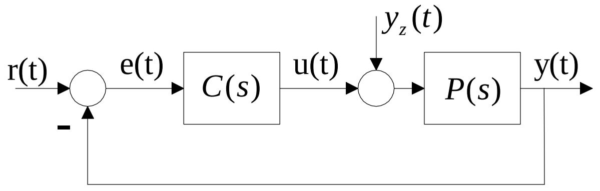
Control theory Exam, December 8, 2008

Name:________________________________

Points:_______________________________

1. Given the following control loop:



$$C(s) = 0.4\frac{1+5s}{s},\ P(s) = \frac{1}{(1+5s)(1+s)(1+0.2s)}$$

a./ Give the gain margin, phase margin and cut-off frequency of the system. Is the closed loop stable? **(4 points)**

In case of $r(t) = 0$ and $y_z(t) = 1(t)$,

b./ draw the y output signal of the system. **(4 points)**

c./ give the steady state value and settling time of the output signal. **(2 points)**

2. In a sampled data system the transfer function of the process is:

$$P(s) = \frac{0.4}{s^2 - 0.8s - 0.2}e^{-2s}.$$ The sampling time is $T_s=1$.

a./ Give the $G(z)$ discrete transfer function of the process in zero-pole form if zero order hold is applied **(4 points)**

b./ Is the $G(z)$ discrete transfer function stable? Explain your answer. **(2 points)**

c./ Give the values of the step response of $G(z)$ in first five sampling points. **(2 points)**

3. A continuous process is given by its state matrices:

$$A = \begin{bmatrix} -1 & 1 \\ 0 & -8 \end{bmatrix}, b = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, c = \begin{bmatrix} 2 & 0 \end{bmatrix}, d = 0.$$

a./ Design a state variable feedback control system that the closed loop system is a second order oscillating element with damping factor of 0.7 and time constant of 0.2. **(5 points)**

b./ Calculate the k_c input gain value for unity static reference following. **(2 points)**

4. The transfer function of a continuous plant is $P(s) = \frac{1}{(1+s)(1+10s)}$.

In case of $u(t) = \sin(0.5t)$ input signal the steady state output signal is $y(t) = A\sin(0.5t + \varphi)$.

Give the value of A and φ. **(5 points)**

Control theory Exam, December 8, 2008, Solution

1.
a.
s=zpk('s'),C=0.4*(1+5*s)/s, P=1/((1+5*s)*(1+s)*(1+0.2*s)), L=C*P,L=minreal(L)
figure(1),margin(L)

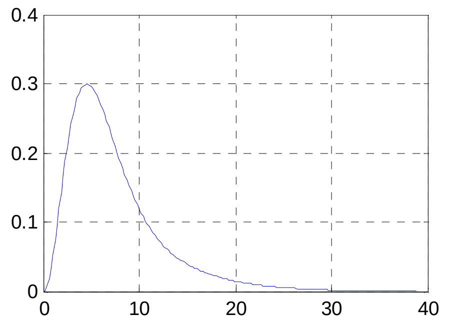
pm=65º, wc=0.37rad/sec, Gm=23.5dB,

gm=margin(L)

gm=15

Tz=P/(1+L),
figure(2), [y,t]=step(Tz),plot(t,y),grid

y_vég=0, ts== 20 sec



2.
a./
s=tf('s'), P=0.4/(s*s-0.8*s-0.2), P=zpk(P), %P=tf(P)%P=2/((s-1)*(5*s+1)), P=tf(P)
Ts=1, Td=2, d=Td/Ts, z=zpk('z',Ts),G1z=c2d(P,Ts),Gz=G1z/(z^d)

0.27065 (z+1.302)
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z^2 (z-0.8187) (z-2.718)

b. Unstable, the absolute value of a pole is greater than 1.

c.
y=step(Gz,5)

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y=     0
       0
       0
  0.2706
  1.5802
  5.6099
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3.
a=[-1, 1;0, -8], b=[1;1],c=[2, 0], d=0
T0=0.2, kszi=0.7, den=[T0*T0, 2*T0*kszi,1], pc=roots(den)

den = [0.0400 0.2800 1.0000],

pc =

-3.5000 + 3.5707i

-3.5000 - 3.5707i

k=acker(a,b,pc), G=1/dcgain(a-b*k,b,c,d)

K= 2.3750 -4.3750

G = 1.3889

4.
s=zpk('s'), P=1/((1+1*s)*(1+10*s)),
w=0.5, [m,f]=bode(P,w)
A=m, fi=f

A=0.1754
f i=-105.2551