Misurata University Faculty of engineering Petroleum Engineering Department	**Instrumentation and control** **Final exam**	Fall 2022/2023 Date : 16/02/2023 Time : 2:30 hours

Q1 (8 points). For the system of figure (1), determine the values of K, and a such as the overall system has a damping of 0.7 and undamped natural frequency of 4 rad/sec.

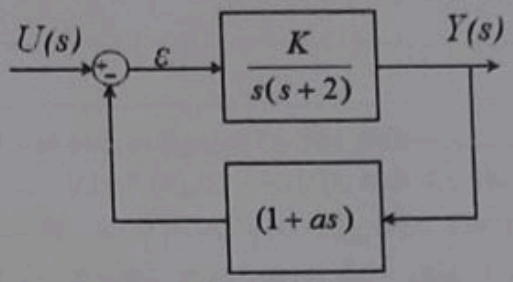

Figure (*1*)

Q2 (12 points). For the system of figure (2-a) the forcing function F is a step input of 2 Newton. Knowing that the transfer function of the system is $\frac{X(s)}{F(s)} = \frac{1}{ms^2+bs+k}$ where and m is the mass of the body, k is the spring constant and b is the friction coefficient. If the response of the system was the function of the figure (2-b) find m, b and k.

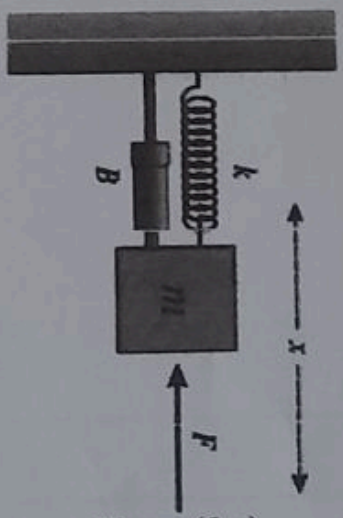

Figure (*2-a*)

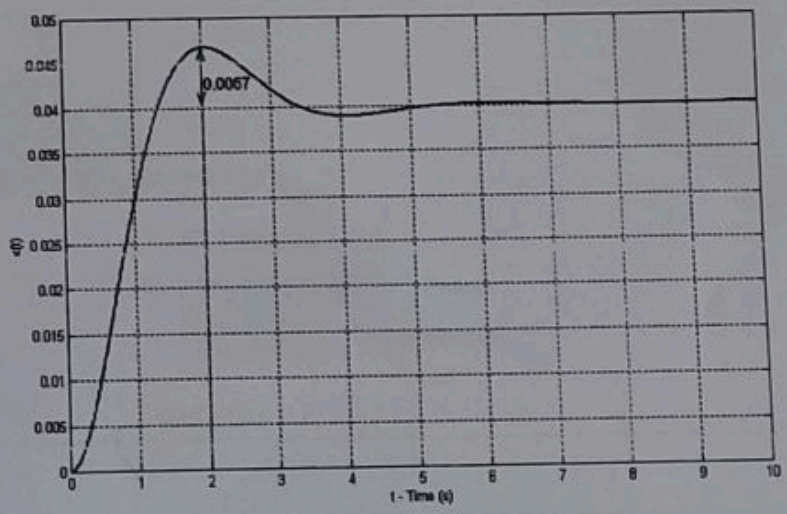

Figure (*2-b*)

Q3 (8 points). Find the overall transfer function for the system given in Figure (3)

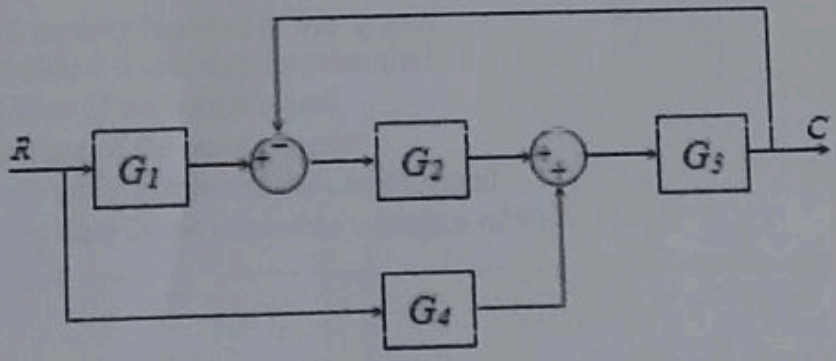

Figure (*3*)

Q4 (4 points). For a second order system described by the transfer function $G(s)=\dfrac{2}{(s^2+3s+12)}$, determine the rise time and the peak time and the maximum overshoot for the system's response to a unit step input..

Q5 (12 points). Consider the cascaded liquid storage tanks shown in figure (5). The differential equation describing the behaviour of the first tank is given as $h_1'(t)=8\,(F_{in}(t)-F_{12}(t))$ and the differential equation describing the behaviour of second tank is given as $h_2'(t)=10(F_{12}(t)-F_{out}(t))$. The first tank output flow rate is given as $F_{12}(t)=0.0625\,h_1(t)$ and the second tank output flow rate is given as $F_{out}(t)=0.05h_2(t)$. Assuming that the two tanks were empty at initial time, find the following:

(a) The transfer function that relates h_1 to F_{in}.
(b) The transfer function that relates h_2 to F_{12}.
(c) The transfer function that relates h_2 to F_{in}.
(d) Find $h_2(t)$, If $F_{in}(t)$ is a unit step signal.
(e) The time constant of the first tank, and the time constant of the dynamic between $h_2(t)$ and $F_{in}(t)$.

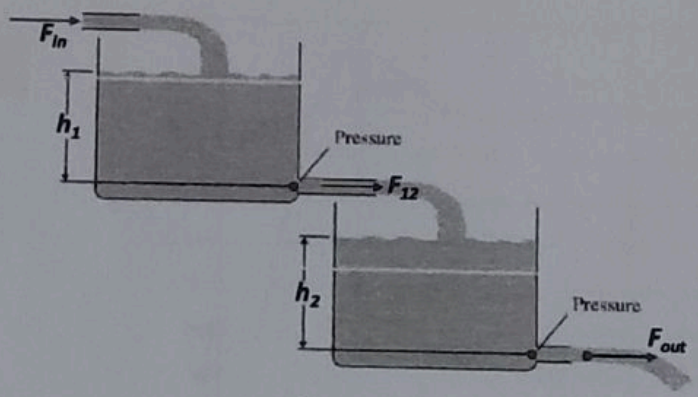

Figure (5)

Q6 (6 points). Consider the system described by the block diagram of the figure (2) with $G(s)=\dfrac{9}{s^2+3s+8}$, and $H(s)=\dfrac{1}{9}$.

(a) Find the overall transfer function of this system.
(b) If the input function is a unit step function find:
- the rise time of the output signal
- the peak time of the output signal
- the maximum overshoot of the output signal
- the setting time for an allowable tolerance of 5%

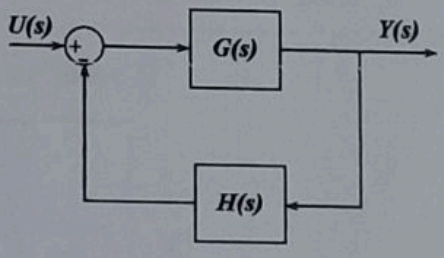

Figure (2)