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

Final Exam

Time: 3 Hours
Code: ELE313
Marks: 100
Date: 18/01/2016

ANSWER ALL THE FOLLOWING QUESTIONS

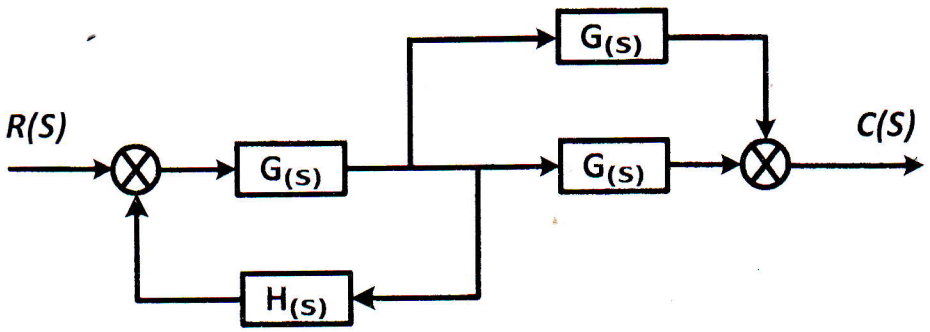
Q1: [15 Marks]

For the three control systems shown;

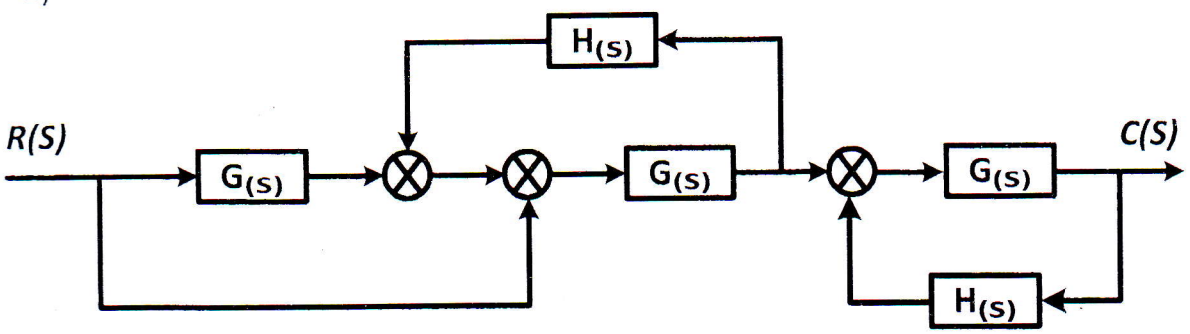
a) Put the suitable signs on the detecting points.

b) Determine $C_{(S)}/R_{(S)}$ by **two** different methods.

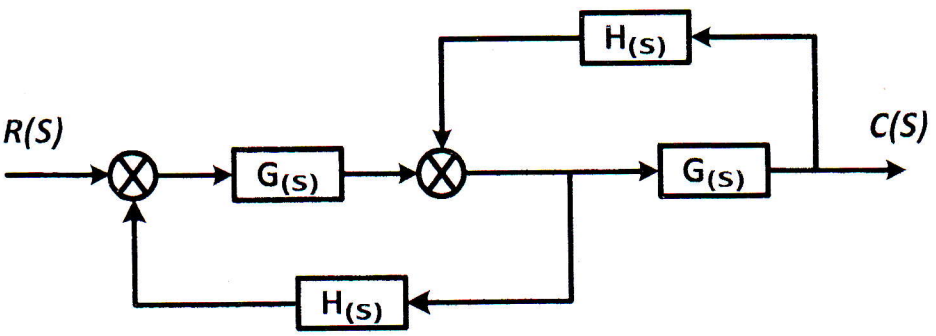
i)



ii)



iii)



Q2: [15 Marks]

a) Give a brief explanation on the following;

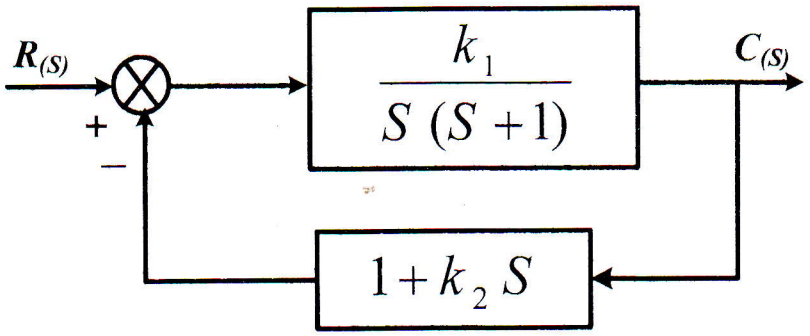
LVDT, Tachometer and Operational amplifier.

b) Consider the unity feed-back control system whose,

$$\frac{C_{(S)}}{R_{(S)}} = \frac{k\,(1+5S)}{S^4+2S^3+7S^2+5k\,S+k}$$

Determine the value of k if e_{ss}= **0.2**, when the system is subjected to unit step acceleration input signal.

c) Consider the system shown,



If μ_p = 20 % and t_p=1*sec*, determine the valueof k_1 and k_2.

Q3: [10 Marks]

The characteristic equations of the control systems are shown;

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

For each system;

a) Determine the number and probability type of roots at ***RHS***.

b) Examine the absolute stability and comment on the result.

Q4: [20 Marks]

The open loop transfer function of a control system is;

$$G(s)H(S)=\frac{k\,(S^2-2S+5)}{(S+2)(S^2+2S+2)}$$

a) Plot the root locus.

b) Determine the exact value of K_{cr} and ω_n.

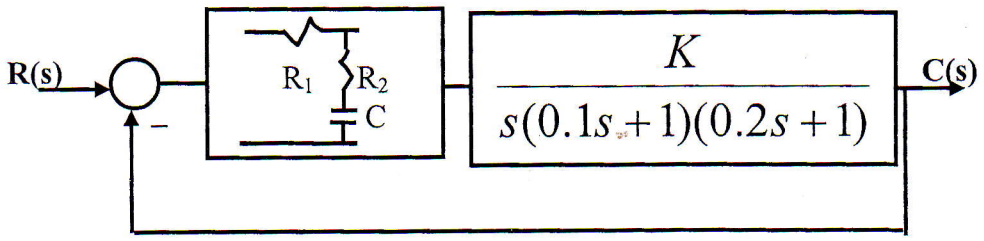
c) What is the condition value of k for stable operation?

d) What is the condition value of k for unstable operation?

e) What is the value of k so that, the system does not exhibit oscillation?

f) Determine the open loop gain K that give $\zeta=\sqrt{3}/2$.

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]