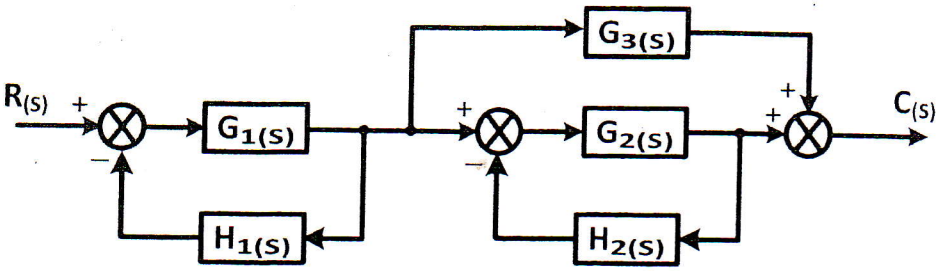
Minoufiya University
Faculty of Engineering, Shebin El Kom
Course: ***Control Systems***
Electrical Engineering Department

Third Year
Time: 3 Hours
Marks: 100
Date: 20/01/2014

ANSWER ALL THE FOLLOWING QUESTIONS:

Q1: Consider the block diagram of a system shown, [20 Marks]



a- Determine the transmittance;
b- Check the result by using **S.F.G.**
c- If one choose at r(t)=1; $G_1(s)$, $G_2(s)$, $G_3(s)$, $H_1(s)$ and $H_2(s)$ such that;

$$\frac{C_{(s)}}{R_{(s)}} = \frac{(S+20)}{S^2+7S+25}$$

1. Determine ζ, ω_n, τ, M_p, t_p, t_r and t_s.
2. Determine e_{ss}.

Q2: [10 Marks]

a. Examine the stability of the system whose characteristic equations;

1. $S^4+2S^3+3S^2+6S+1=0$
2. $S^5+S^4+4S^3+4S^2+2S+2=0$

b. Determine the condition of K to stabilize the system whose characteristic equation;

$$2S^4+2S^3+5S^2+S+k=0$$

Q3: The open loop transfer function of a control system; [15 Marks]

$$G_{(s)}H_{(s)} = \frac{K(S-1)^2}{(S+5)(S+3)^2}$$

a- Plot the Root Locus.
b- Determine K_{cr} and ω_n .
c- Discuss the conditionally stability of the system.

Q4: The overall transfer function of 6 control systems are; [15 Marks]

1. $\frac{C_{(s)}}{R_{(s)}} = \frac{1}{S(S+1)(S+2)}$
2. $\frac{C_{(s)}}{R_{(s)}} = \frac{S+3}{(S+5)(S^2+2S+2)}$
3. $\frac{C_{(s)}}{R_{(s)}} = \frac{S^2+S+4}{(S-0.01)(S+10)(S+100)}$
4. $\frac{C_{(s)}}{R_{(s)}} = \frac{K}{(S^2+1)(S+3)}$
5. $\frac{C_{(s)}}{R_{(s)}} = \frac{2S+5}{(S^2+2S+5)(S+0.2)}$
6. $\frac{C_{(s)}}{R_{(s)}} = \frac{3S^2+1}{(S^2-2S+5)(S+200)}$

Choose the correct answer from a and from b:

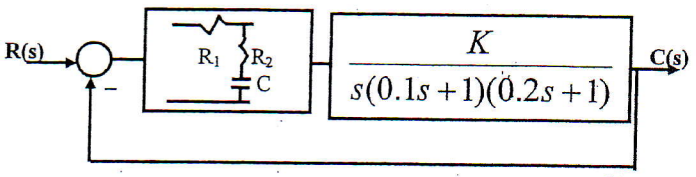
a. The resultant time characteristic is:
1. step,
2. exponential decay,
3. damped oscillation,
4. sustained oscillation,
5. exponential rise,
6. grow-up oscillation.

b. the system stability is:
1. stable,
2. conditionally stable,
3. critically stable,
4. unstable.

Put the answer in the form:

	System 1	System 2	System 3	System 4	System 5	System 6
a						
b						

5- For the third order servomechanism shown in the figure. It is required that the steady state error be 0.1 of the final output velocity and the phase margin be 50°. Design the required compensator and find the suitable values of R_1, R_2 and C to satisfy the above condition.



[20 Marks]

6- A. A linear multivariable system is described by the following set of differential equations:

$$y_1^{\bullet\bullet} + y_1^{\bullet} + 2y_1 - 2y_2 = U_1$$

$$y_2^{\bullet\bullet} - y_1 + y_2 = U_2$$

i- Write the state equations of the system in matrix vector form
ii- Write the output equation of the system in matrix vector form
iii- Find the transfer matrix between output vector and input vector

B. A closed loop multi-input multi-output system has a plant transfer matrix

$$G_p(s) = \begin{bmatrix} \frac{1}{2s+1} & 0 \\ 1 & \frac{1}{s+1} \end{bmatrix}$$

Determine the transfer matrix of the series compensator such that the closed loop matrix is:

$$G_{c.L}(s) = \begin{bmatrix} \frac{1}{s+1} & 0 \\ 0 & \frac{1}{5s+1} \end{bmatrix}$$

C. Consider the linear system whose Transfer function

$$\frac{Y(s)}{U(s)} = \frac{S+Z_1}{S^2+3S+2}$$

Determine the values of the parameter Z_1

For which the system is both state Controllable and observable

[20 Marks]