



THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY

EEC 2308: PROCESS CONTROL I

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: OCTOBER 2011

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer booklet*
- *Non-programmable calculator*

This paper consists of **FIVE** questions. Answer question **ONE (COMPULSORY)** and any other **TWO** questions

Maximum marks for each part of a question are clearly shown.

This paper consists of **FOUR** printed pages

SECTION A (COMPULSORY)

Question 1

- a) (i) Sketch a typical reaction curve for an industrial process
- (ii) A temperature controller has a range of 0-1000oc. The process reaction curve gives a temperature rise of 20oc in 1 minute. Calculate the reaction rate
- (iii) Distinguish between the direct and the reverse acting controllers (6 marks)
- b) (i) Explain the floating single speed controller mode
- (ii) Use the controlled variable and position of the final control element to illustrate (i)
- (iii) Define the following
- I. Proportional
 - II. Integral plus integral
 - III. Derivative plus proportional
 - IV. Controlled variable (10 marks)
- c) (i) Sketch a process control loop response characteristic and show the following parameters.
- I. Peak error
 - II. Settling time
 - III. Residual error
 - IV. Allowable error

SECTION B (Answer any TWO questions from this section - 20 marks each)

Question 2

- a) Figure 1 represents a proportional plus integral electronic controller with the following parameters.

Gain = 3, integral time constant = 40 seconds

in

Fig 10

Obtain:

- i. Valves of R and R1
 - ii. Time domain output equation
 - iii. Frequency domain transfer function (6 marks)
- b) A liquid level control system linearly converts displacement of 20 – 30 metres into a 4-20 MA control signal. A relay serves as the two position controller to open or close a valve
- The relay closes at 24MA and opens at 20Ma. Calculate
- i. Displacement to correct ratio in m/MA
 - ii. Displacement gap in metres (8 marks)
- c) A PI controller has a proportional band of 30%. A 4-20mA input converts to a 0 – 2V error signal and the output is 0 – 1 volt. Calculate the gain and state the reason for the answer (6 marks)

Question 3

- a) (i) Sketch a labeled block diagram of a programmable logic controller (PLC) and hence explain the functions of each block
- (ii) State any **TWO** factors that should be taken in account when selecting PLC for a particular process.
- (iii) Explain the two modes of operation of PLC (12 marks)
- b) Explain the following as applied to analogue computing
- i. The summer
 - ii. The integrator
 - iii. The coefficient potentiometer
 - iv. The differentiator (8 marks)

Question 4

- a) (i) With the aid of a diagram, show how an op-amp can be connected to provide an exponential time lag with facility for adjustment of the time constant
- (ii) Derive the expression for the output voltage for the circuit of (a) (i) (9 marks)
- b) (i) Prepare a computer flow diagram for the solution of the following simultaneous differential equation

$$\frac{d^2x}{dt^2} + 3\frac{d^2y}{dt^2} + 4\frac{dx}{dt} + 14x = 2$$

$$\frac{d^2y}{dt^2} + 5\frac{d^2x}{dt^2} + 3\frac{dy}{dt} + 7\frac{dx}{dt} + 12y = 0$$

- (ii) Compare the advantages and disadvantages of closed loop and open-loop analog flow computer diagrams (11 marks)

Question 5

- a) (i) Sketch a block diagram, showing the elements of a process loop
(ii) Explain the operation of a two-position controller with overlap (10 marks)
- b) Draw a block diagram of a data logging system and explain the function of any **FOUR** blocks (10 marks)