LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO
FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
2020/2021 HAMARTTAN SEMESTER EXAMINATION

COURSE TITLE: MACHINE DESIGN I
COURSE CODE: MEE 323 COURSE UNIT: 3
TIME ALLOWED: 2½ HOURS
INSTRUCTION: ATTEMPT ANY FIVE QUESTIONS

Question one

a. What do you understand by (i) adaptive design (ii) development design and (iii) new design? [6 marks]

b. When new machines or their elements are to be designed, no rigid rules can be specified for a designer to follow. The problem on hand can be solved in many ways. However, a designer may proceed following some basic steps. Identify these basic steps. [8 Marks]

Question two

a. What are the factors to be considered in the selection of materials for helical springs? [4 marks]

b. Find the maximum shear stress and deflection induced in a helical spring of the following specifications if it has to absorb 1000 Nm of energy. Mean diameter = 100 mm; diameter of steel wire used for making spring = 20 mm; number of coils = 30; Modulus of rigidity for steel is 85kN/mm^2. [10 marks]

Question three

a. When shafts are subjected to combined twisting and bending moments, two theories are usually applied. Highlight these theories and state their mathematical expressions. [4 marks]

b. Find the diameter of a solid steel shaft to transmit 20 kW at 200 r.p.m. The ultimate shear stress for the steel material is 360 MPa. Take the factor of safety for the design to be 8. If a hollow shaft is to be used in place of the solid shaft, find the inside and outside diameter of the hollow shaft when the ratio of inside to outside diameter is 0.5. [10 marks]

Question four

a. Identify five advantages offered by screwed joints. [5 marks]

b. What is the main disadvantage associated with the use of screwed joints? [2 Marks]

c. Show that the torsional shear stress caused by the frictional resistance of the threads during the tightening of a bolt is given by: [3 Marks]

$$\tau = \frac{16T}{\pi(d_c)^3}$$

Where τ = torsional shear stress, T = torque applied, and d_c = thread core diameter

d. Two shafts are connected by means of a flange coupling to transmit torque of 25 Nm. The flanges of the coupling are fastened by four bolts of the same material at a radius of 30 mm. Find the sizeof the bolts if the allowable shear stress for the bolt material is 30 MPa [Table Q4 is given for your use] [4 Marks].

Question five

a. What are the factors used for the classification of bearings? [3 marks]

b. As a new maintenance engineer in LAUTECH Botanical Garden, your attention has been drawn to the undue noise and frequent failure of the bearings used for the children's swing in the garden. Your responsibility is to select another set of bearings to prevent future occurrences of the failure. How will you go about it? [7 marks]

c. Determine the static capacity of a single row deep groove ball bearings series 208 with 9 balls having a diameter of 12 mm. Stribeck's equation constant, $K = 60.8 \times 10^6$. [4 marks]

Question six

a. Discuss briefly, the effect of keyways on shafts [4 Marks]

b. A 45 mm diameter shaft is made of steel with a yield strength of 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with a yield strength of 340 MPa is to be used to secure a pulley on the shaft. Find the required length of the key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2. [Hint: Maximum shear stress theory states that $\tau_{max} = \frac{\sigma_{yt}}{2 \times F.S.}$, where τ_{max} = Maximum shear stress, σ_{yt} = yield strength &$F.S.$ = factor of safety, $\sigma_{ck} = \frac{\sigma_{yt}}{F.S.}$ σ_{ck} is the key crushing stress] [10 Marks]

Question seven

a. What are the basic requirements of a good shaft coupling? [5 Marks]

b. Design a muff coupling for the purpose of connecting two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses are 40 MPa and 80 MPa, respectively. The material for the muff is cast iron, whose allowable shear stress may be assumed as 15 MPa. [Table Q7 is given for your use]. [9 Marks]

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HARMATTAN SEMESTER EXAMINATION 2017/2018
MEE323: Machine Design I (3 Units)
Time Allowed: 2hours
Instruction: Answer 2 Questions from each Section

SECTION A

Question one

(a) What are the factors to be considered in the selection of a belt drive?

(b) State at least three factors that determine the amount of power transmitted in belt drives.

(c) Two pulleys, 450 mm and 200 mm diameters, on parallel shafts, 1.95 m apart are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley. What power can be transmitted by the belt when the larger pulley rotates at 200 rev/min, if the maximum permissible tension in the belt is 1 kN, and the coefficient of friction between the belt and pulleys is 0.25?

Question two

(a) State five applications of springs.

(b) Show that the deflection (δ) of a helical spring under an applied axial load is given by

$$\delta = \frac{8WC^3n}{Gd}$$

where W is the axial load, C is the spring index, n is the number of active coils, G is the modulus of rigidity for the spring material and d is the diameter of the spring wire.

(c) Find the maximum shear stress and deflection induced in a helical spring of the following specifications; if it has to absorb 1000 Nm of energy; mean diameter = 100 mm; Diameter of steel wire , used for making the spring = 20 mm; Number of coils = 30 mm; Modulus of rigidity for steel = 85 kN/mm^2.

Question three

(a) What are bearings?

(b) Show that the frictional torque acting on the rings of a pair of plate clutch, when uniform axial wear condition prevails is given by:

$$T = \frac{2}{3}\mu w (r_1 + r_2)$$

where r_1 and r_2 are external and internal radii of friction surfaces, μ is the coefficient of friction and W is the axial thrust with which the friction surfaces are held together.

(c) Determine the maximum, minimum and average pressure in a plate clutch when the axial force is 4 kN. The inner radius of contact surface is 50 mm and the outer radius is 100 mm. Assume uniform wear.

SECTION B

Question 4

(a) Find the diameter of a solid steel shaft to transmit 25 kW at 250 r.p.m. The ultimate shear stress for the steel may be taken as 420 MPa and factor of safety as 6. If a hollow shaft is to be used in place of a solid shaft, find the inside and outside diameter if their ratio is 0.5.
(b) State the factor(s) that may influence the decision of using plastics as materials for shaft design.
(c) List the desirable properties of a material to be used for shaft design.

Question 5

(a) What are the differences between bolts, screwsand nuts?
(b) Highlight the merits of threaded fasteners.
(c) A screw is operated by a torque applied to the lower end. The nut is loaded and prevented from turning by guides. Assume the friction in the ball bearing is negligible. The screw has 48 mm outside diameter (d_o) and triple ISO trapezoidal thread. The pitch is 8 mm and the thread coefficient is 0.10. Determine (i) the load which could be raised by a torque of 450 Nm (ii) the average bearing pressure , if the nut length is 50 mm and (iii) the efficiency of the screw mechanism.

Question 6.

(a) What are the necessary factors a design engineer must consider before the selection of a proper factor of safety (FOS)?
(b) A copper wire, which is 1.6 mm diameter and 4 m long extends 1.7 mm when carrying a mass of 10 kg. Find (i) the stress and the strain in the wire (ii) the modulus of elasticity and (iii) the factor of safety, if the ultimate tensile strength of the copper is 220 MN/m^2
(c) State the advantages of standardization.