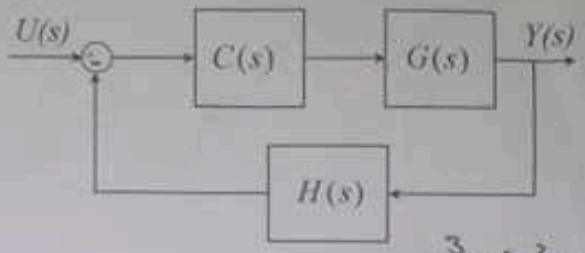
Control theory I	First Exam (Fall 2020-2021)	Date 20/03/2021 Time : 1:30 hour

Q1 *(5 points)*. For the control system of figure (1),

$G(s)=\dfrac{1}{(s+2)(s+3)}$, $C(s)=K$

and $H(s)=\dfrac{1}{(s+1)}$. Find :

a) The overall transfer function.
b) The open loop transfer function.
c) The characteristic equation of this system.
d) The values of the gain K that keeps this control system stable.



$s^3+6s^2+11s+6=0$

Figure (1)

Q2 *(3 points)*. Find the overall transfer function of the control system of figure (2).

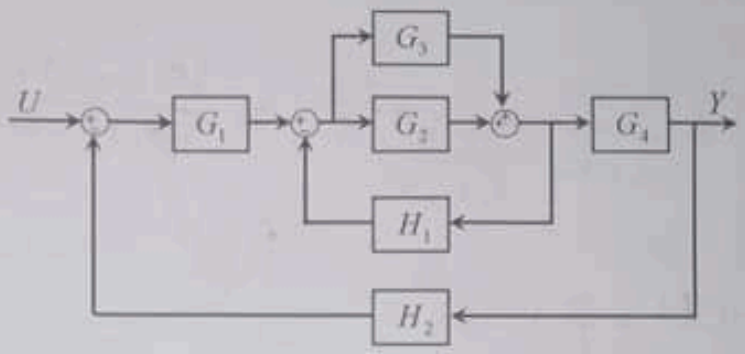


Figure (2)

Q3 *(4 points)*. Consider the liquid storage tank schematized as in figure (3). The differential equation describing the behaviour of this system is given as $h'(t)=K_1(F_{in}(t)-F_{out}(t))$. The output flow rate is given as $F_{out}(t)=K_2h(t)$. (K_1 and K_2 are constants)

(a) Find the transfer function that relates h to F_{in} with the initial condition $h(0)=0$.
(b) If the input F_{in} is a unit step signal express the output signal ($h(t)$) as a function of time.

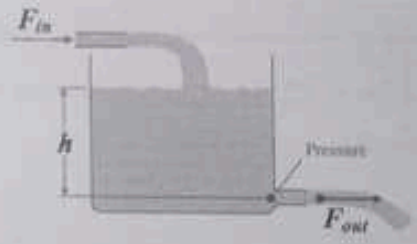


Figure (3)

Q4 *(4 points)*. For the control system of the figure *(4-a)*, $G_c(s)=K$ and

$G(s)=\dfrac{2}{(s+b)}$. Knowing that an input signal $U(s)=\dfrac{10}{s}$ gives the output signal plotted in figure (4-b). Find:

a) The overall transfer functions of the system.
b) The values of K and b.
c) The expression of the error signal as a function of time e(t).
d) The position error coefficient (K_p) of the system.

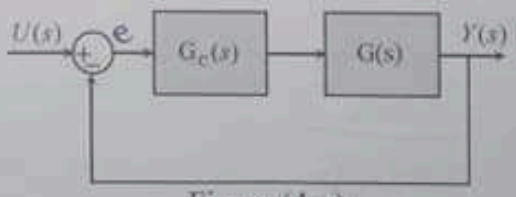


Figure (4-a)

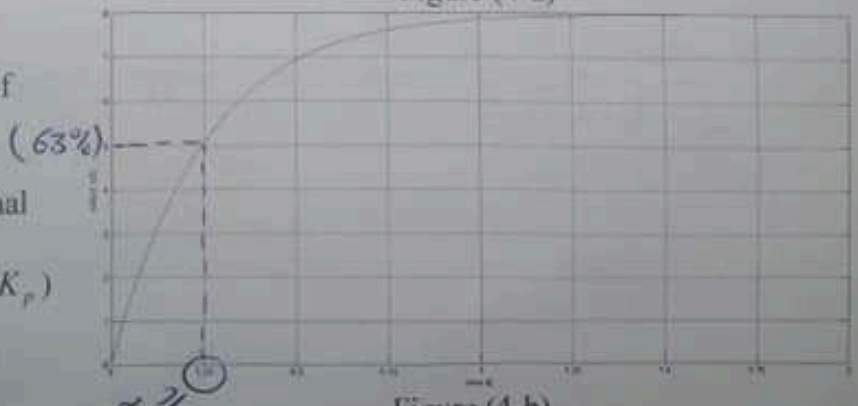


Figure (4-b)