



KENYATTA UNIVERSITY
UNIVERSITY EXAMINATIONS 2011/2012
FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF
SCIENCE (MANUFACTURING ENGINEERING)

SET 304: MACHINE ELEMENTS 1

DATE: Thursday 24th November 2011

TIME: 2.00p.m – 4.00p.m

INSTRUCTIONS

1. This paper contains **FIVE** questions
2. Question **ONE** carries **30 Marks**, and is **COMPULSORY**
3. The other **FOUR** questions carry **20 Marks** each, answer any **TWO**

QUESTION ONE (30 Marks):

- a) State four properties that materials for making a shaft should have
(4 Marks)
- b) Find the diameter of a solid steel shaft to transmit 25 kW at 200 r.p.m. The ultimate shear stress for the steel may be taken as 360 NM/m^2 and a factor of safety as 8.
(4 Marks)

If a hollow shaft is to be used in place of the solid shaft, find the inside and outside diameter - when the ratio of inside to outside diameters is 0.7.

(4 Marks)

- c) With the aid of well labeled diagrams, briefly describe the following types of keys
- i) Tangent key (2 Marks)
 - ii) Flat saddle key (2 Marks)
 - iii) Hollow saddle key (2 Marks)
 - iv) Woodruff key (2 Marks)
- d) State Five requirements for a good shaft coupling. (5 Marks)

- e) State Five limitations of plain / sliding contact bearings

(5 Marks)

QUESTION TWO (20 Marks)

- a) List two considerations kept in mind while designing a frictional clutch
(2 Marks)
- b) Show that the torque transmitted by a plate clutch T is given by:

$$T = \mu.W.R \quad \text{Where: } R = \frac{2}{3} \left[\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2} \right]$$

Considering a uniform pressure plate clutch (10 Marks)

- c) A plate clutch having a single driving plate with contact surfaces on each side is required to transmit 120 kW at 1500 rpm. The outer diameter of the contact surfaces is to be 300 mm. The coefficient of friction is 0.4. Assuming a uniform pressure of 0.17 N/mm^2 , determine the inner diameter of the inner surface.

(8 Marks)

QUESTION THREE (20 Marks)

- a) Show that the turning moment of a hollow shaft T, is given by:

$$T = \frac{\pi}{16} \cdot \tau (d_o^3) (1 - k^4) \quad (6 \text{ Marks})$$

- b) A hollow shaft of diameter ratio 3/8 is to transmit Power, P = 600 kW, at a speed of 110 rpm. The maximum torque being 20% greater than the mean. (i) The shear stress being 63 MN/m^2 and (ii) the twist in length of 3m is not to exceed $\theta = 1.4^\circ$ ($C = 84 \text{ GN/m}^2$). Calculate the diameter of the shaft that satisfies the conditions above. (8 Marks)

- c) A foot-step bearing supports a shaft 150mm in diameter which is counter-bore at the end with a hole diameter of 50mm. If the bearing pressure is limited to 0.8 N/mm and the speed is 100 rpm, find:

- i) Load to be supported (2 Marks)
- ii) Power lost in friction ($\mu = 0.015$) (2 Marks)
- iii) Heat generated at the bearing (2 Marks)

QUESTION FOUR (20 Marks)

- a) State two advantages and two disadvantages of the woodruff key
(4 Marks)
- b) A 45mm diameter shaft is made of steel with yield strength of 400 NM/m^2 . A parallel key of size 14mm wide and 9mm thick made of steel with yield strength of 340 NM/m^2 is to be used. Find the required length of 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.
(8 Marks)
- c) Briefly describe any eight factors that you would consider when designing a machine component.
(8 Marks)

QUESTION FIVE (20 Marks)

- a) Briefly describe four uses of a shaft coupling.
(4 Marks)
- b) Shaft couplings are divided into two main groups. Briefly describe each group and mention **two** examples of shaft couplings under each group. (4 Marks)
- c) Design a clamp coupling to transmit 30 kW at 100 rpm. The allowable shear stress for the shaft and the key is 40 NM/m^2 and the number of bolts connecting the two halves are six. The permissible tensile stress for the bolts is 70 NM/m^2 . The coefficient of friction between the muff and the shaft surface may be taken as 0.3.
(12 Marks)