UNIVERSITY OF BUEA

FACULTY OF ENGINEERING AND TECHNOLOGY

LEVEL 400 ELECTRICAL ENGINEERING AND COMPUTER ENGINEERING

Continuous Assessment February 2014

Course Title: Feedback Systems

Course Code: EEF 409

Course Instructor: Professor Tanyi Emmanuel

Time: 2 Hours

Tables of Laplace Transforms are allowed

Question 1

Routh formulated necessary and sufficient conditions for the **Absolute Stability** of a system, but did not address the problem of **Relative Stability :** If stable, how stable?.

The **Nyquist Criterion** addresses the twin-problem of **Absolute** and **Relative Stability**.

a) Use the Routh Criterion to analyze the stability of a system with characteristic equation $q(s) = s^4 + 3s^3 + 6s^2 + 12s + K$

   i) For K=8

   ii) For K=10

b) Use the Routh Criterion to analyze the stability of a system with characteristic equation $q(s) = s^5 + s^4 + 4s^3 + 4s^2 + 2s + 1$

c) Apply the Nyquist Criterion to determine the Value of the Gain $K = K_{\max}$ for which the system with Open-loop Transfer Function $L(s) = \dfrac{K}{(1+s)(1+2s)(1+10s)}$ is marginally stable.

For $K = \dfrac{K_{\max}}{2}$, calculate:

   i) The Gain Margin

   ii) The Phase Margin

Question 2

A system is described by the Open-loop Transfer Function $L(s) = \dfrac{10(1+s)}{s(1+0.1s)(1+0.01s)}$

a) Represent the Frequency Response on a Bode Diagram.
   Calculate the Phase Margin from the Bode Diagram.

b) Represent the Frequency Response on a Polar Diagram.
   Calculate the Gain Margin from the Polar Diagram

Question 3

A system is described by the closed-loop Transfer Function $W(s) = \dfrac{100}{s^2 + 4s + 100}$

A unit step input is applied to the system. Calculate:

a) The output, y(t).

b) The Peak Response (Maximum Response), M_p

c) The time-to-peak (time taken to reach the maximum response), T_p

d) $y(T_p + T)$, where T is the period of the damped oscillation

e) The ratio $\dfrac{a_1}{a_2}$, where a_1 and a_2 are the first and second overshoots respectively

f) The steady-state error to the unit step input