THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

FACULTY OF ENGINEERING &TEHNOLOGY

Department of Mechanical & Automotive Engineering

Diploma in Mechanical Engineering (Plant DPL 3P)

Diploma in Mechanical Engineering (Production DPR 3)

Diploma in Automotive Engineering (DAE 3P)

Second III Semester I SUP Exam

2340

CONTROL & INSTRUMENTATION III

OCTOBER SERIES

Time 2 Hours

Instructions

You should have the following for this examination:

- Answer booklet
- Scientific calculator & SMP Table.
- Drawing Instruments.

This paper consists of **FIVE** Questions, answer Question **ONE** (Compulsory) and any other **TWO** Questions.

Question ONE (Compulsory)

(a) For the system in figure I, show that:

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 \pm G(s)H(s)}$$

(6 Marks)

(b) Describe the following control action giving their respective transfer functions:

(i) Proportional control action
(ii) Integral control action
(iii) Proportional + desirative control action
(iv) PID control action

(14 Marks)

Question TWO

(a) Determine the value of k and a such that the system has a damping ratio of 0.7 and an undamped natural frequency of 4 rad/sec for the system shown in figure 2.

(8 Marks)

(b) With the help of a diagram define the following terms:

(i) Delay time
(ii) Rise time
(iii) Peak time
(iv) Settling time

(12 Marks)

Question THREE

Using the data below, find the transfer function for a PID controller.

Question FOUR

For the system whose transfer function is given by:

$$\frac{C(s)}{R(s)} = \frac{25}{3S^2 + 5S + 25}$$

Determine:

(i) Natural frequency (3 Marks)

(ii) Damping ratio (3 Marks)
(iii) Damped frequency (3 Marks)
(iv) Time constant (3 Marks)

Sketch the graphs for the following test signals.

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

(8 Marks)

Question FIVE

A stired tank blending systems initially is full of water and is being fed pure water at a constant flow rate, q. at a particular time an operator adds caustic solution at the same volumentric flow rate q but with concentration C_i. If the liquid volume V is constant, the dynamic model for this process is:

$$V\frac{dc}{dt} + qc = qc_i$$

With C(o) = O
C_i = Inlet concentration
C = tank outlet concentration

Data = V= $2m^3$, q = $0.4m^3/min$, C_i = $50kg/m^3$

(a) Derive the transfer function between C and C_i
(14 Marks)

(b) Find the time constant τ and the gain k of the transfer function.
(4 Marks)

(c) What are the units for k & τ (2 Marks)