



MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 317: DESIGN OF MACHINES AND MACHINE ELEMENTS

DATE:

TIME:

INSTRUCTIONS

This paper contains FIVE questions.

Question ONE is compulsory and carries 30 marks.

Four remaining questions carry 20 marks each.

Attempt question ONE and any other TWO.

QUESTION 1 (30 MARKS)

- a) Describe two types of bearings and their application. **(8 Marks)**
- b) List three (3) advantages and three (3) disadvantages of gears vs pulleys in engineering applications. **(6 Marks)**
- c) What are the four geometric and material factors that a design engineer needs to consider when designing a shaft? **(4 Marks)**

d) What is the purpose of a clutch in a manual transmission vehicle. **(3 Marks)**

e) What material properties should a candidate material possess in order for a materials engineer to consider it suitable for use as a clutch disc? **(4 Marks)**

g) An engine running at 200 r.p.m drives a line shaft by means of a flat belt drive. The engine pulley is 700 mm diameter and the pulley on the line shaft is 350 mm. A 750 mm diameter pulley is affixed on the line shaft and this in turn, is to drive a pulley on a dynamo shaft which is to rotate at 2000 r.p.m. Calculate the appropriate diameter of the dynamo shaft pulley assuming:

- There is no slip. **(2 Marks)**

- 1% slip on each drive (i.e. $S_1 = S_2 = 0.01$) **(3 Marks)**

QUESTION 2 (20 MARKS)

(a) A steel shaft 35 mm in diameter and 1.2 meters long is held rigidly at one end and has a hand wheel 500 mm in diameter keyed in to the other end. The modulus of elasticity of the steel is 80 GNm^{-2} .

(i) What load applied tangentially to the wheel will produce a torsional shear stress of 60 MNm^{-2} in the shaft? **(8 Marks)**

(ii) How many degrees will the wheel turn when the load is applied? **(4 Marks)**

(b) A shaft is transmitting 100 KW at 160 r.p.m. Find a suitable diameter for the shaft if the maximum torque transmitted exceeds the mean by 25%. Take the maximum allowable shear stress in the shaft to be 70 MNm^{-2} . **(4 Marks)**

(c) If a hollow shaft is to be used in place of the solid shaft in Q2(b), find the inside and outside diameter when the ratio of inside to outside diameters is 0.5 **(4 Marks)**

QUESTION 3 (20 MARKS)

(a) Give two instances when the clutch is engaged in a manual transmission vehicle **(2Marks)**

- (b) Determine the maximum, minimum and average pressure in a plate clutch where the axial force is 4 KN. The inside radius of the contact surface is 50 mm and the outer radius is 100 mm. Assume uniform wear. **(9marks)**
- (c) A single plate clutch with both sides of the plate effective is required to transmit 25 KW at 1600 r.p.m. The outer diameter of the plate is limited to 300 mm and the intensity of the pressure between the plates is not to exceed 0.07 MNm^{-2} . Assuming uniform pressure and a coefficient of friction of 0.3, find the inner diameter of the plate and the axial force necessary to engage the clutch. **(9 marks)**

QUESTION 4 (20 MARKS)

- (a) List four factors that determine the amount of power transmitted by a belt drive. **(4 Marks)**
- (b) The selection of a belt drive depends on various important factors. List seven (7) factors that you would consider while selecting a belt drive. **(7 Marks)**
- (c) Discuss 3 different types of materials used to make belts. **(9 Marks)**

QUESTION 5 (20 MARKS)

- (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 C8 steel having ultimate tensile stress of 700 MNm^{-2} and ultimate shear stress of 500 MNm^{-2} . Assuming a factor of safety of 6, determine the diameter of the shaft using:
- i. Maximum Shear Stress Theory (Guest's theory) **(9 marks)**
- ii. Maximum Normal Stress Theory (Rankine's theory) **(9 marks)**
- iii. Which shaft diameter would you recommend? **(2 Marks)**