantages of gears over chains and belts.

(ii) List the two forms of gear teeth.

(iii) List the four systems of gear teeth.

(b) A bronze spur pinion rotating at 500 rpm drives a cast iron spur gear at a transmission ratio of 5:1. The allowable static stresses for the bronze pinion and cast iron gear are 85 MPa and 115 MPa, respectively. The pinion has 16 standard 20° stub system involute teeth of module 8 mm. The face width of both the gears is 80 mm. Find the power that can be transmitted from the standpoint of strength. ($y = 0.175 - \frac{0.841}{T}$ for 20^o stub system, $C_v = \frac{3}{3+v}$ when v is less than 12.5 m/s, tangential load on the tooth $W_T = (\sigma_{OP}. C_V). b. \pi. m. y$)