University of Eswatini
Faculty of Science and Engineering
Department of Electrical and Electronic Engineering

Main Examination 2019

Title of Paper:	Control Engineering I
Course Number:	EEE431
Time Allowed:	3 hrs

Instructions:

1. Answer any four (4) questions.
2. Each question carries 25 marks.

This paper should not be opened until permission has been given by the invigilator.

This paper contains eight (4) pages including this page.

b) Find the transfer function of the system on Figure 2. (6)

c) Sketch its poles and zeros on the S-plane. Discuss if this system is stable or unstable? (4)

d) Determine if a system with the following characteristic polynomial is stable. How many poles are stable, unstable, or on the imaginary axis? (8)

$$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$$

e) Determine the step response function y(t) of the following transfer function. (5)

$$\frac{Y(s)}{R(s)} = \frac{s(s+2)}{(s+3)(s+5)(s+10)}$$

Question 3

a) Define the following terms for an under-damped second order response: Rise time, Peak time, Maximum overshoot, settling time and steady state error. (5)

b) For a system with the transfer function $G(s) = \frac{25}{s^2+5s+25}$, calculate the: rise time, peak time, maximum overshoot, and settling time (to within 2%). (10)

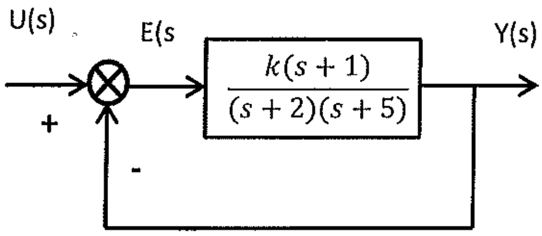

Figure 3

c) For the system on Fig.3, calculate the value of *k* for which the steady state error to a step input is 0.5 (6)

d) For *k* = 1, calculate the steady state error for ramp input and for a parabolic input. (4)

Question 4

A system has the open-loop transfer function shown below, with regards to its root locus plot:

$$G(s)H(s) = \frac{1}{s(s^2 + 5s + 6)}$$

a) Determine its poles and zeros. (2)

b) Calculate the angles of asymptotes. (3)

c) Where do the asymptotes intersect on the real axis? (2)
d) Calculate the breakout point. (5)
e) Sketch the root locus. (no need to calculate the imaginary axis crossing if it exist). (6)
f) What would be your recommendations with regards to increasing the gain indefinitely? (3)

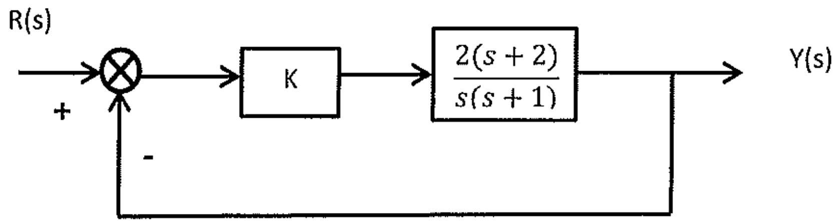

Figure 4

g) For the system on fig.4, find the value of K that will place the closed loop poles at $s = -1 \pm j1$ (4)

Question 5

a) Calculate the range of K for which the system T(s) is stable. (6)

$$T(s) = \frac{K}{s^3 + 10s^2 + 7s + K}$$

b)

1) Given the following transfer function G(s), sketch the Bode diagram of the system. (10)

$$G(s) = \frac{50}{s + 20}$$

2) Show the phase margin of the system (3)
3) Is the closed-loop system stable? (3)
4) Show the bandwidth of the system? (3)