# MURANG'A UNIVERSITY OF TECHNOLOGY

## SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

**THIRD** YEAR **SECOND** SEMESTER EXAMINATION FOR THE DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

SEE 1308 – CONTROL ENGINEERING II

DURATION: 2 HOURS

DATE: 24TH APRIL, 2018

TIME: 9.00 – 11.00 A.M.

**Instructions to Candidates:**

1. Answer **Question 1** and **Any Other Two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

## SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

**QUESTION ONE**

a) Explain how a frequency response test is carried out an how the data obtained can be used to assess the stability of a control system (4 marks)

b) Outline the general procedure for obtaining the bode plot given a transfer function. (4 marks)

c) Using a diagram, describe how the following can be determined using Nichol's Chart

i. Gain margin

ii. Phase margin

iii. Stability (6 marks)

d) i) Highlight any two advantages of Nyquist stability criterion over bode plot (2 marks)

ii) Using diagrams describe Nyquiist stability criterion (6 marks)

e) Explain why it is an advantage in some applications to use a controller which gives;

i. Integral action

ii. Derivative action

iii. Integral and derivative action, in addition to proportional control action (8 marks)

## SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

**QUESTION TWO**

a) Distinguish between ON/OFF control and floating control (2 marks)

b) A factory crane operator is to control Red and Green safety lights by four switches A,B,C and D. Design a simple logic system which will operate under the following conditions;

- Red light on for

i. Switch A on, Switch B off, OR

ii. Switch C on

- Green light on for

i. Switches A and B on AND

ii. Switches C and D off (8 marks)

c) A system has the following open-loop frequency response

| W(rad/s) | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 30 |
|---|---|---|---|---|---|---|---|---|
| Gain (dB) | 2.8 | 1.9 | 1.3 | 0.9 | 0.68 | 0.4 | 0.26 | 0.12 |
| Ø (degrees) | -120 | -130 | -140 | -149 | -157 | -170 | -180 | -200 |

i. Plot the Nyquist diagram and determine the phase margin and gain margin of the system

ii. State with reasons whether the system is stable or not (10 marks)

**QUESTION THREE**

a) Highlight any Two differences between analogue and digital computers (2 marks)

b) Explain with the aid of a diagram how a digital computer may be used to control a process (6 marks)

c) The open loop transfer function of a control system is given by

$$G(jw) = \frac{5}{jw\ (1+0.5jw)(1+0.1jw)}$$

i. Draw the Nichol's chart over the frequency range of $1 \leq w \leq 5\ rad/s$

ii. Determine:

- Phase margin
- Gain margin
- Phase cross over frequency
- Gain cross over frequency (12 marks)

**QUESTION FOUR**

a) Explain why "compensation" is often needed in control systems (4 marks)

b) The open-loop transfer function of a control system is given below

$$G(s) = \frac{120}{S(1+0.1s)(1+0.02s)}$$

i. Draw the bode plot of the system (10 marks)

ii. Determine the gain and phase margin of the system (4 marks)

iii. State, with reasons, whether the system is stable or unstable (2 marks)