KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2008/2009

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (COMPUTER ENGINEERING)

SCE 215: MECHANICAL ENGINEERING PRINCIPLES

DATE: FRIDAY, 28TH NOVEMBER 2008 **TIME: 11.00 A.M. – 1.00 P.M.**

INSTRUCTIONS:

- **Answer question ONE and any other TWO questions.**
- **You may use the following constants and formula.**

Gravitational acceleration, g = 9.81 ms^{-2}

1 bar = 10^5 pascals

Density of water $_{water} = 1000 kgm^{-3}$

Question One (30 marks)

a) Define the following terms as used in materials:

(i) Rotational Inertia (2 marks)

(ii) Young's modulus of elasticity (2 marks)

(iii) Cantilever (2 marks)

b) A lift cage has a mass of 200 kg. Its outside diameter is 1.5 m and moment of inertia 130 kgm^2. Ignoring the effect of the rope, calculate the total k.e. in the system when the cage is being raised at a uniform speed of 1.5 ms^{-1} (3 marks)

c) A pipe used to carry water is raised at some angle from the horizontal axis. Water enters the pipe with a pressure of 3 bar and velocity 6 ms^{-1}. The pressure in the water 30 m below entry point is 1.4 bar, calculate its velocity. (3 marks)

d) Distinguish between space diagram and force diagram. (1 mark)

e) Verify from initial state that the general solution for under damped harmonic motion is given by $x = ce^{-\alpha t}\cos(\lambda t-\phi)$ where symbols have their usual meanings. (3 marks)

f) State three types of gears (3 marks)

g) Water of density 1000 kgm^{-3} enters a horizontal pipeline with a pressure and velocity of 2 Mpa and 7.5 ms^{-1} respectively and leaves with pressure of 1.65 Mpa and velocity 25 ms^{-1}. Determine the loss of head due to frictional force. (3 marks)

h) What is fatigue test on a material? (2 marks)

i) Identify two conditions for a body to be in equilibrium. (2 marks)

j) What are the two assumptions made in the simple theory of bending? (2 marks)

k) Distinguish between angular velocity ratio and pressure angle in gear forces. (2 marks)

Question two (20 marks)

a) Write down the equation of power transmitted by a belt drive as a function of belt tensions and belt speed defining all symbols used. (4 marks)

b) A V-belt drive is to transmit 18.5 Kw from a 250 mm pitch diameter sheave operating at 1800 rev/min to 900 mm diameter flat pulley. The centre distance between the input and output shafts is 1 m. The groove angle $\theta = 40^{o}$ and the coefficient of friction for the belt and sheave is 0.2 and the coefficient of friction between the belt and flat pulley is 0.2. The cross section of the belt is $b_2 = 38$ mm wide at the top and $b_1 = 19$ mm wide at bottom by $d = 25$ mm deep. Each belt weighs 11 KNm^{-3} and the allowable tension per belt is 900 N. How many belts are required? (16 marks)

Question three (20 marks)

a) Distinguish between a strut and a tie in girders. (2 marks)

b) Determine the forces acting on each member of the truss shown in figure 1. The ends of the truss rest on a smooth surface. (18 marks)

Figure 1

Question four (20 marks)

a) Distinguish between free harmonic vibration and forced harmonic vibration. (3 marks)

b) A particle of mass 5 kg moves along the x-axis under the influence of two forces (i) a force of attraction to origin O which in Newtons is numerically equal to 40 times the instantaneous distance from O and (ii) a damping force proportional to the instantaneous speed such that when speed is 10 ms^{-1}, the damping force is 20 m from O,

(i) set up the differential equation and conditions describing the motion. (6 marks)

(ii) find the position of the particle at any time. (3 marks)

(iii) determine the amplitude, period and frequency of the damped oscillations. (6 marks)

(iv) graph the motion. (2 marks)

Question five (20 marks)

a) Briefly explain the reasons for lubricating parts of a machine. (2 marks)

b) Identify <u>two</u> items which may influence the strength of a machine member. (2 marks)

c) A hollow shaft of external diameter 50 mm and bore 35 mm is to transmit a torque of 70 Nm. If the shaft is 0.8 m long and shear modulus is 80 GNm^{-2}, determine:

(i) the maximum shear stress (4 marks)

(ii) the maximum angle of twist (4 marks)

d) An experimental which disc flywheel has a mass of 120 kg and an outside diameter of 300 mm. With the flywheel at rest, a constant torque of 10 Nm is applied for a period of 2 seconds. Ignoring the effect of friction, determine:

(i) the moment of inertia (3 marks)

(ii) the angular acceleration (2 marks)

(iii) the angular velocity after 2 seconds (3 marks)

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