***Q1** (5 points). Modelling a Hydraulic Piston. Consider the hydraulic piston described in Figure (1).*

Consider that the input variable is the applied force F_D and the output variable is the displacement of the position x. Given that the differential equation that describes the motion of the piston is:

$$M\,x'' = F_D - A\,p$$

where A is the area of the piston, M is the Mass of the piston and p is the pressure in the chamber given as $p = K\,x$ for some constant K. Find the transfer function that relates the output variable to the input variable.

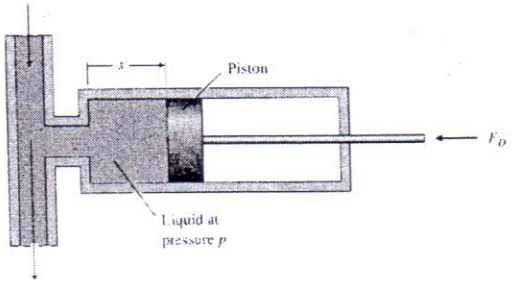

Figure (*1*)

***Q2** (5 points). For the system described by the block diagram of figure (2) find the overall all transfer function that relates the output signal $V(s)$ to the input signal $R(s)$.*

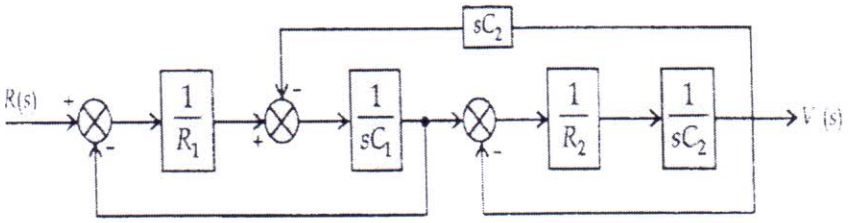

Figure (*2*)

***Q3** (5 points). For the closed loop control system shown in figure (3).*

- Determine the value of the two system variables K and α so that the maximum overshoot is 25% and the peak time is 2 sec.
- Find also the corresponding values of the rise time and the setting time.

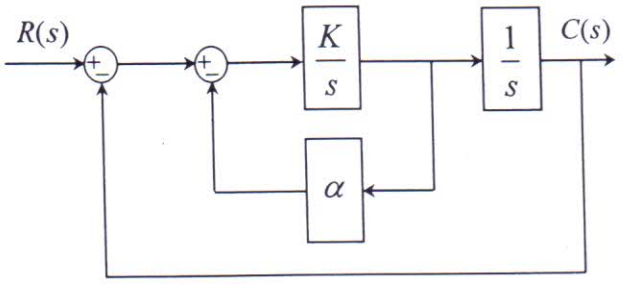

Figure (*3*)

***Q4** (5 points). For the system described by the block diagram of figure (4) find the overall all transfer function that relates the output signal $Y_1(s)$ to the input signal $U_1(s)$.*

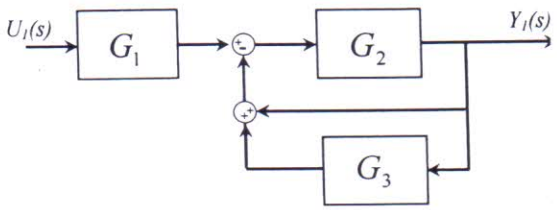

Figure (*4*)