THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY

EEC 2203

CONTROL SYSTEMS I

END OF SEMESTER EXAMINATION

SERIES: FEBRUARY 2011 SERIES

TIME: 2 HOURS

Instructions to Candidates:

1. You are required to have the following for this examination;
   - Answer booklet
   - A non-programmable calculator
   - La Place transform tables

2. Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions.

3. Maximum marks for each question are shown.

(COMPULSORY)

<u>Question ONE</u>

a) i) With the aid of a canonical form block diagram of a closed loop system derive closed loop transfer function

$$\frac{C_{(S)}}{R_{(S)}} = \frac{G_{(S)}}{1+G_{(S)}H_{(S)}}$$

ii) Define the following control terms

I) System

II) Controlled variable

III) Reference variable

IV) Plant

V) Error signal

iii) State FOUR features that feedback effects to a system. (15marks)

b) Reduce the block diagram in figure 1 to open loop form hence find the relationship

$$\frac{R_{(S)}}{C_{(S)}}$$ (5 marks)

Fig 1

c) Reduce the signal flow graph in fig 2 to get the ratio of output to input.

$$\frac{X_S}{X_1}$$ (6 marks)

Fig 2

d) Obtain the transfer function of the fig 3 below (4 marks)

Fig 3

(ANSWER ANY OTHER TWO QUESTIONS)

Question TWO

a) Construct the signal flow graph of the following simultaneous equations making y_4 as the output node hence determine the transfer function using Masous gain formula. (15marks)

$$y_2 = t_{21} y_1 + t_{23} y_3$$
$$y_3 = t_{31} y_1 + t_{32} y_2 + t_{33} y_3$$
$$y_4 = t_{42} y_2 + t_{43} y_3$$

b) Define the following terms as used in signal flow graphs (5 marks)

i) Feedback loop
ii) Self loop
iii) Input node
iv) Output node
v) Path

Question THREE

a) Define with the aid of sketches the following input signals used for testing control systems. Give their mathematical representation.

i) Step
ii) Impulse
iii) Ramp
iv) Parabolic

b) For the system shown in fig 4 below, find 'a' such that the damping ratio is 0.5. Determine the:

i) Rise time
ii) Peak time
iii) Maximum overshoot
iv) Settling time

In the unit step response input. (10marks)

Fig 4

Question FOUR

a) Simplify the block diagram in fig 5 below hence determine the outputs $G_{(S)}$ (16marks)

Fig 5

b) Simplify the block diagram in figure 6 below and obtain closed loop transfer function.

$$\frac{C_{(S)}}{R_{(S)}}$$

(4 marks)

Fig 6

Question FIVE

a) For the spring mass damper system shown in fig 7 below shows that when subjected to a forcing function $F_{(t)}$, it shifts from rest position X_0 to final displacement X_1 by the value:

$F_{(t)} = mx_1 + Cx_1 + kx_1$ (6 marks)

Fig 7

Where

X_0	=	initial position
X_1	=	position after displacement
M	=	mass
K	=	spring
C	=	damper

b) For a system described by

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y = 6$$

With initial conditions

$y^1(0) = 2$; y (0) = 2. Obtain y(t).

Using La place transforms obtain value of y(t) (8 marks)

c) For the circuit shown in fig 8 below, determine the relationship. (6 marks)

$$\frac{E_{O(S)}}{E_{i(S)}}$$

Fig 8