



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 317: DESIGN OF MACHINES AND MACHINE ELEMENTS

DATE: 1/8/2019

TIME: 2.00-4.00 PM

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) 30 MARKS.

- a) Explain the effect of a key-way on the strength of a shaft (4 marks)
- b) A sunk key and a shaft of 90mm diameter has the same material shearing resistance. The width of the key is 25mm. Assuming shear stress $= \frac{2}{5}$ crushing stress for the material, determine the length and thickness of the sunk key. (6 marks)
- c) Two shafts of solid and hollow cross-sections have the same material, length and external diameters. The external diameter of the hollow shaft is twice the internal diameter. Show that the ratio of the weight of hollow shaft to that of the solid shaft is 0.75. (4 marks)
- d) State three economic considerations that the designer must have in mind when designing a new product (3 marks)
- e) State any 3 activities that must be carried out before commercialisation of an engineering product by a start-up company. (3 marks)
- f) Explain four main considerations made before design and selection of a dynamic seal (2 marks)
- g) Define the term 'cam pressure angle' and illustrate your answer with a suitable diagram. Why is it important to keep this angle minimum? (5 marks)
- h) Give three advantages of gears as compared to other types of power transmission mechanisms (3 marks)

QUESTION TWO (20 MARKS)

- a) Explain any four functions of couplings in machinery. (4 marks)
- b) With the aid of neat sketches, describe the following types of couplings with an application for each.
 - i. Oldham coupling
 - ii. Universal coupling (10 marks)
- c) Design the hub of a cast iron flange coupling for mild steel shaft transmitting 15kW at 200 rpm. The allowable shear stress in the shaft is 40Mpa. Take shaft diameter to be 50mm and the shear stress for cast iron is 14Mpa. (6 marks)

QUESTION THREE (20 MARKS)

- a) Design a V-belt drive of groove angle 35° that can transmit 15kW to a compressor. The compressor pulley speed runs at 250 rpm and the motor speed is 750rpm. The cross-sectional area of each belt is 375mm^2 and the permissible stress in the material is 2.5Mpa. Ignore centrifugal tension and assume centre distances to be 1750mm and $\mu = 0.3$ (8 marks)
- b) A multiple disc clutch plate is required to transmit a torque 85Nm. The outer diameter of the plate is limited to 100mm and the intensity of pressure between the plates is not to exceed 1.4Mpa. Assuming uniform wear and coefficient of friction is 0.06. Determine;
 - i The inner diameter of the disc plates
 - ii Axial force necessary to engage the clutch.
 - iii The total number of discs. (12 marks)

QUESTION FOUR (20 MARKS)

- a) Describe the following types of gear mechanisms:
 - i. Rack and Pinion (2 marks)
 - ii. Worm and Worm wheel gears (2 marks)
- b) A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio (10 marks)
- c) Differentiate between hydrodynamic and anti-friction bearings (2 marks)
- d) Discuss the effects of anti-friction bearing misalignment on their life (4 marks)

QUESTION FIVE (20 MARKS)

- a) Discuss the function of the following components in a vehicle power train system (engine plus the transmission).
 - i Clutch (2 marks)
 - ii Gearbox (2 marks)
 - iii Cams (2 marks)
- b) Using examples, differentiate between a shaft and an axle (4 marks)
- c) Discuss any five desirable properties in materials for manufacturing of bearings (5 marks)
- d) Derive the expression for the torque transmitting capacity of a single plate clutch by considering uniform pressure theory (5 marks)