UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION DECEMBER 2010

TITLE OF PAPER:	**CONTROL SYSTEMS**
COURSE CODE: **E430**	
TIME ALLOWED:	**THREE** HOURS

INSTRUCTIONS:

1. Answer **question 1** and any other three (3) questions.
2. Each question carries 25 marks.
3. Marks for different sections are shown in the right-hand margin.

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QUESTION 1

For the computer compensated system shown in Figure 1 below

$$D(Z) = \frac{z-0.05}{z+0.203} \qquad KG_p(s) = \frac{K}{s(s+2.995)}$$

$$K = \frac{5}{1.1}$$

Determine

a) Y(z)/R(z) [15 marks]

b) $y(k)$ when $r(t) = e^{-2t}$ for $t \geq 0$. [10 marks]

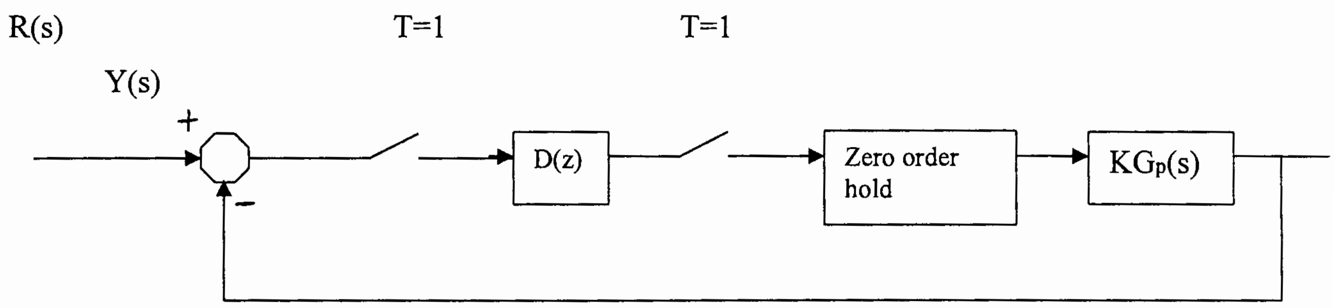

Figure 1

Question 2

For the system shown in Figure 2

i) determine the break-away or break-in points and the value of gain k at each point

[8 marks]

ii) draw the root locus plot. [17 marks]

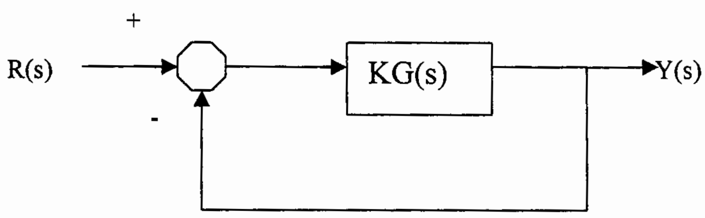

Figure 2

$$G(s) = \frac{K(s^2 + 10s + 24)}{s^2 + 2s}$$

Question 3

For a system with $G(s)H(S) = \frac{500s}{(s+1)(s+50)}$,

a) draw Bode diagrams, and [22 marks]

b) find the gain cross-over frequency. [3 marks]

Question 4

a) Consider the single –input, single output system described by

$$\dot{x}(t) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t)$$

where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 1 \\ -3 & -2 & 10-k \end{bmatrix}$,

Find the values of K for-which the system is stable. [13 marks]

c) Obtain a state variable matrix for a system with a differential equation

$$\frac{d^3y(t)}{dt^3} + 2\frac{d^2y(t)}{dt^2} + 10y(t) = 3u(t)$$

Note that u(t) is the input and y(t) is the output. [12 marks]

Question 5

For of a system whose transfer function is $\frac{Y(s)}{R(s)} = \frac{100}{s^2 + 16s + 100}$ with the input being a unit step.

(a) determine the value of the damping ratio ζ, [2 marks]
(b) find y(t), [8 marks]
(c) determine the rise time, [2 marks]
(d) determine the peak time, [2 marks]
(e) determine the maximum overshoot, [2marks]
(f) determine the steady state value, and [2 marks]
(g) plot y(t) for $0 < t < 1.2$. [7 marks]

Partial Tables of z-and s-Transforms

	f(t)	F(s)	F(z)	f(kt)
1.	$u(t)$			$u(kT)$
2.	t			kT
3.	t^n			$(kT)^n$
4.	e^{-at}			e^{-akT}
5.	$t^n e^{-at}$			$(kT)^n e^{-akT}$
6.	$\sin(\omega t)$			$\sin(\omega kT)$
7.	$\cos(\omega t)$			$\cos(\omega kT)$
8.	$e^{-at}\sin(\omega t)$			$e^{-akT}\sin(\omega kT)$
9.	$e^{-at}\cos(\omega t)$			$e^{-akT}\cos(\omega kT)$
10				$a^k\cos(k\pi)$

z-Transform Theorems

	Name	Theorem
1.	Linearity theorem	$z\{af(t)\} = aF(z)$
2.	Linearity theorem	$z\{f_1(t)+f_2(t)\}=F_1(z) + F_2(z)$
3.	Complex differentiation	$z\{e^{-at}f(t)\}=F(e^{aT}z)$
4.	Real translation	$z\{f(t-nT)\}=z^{-n}F(z)$
5.	Complex differentiation	
6.	Initial value theorem	If the limit exists
7.	Final value theorem	if the limit exists and the system is stable