



# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

## *Faculty of Engineering and Technology*

DIPLOMA IN TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING  
2<sup>ND</sup> YEAR/2<sup>ND</sup> SEMESTER EXAMINATIONS

INSTITUTIONAL-BASED PROGRAMME

EEC 2204: CONTROL SYSTEMS II

SERIES: JULY 2011

TIME: 2 HOURS

### **Instructions to Candidates:**

You should have the following for this examination

- *Answer booklet*
- *Non programmable calculator*

Answer question **ONE** and any other **TWO** questions

This paper consists of **THREE** printed pages

### Question 1 (Compulsory)

a) The open loop transfer function of a unity feedback control system is give by

$$G(S) = \frac{K}{(S + 2)(S + 4)(S^2 + 6S + 25)}$$

Using Rooth Hurwitz stability, determine

- i) Range of values of K for stability to occur
  - ii) Values of K which will cause sustained oscillations in the closed loop.
  - iii) The corresponding oscillation frequency (13 marks)
- b) From first principles derive the equation for a;
- i) Constant M circle showing co-ordinates of centre and radius
  - ii) Constant N circle showing co-ordinates of centre and radius (10 marks)
- c) (i) With the aid of a sketch explain the Nyquist stability outerion  
(ii) With reference to Nyquist Polco plot define the following
- I. Gain margin
  - II. Phase margin (7 marks)

### Question 2

A unity feedback system has an open loop transfer function

$$G_{(s)} = \frac{K(S + 2)}{(S + 1)^2}$$

Determine

- i) Position and number of open loop poles (n) an open loop zeros (m)
  - ii) Number of separate root loci and asymptotes
  - iii) Assymptots angles
  - iv) The centroid
  - v) Breakaway points
- Hence sketch the root lows plot for system (20 marks)

### Question 3

- a) Explain
- i) The Rooth Hurwith stability oriterion
  - ii) The two unique or special cases that are encountered when using the method in axis and how this special cases are dealt with (11 marks)
- b) Using Rooth Hurwitz oriterion evaluate stability for system represented by characteristic equation shown

$$S^5 + S^4 + 25^3 + 25^2 + 3S + 5 = 0$$

(9 marks)

**Question 4**

- a) State any **TWO** advantages of Nichol's chart over the Nyquist diagram(2 marks)
- b) The results from Table 1 were obtained from an open-loop frequency response test on an automatic control system

W(rad/s	2	4	6	8	10	15	19
Gain (dB)	13.3	5.8	0.5	-3.7	-7.2	-13.9	-18
Phase (degrees)	-114	-133	-147	-157	-164	-178	-186

- i) Plot the response test information on a Nichols chart and determine the:-
- I. Gain margin
  - II. Phase margin (6 marks)
- ii) Assuming the system to have unity feedback, sketch the closed loop response and determine
- I. Peak magnitude,  $M_{pf}$
  - II. The frequency,  $w_{rf}$  at which the peak magnitude occurs (12 marks)

**Question 5**

- a) State any **THREE** advantages a Bode Plot has over a Nyquist diagram (3 marks)
- b) Draw the bode plot of

$$G_{(s)} = \frac{300(S^2 + 2S + 4)}{S(S + 10)(S + 20)}$$

and determine Gain Margin and Phase Margin if possible  $0.1 \leq w \leq 100$  (17 marks)