University of Jordan
Electrical Engineering Department

Control Systems EE93441 **First Midterm Exam** **Tuesday 28th of October 1997**

~~Answer all questions. Your writing should be in ink.~~

Question 1

a) State possible parameter variations and external disturbances considering the following control systems
i) an antenna ***ii)*** a multistage rocket ***iii)*** a winding machine.

b) A system is described by the following transfer function

$$G(s) = 20(s+1)/(s^2+2s+5)$$

Determine the output time response when the system is excited by a unit step. What is its steady state value

b)Given the circuit shown in Fig **1**. Write down the necessary equations describing the circuit. Hence represent the circuit as a block diagram with $\mathbf{V_c(s)}$ as output and **E** as the set value. Your block diagram ***should not have*** powers of ***s*** in the numerators of the transfer functions.

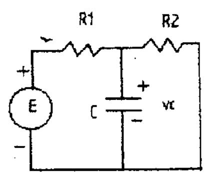

Fig 1

Question 2

a) A system is given by the transfer function $1/(s+1)(s+2)$
Introduce minimum number of additional components such that the new system will have a steady state output **one** due to a unit step.

b) A system is given by the transfer function $1/(s+2)(s+3)$.
Control the system in order to have a natural frequency of **4** rad s^{-1} and a damping ratio of **0.9** .

c)A system is given by the transfer function $K/(s+1)(s+2)$

where **K** is variable in an unpredictable manner between

2 and **12**. Introduce additional components , if possible,

in order to have a steady state output **one** due to a unit step

in the cases where **K** ranges between **2 to 5** and when K

ranges between **8 to 12**.

d) Given the block diagram shown in **Fig 2**, find ***C(s)/R(s)*** using block ***diagrams reduction techniques.***

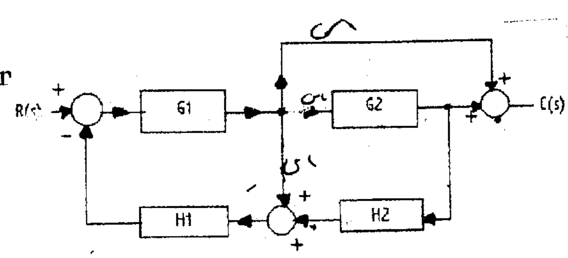

Fig2

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Control Systems EE93441 **Second Midterm Exam**

Answer all questions. Your answer should be in ink

Question 1

a) Sketch the root locus for a control system whose

$G(s) = k\,(s+1) / (s^2 - 2s + 2)$ and $H(s) = 1 / (s + 4)$

(N.B : Do not find the breakaway point even if it exists)

b) Find **graphically** the **output time response** due to a **unit step** for the system given in **a** in the case where the closed loop system has **pure imaginary** closed loop poles.

Question 2

a) Plot the **Bode diagram** (both **magnitude** and **phase**) for the System whose open loop transfer function is given by

$G(s)\,H(s) = 0.5\,(4 - s) / s\,(2 + s)$

Hence, use the Bode diagram to determine the **gain margin**. Can Routh's stability criterion be used to verify the value of the gain margin? If yes, verify your answer numerically. If no, state the reasons.

b) A **unity** feedback system has an open loop transfer function

$G(j\omega) = k / (j\omega\,(1 + j\omega)^2)$

For $k = 1$ obtain the open loop frequency response for ω equals 0.7 and 0.9 and 1 rad s^{-1} respectively. Plot the **Nyquist** diagram and find **GRPHICALLY** the closed loop magnitude and phase at $\omega = 0.9$ when $k = 1$ and when $k = 1.5$.

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Control Systems 93441 | **First Exam** | **Tues. 31/10/1995**

1

a) Imagine that you constructed a schematic block diagram to represent a control system regarding a person who is driving a motor cycle at constant speed and following a prescribed path for five hours.
In your diagram what represent :
the sensor , the comparator , the feedforward element , the disturbance and the parameter variations.

b) Given the block diagram shown in **Fig.1** :

i) Find c(t) when k = 100 and the set value is a unit step.
ii) What positive k will destabilize the system ?

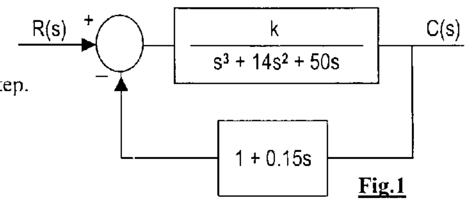

Fig.1

c) Using analog computers ;
simulate $\dot{x} + 8x = 40$; $x(0) = 3$ such that x and $\dot{x}$ are available for measurements .
sketch $\dot{x}(t)$.

2

a) If possible **; introduce minimum number** of components in order to have :

i) $\zeta = 0.75$ and steady state output = 2 , given $G(s) = \dfrac{1}{s^2 + 3s + 4}$

ii) $\zeta = 1$ and ω_n 4 rad/s , given G(s) as in (2ai) .

iii) $e_{ss} = \frac{1}{4}$ due to **a unit ramp** , given $g(s) = \dfrac{k}{s^3 - 2s^2 - 3s}$

b) Given $\dot{x} = -2x + 5h$ and $\ddot{h} = 6x - 15h + r(t)$;
represent as a block diagram with X(s) as output ; R(s) as set value ;
using integrators , any gains and two input comparators .

c) Using block diagrams reduction techniques .

Find $\dfrac{C(s)}{R(s)}$ for the diagram shown .