



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 213: MACHINE ELEMENTS

DATE: Wednesday 18th April 2012

TIME: 2.00p.m – 4.00p.m

INSTRUCTIONS

1. This paper contains FIVE questions
 2. All questions carry EQUAL MAXIMUM MARKS
 3. Attempt any THREE questions
 4. All symbols have their usual meaning unless specified otherwise.
 5. Use clear and neat sketches
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QUESTION ONE

- a) List two considerations kept in mind while designing a frictional clutch. [2marks]
- b) Show that the torque transmitted by a plate clutch τ 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. [10marks]

- c) A plate clutch having a single driving plate with contact surfaces on each side is required to transmit 120kW at 1500 rpm. The outer diameter of the contact surface is to be 300mm. The coefficient of friction is 0.4. Assuming a uniform pressure of 0.17 N/mm², determine the inner diameter of the inner surface. [8marks]

QUESTION TWO

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

$$T = \frac{\pi}{16} \cdot \tau (D^3)(1 - k^4) \quad [6\text{marks}]$$

- b) A hollow shaft of diameter ratio $\frac{3}{8}$ is to transmit power $P = 600\text{kW}$, at a speed of 110 rpm. The maximum torque being 20% greater than the mean.

- i) The shear stress being 63MN/m^2 and
ii) The twist length is 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. [8marks]

- c) Find the diameter of a solid steel shaft to transmit 25 kW at 200rpm. The ultimate shear stress for the steel may be taken as 360mpa and a factor of safety as 8. [3marks]

If a hollow shaft is to be used in place of a solid shaft, find the inside and outside diameter when the ratio of inside to outside diameter is 0.7. [3marks]

QUESTION THREE

- a) State four properties that materials for making a shaft should have. [4marks]
- b) With the aid of a well labeled diagrams, briefly describe the following types of keys: [2marks]
- i) Tangent key [2marks]
- ii) Flat saddle key [2marks]
- iii) Hollow saddle key [2marks]
- iv) Woodruff key [2marks]
- c) State two advantages and two disadvantages of the woodruff key. [3marks]
- d) State five requirements for a good shaft coupling. [5marks]

QUESTION FOUR

- a) Briefly describe any eight factors that you would consider when designing a machine component. [8marks]
- b) Design a clamp coupling to transmit 30kW at 100 rpm. The allowable shear stress for the shaft and key is 40mpa and the number of bolts connecting the two halves are six. The permissible

tensile stress for the bolts is 70mpa. The coefficient of friction between the muff and the shaft may be taken as. 0.3. [12marks]

QUESTION FIVE

- a) A shaft running at 200rpm is to drive a parallel shaft at 300 rpm. The pulley on the driving shaft is 600mm diameter. Calculate the diameter of the pulley on the driven shaft:
- i) Neglecting belt thickness. [2marks]
 - ii) Taking belt thickness of 5mm into account. [2marks]
 - iii) Assuming in case (ii) a total slip of 4%. [2marks]
- b) Two parallel shaft 6m apart are connected by cross belt running over pulleys of diameter 600mm and 400mm respectively. Determine the length of the belt required:
- i) If the belt is open. [2marks]
 - ii) If the belt is crossed. [2marks]
- c) Two pulleys on parallel shafts are connected by cross belt. The diameters of the pulley are 450mm and 200mm. The shafts are 1.95m apart. Find:
- i) The length of the belt required, and
 - ii) The angle of contact between the belt and each pulley.
 - ii) Power transmitted when the larger pulley rotates at 100 rpm, if the maximum permissible tension in the belt is 1000N and the co-efficient of friction between the belt and pulley is 0.5. [6marks]
- d) The maximum allowable tension in a flat belt is 1500N. The coefficient of friction between the belt and material of the pulley is 0.27. Neglecting the effect of centrifugal tension, calculate the net driving tension and power transmitted if the belt speed is 2m/s. [4marks]

