



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE
IN MECHANICAL ENGINEERING

EMM 317: DESIGN OF MACHINES AND MACHINE ELEMENTS

DATE: 12/6/2017

TIME: 2:00 – 4:00 PM

INSTRUCTIONS

1. You should have the following for this examination
Answer booklet
Scientific calculator
2. This paper contains Five questions.
3. Answer **Question ONE** compulsory and carries 30 marks.
4. Answer any **TWO** questions from the remaining Four. All carry 20 marks each.

QUESTION ONE (COMPULSORY) 30 MARKS.

- a) Define factor of safety and state the factors necessary for a suitable factor of safety in design. (4 marks)
- b) Discuss any **Four** factors which are considered in the design of machines and machine elements. (4 marks)
- c) Compare the stress distribution in a bar subjected to axial force and a beam subjected to bending. (3 marks)
- d)
 - i. With the aid of neat sketch, describe the two forces acting on sunk keys. (3 marks)
 - ii. 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. (8 marks)

- e) Describe any **three** methods to improve the fatigue strength (3 marks)
- f) 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. (5 marks)

QUESTION TWO (20 MARKS)

- a) Kenya's first Standard Gauge Railway from the port of Mombasa is designed to meet both speed and weight. The rail is designed to hold a pair of wheels for wagons carrying a load of 50kN on each axle box acting at a distance of 0.1metre outside the wheel base. The gauge/width of the rails is 1.4metre.
As a design Engineer, if stress is not to exceed 10^8Pa , determine the diameter of the axle solid shaft between the wheels. (16 marks)
- b) Explain the effect of a key-way on the strength of a shaft (4 marks)

QUESTION THREE (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 C.I is 14Mpa. (6 marks)

QUESTION FOUR (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 FIVE (20 MARKS)

- a) i. Show that the maximum shear stress for an helical spring is given by;

$$\tau_{\max} = K_s \frac{8FD}{\pi d^3} \quad (8 \text{ marks})$$

- ii. In the design of a helical extension spring for average service life to exert a load F of 340N and maximum shear stress 596Mpa. Calculate the mean spring diameter and wire diameter D using Bergstraser factor $K_B = 1.25$. Take spring index = 6. (5 marks)

- b) Discuss the influence of standardization on the design of a component. (7 marks)