TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology in Conjunction with Kenya Institute of Highways and Building & Technology (KIHBT)

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

HIGHER DIPLOMA IN TECHNOLOGY

ECI 3201: CONTROL ENGINEERING

END OF SEMESTER EXAMINATION
SERIES: MAY 2015
TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*

This paper consists of **FIVE** questions. Answer any **THREE** questions
This paper consists of **FOUR** printed pages

Question One

a) With the aid of a diagram, define the following terms as used in specifying the transient response characteristics of a control system to a unit step input:
   (i) Delay time, t_d
   (ii) Rise time, t_r
   (iii) peak time, t_p
   (iv) Maximum overshoot, M_p
   (v) Settling time, t_s **(12 marks)**

b) Consider the system with the transfer function:

$$G(s) = \frac{1}{(s+1)(s+2)}$$

Obtain the gain and phase shift of G(s) for w = 2 and w = 10 **(8 marks)**

Question Two

a) A system is described by the following differential equation:

$$4\frac{dy}{dt} + 2y = 210^{-3}x$$

Determine:

$$G(s) = y(s)/x(s)$$

(i) The transfer function
(ii) Time constant, t and the steady state gain, K Expression for
(iii) Time response to a unit step input **(12 marks)**

b (i) State the routh stability criterion

(ii) The open loop transfer function of a unity feedback control system is given as:

$$G(s) = \frac{1}{s^3 + 3s^2 + 3s + 1 + k}$$

Using the Routh stability criterion, what restrictions must be placed upon the parameter k in order to ensure that the system is stable **(8 marks)**

Question Three

a) (i) Explain the term compensation as applied to control system.

(ii) An R-C network mechanization of a lead compensator is shown in figure Q3(a). Find its transfer function **(12 marks)**

b) A closed loop control system with negative feedback has:

$$G(s) = \frac{2}{s(1+s)}$$

$$H(s) = \frac{2}{1+0.5s}$$

(i) Write down an expression for the open loop transfer function
(ii) Sketch the Nyquist diagram and comment on the stability of the system

(8 marks)

Question Four

a) Consider the following second-order differential system given:

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 9y = 9u$$

Determine:

(i) The undamped natural frequency ω_n

(ii) The damping ratio ζ

(iii) The time constant τ

(iv) The damped natural frequency ω_δ **(12 marks)**

b) (i) Name any THREE standard test signals that commonly used for system performance analysis.

(ii) State the justification of using the test signals mentioned in (i) **(8 marks)**

Question Five

a) Simplify the block diagram given in figure Q5(a) to a canonical form **(10 marks)**

b) Consider a system shown in figure Q5bi when it is subjected to a unit-step input the system output responds as shown in figure Q5b ii.
Determine the values of K and T from the response curve