Date of Issue: 23.03.2016
Deadline: 11.04.2016, (must be submitted to Şirin Akkaya or Erhan Yumuk until 17.00).

KON 326E
COMPUTER CONTROLLED SYSTEMS
PROJECT – 2

1. Answer the questions below.

a) Write the frequency domain expression $G(j\omega)$ of the system having the transfer function $G(s)$ in terms of its magnitude and phase. By using this expression, write the steady state response $y_{ss}(t)$ in time domain when the input $x\ t\ = Asin(\omega_0 t)$ is applied to the system.

b) Define the *resonant frequency*, *resonant peak value* and the *bandwidth* which are frequency domain criterions. Explain the relationship between the time response and these criterions.

c) Explain the concept of *phase margin* and *gain margin* in frequency domain. Express the relationship between these notions and the stability of the linear minimum phase systems.

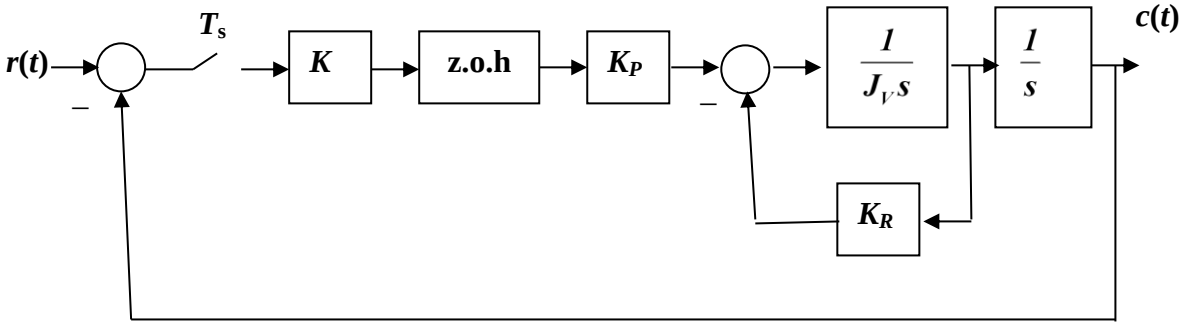
d) The systems $G_1\ s\ = \frac{1}{s\ s+2}$, $G_2\ s\ = \frac{1}{s\ s+0.5}$, $G_3\ s\ = \frac{1}{s\ s+0.5\ (s+2)}$ are given. Perform the followings using MATLAB and **interpret** if it is asked.

I. Apply the input signal $x\ t\ = 2\sin(5t)$ to all systems and plot the corresponding three responses on the same figure.

II. Calculate the *resonant frequency*, *resonant peak value* and the *bandwidth* of the closed loop systems obtained by adding feedback loops to the each of open loops systems $G_1\ s$, $G_2\ s$ ve $G_3\ s$. Plot the graphics of step responses of each closed loop sytem and **interpret** the results in the light of the frequency response criterions you found.

III. Plot the Bode diagrams of the systems $G_1\ s$, $G_2\ s$ ve $G_3\ s$ and find the gain and phase margins of them. Plot the root locus of $G_1\ s$ and **interpret** the relationship between its root locus and the gain margin. Add the gain margin value of $G_3\ s$ to the feedforward transfer function and find the closed loop poles of the system. Also, plot the step response of the closed loop systems and **comment** on the results you obtained.

2. The block diagram of the proportional digital control of a vehicle system by using its simplified linear continuous model is given as in the following figure.



System parameters in appropriate units are as follows:

$\boldsymbol{K_P}$ =1.65 x 10^6
$\boldsymbol{K_R}$ =3.71 x 10^5
$\boldsymbol{K}$ = 1
$\boldsymbol{J_V}$ = 41822

a) Find the open loop and the closed loop transfer functions of the system when the sampling switch is closed and the sample-and-hold block does not exist (in other words in the situation of continuous time proportional control). Obtain the unit step response and the frequency response (both for open loop –Bode diagram- and closed loop) by using MATLAB and SIMULINK.

b) Some values for sampling period $\boldsymbol{T_s}$ are given as: 0,005 s; 0,05 s; 0,1 s; 0,2 s; 0,5 s; 0,6 s; 0,6741 s; 0,7s.

I. Plot the discrete system responses for each sampling period given above and the continuous system response on the same figure.

II. Calculate the poles of the discrete closed loop system for each sampling period and show them on the z-plane.

III. Discuss and interpret the results you obtained in the light of your knowledge about choosing the sampling period and the frequency responses of the system (open loop and closed loop) that you found in part (a).