KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2010/2011

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

SCE 317: CONTROL SYSTEMS I

DATE: Wednesday, 24th November, 2010 TIME: 2.00 p.m. – 4.00 p.m.

INSTRUCTIONS:

Question **ONE** is **COMPULSORY**.

Answer any other **TWO** questions.

QUESTION ONE

a) What is a mathematical model? Identify two physical laws used in establishing mathematical models.

(3 marks)

b) What is a transfer function?

(2 marks)

c) Given below in figure 1 is a separately excited DC brush motor drive. The field current is assumed to be constant. The rotor of the motor has an inertia J[kgm^2] and is driving a load torque T_L. The motor's viscous friction constant is $B\left[\frac{Nm-\sec}{rad}\right]$. If the machine constant is $K_T=K_m=K\left[\frac{V-\sec}{rad}\right]$, derive:

(i) the performance equations and their Laplace transform

(ii) the transfer function

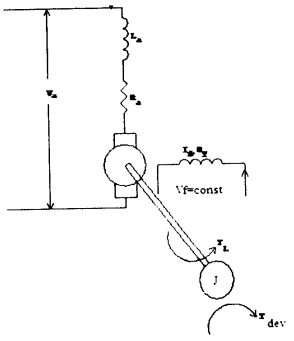

Figure 1 **(9 marks)**

d) i) Derive for the following circuit the time response $e_{out}(t)$ due to a step input equal to E_{in} for the filter given in figure 2.

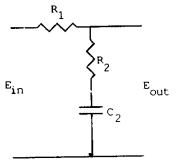

Figure 2

ii) Decompose the following transfer function into partial fractions. Hence obtain the response due to a unit step input on the system.

$$\text{Transfer function} = \frac{s+3}{s^2-3s-40}$$

(16 marks)

QUESTION TWO

a) With the aid of a sketch define the following transient response specifications

i. Delay time

ii. Rise time

iii. Peak time

iv. Maximum overshoot

(8 marks)

b) Draw the block diagram for the circuit shown in figure 2 below. *Vi* and i_L are the input and output variables respectively.

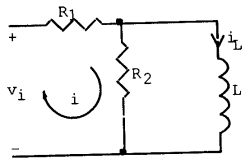

Figure 2.

(12 marks)

QUESTION THREE

a) Using block algebra determine the ratio $\frac{C(s)}{R(s)}$ for the system shown in figure 3.1.

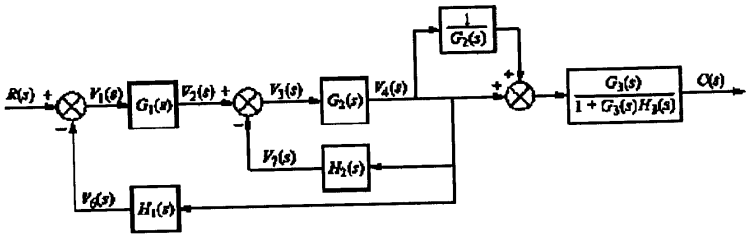

Figure 3.1

(8 marks)

b) State the D Alembert's principle. Using this principal write the differential equations describing the dynamics of the mechanical system shown in fig 3.2. Find the ratio $\frac{X_2(s)}{F(s)}$.

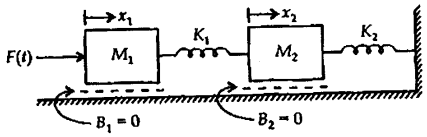

Figure 3.2

(12 marks)

QUESTION FOUR

a) What is a Polar plot? What are its advantages and disadvantages?

(4 marks)

b) Sketch the Polar plot for

$$G(s) = \frac{20}{s(s+1)(s+2)}$$

(16 marks)

QUESTION FIVE

a) State Routh-Hurwitz stability criterion.

(2 marks)

b) Consider a unity feedback control system with the following feedforward transfer function

$$G(s) = \frac{K}{s(s^2 + 4s + 8)}$$

Plot the root loci for the system.

(18 marks)