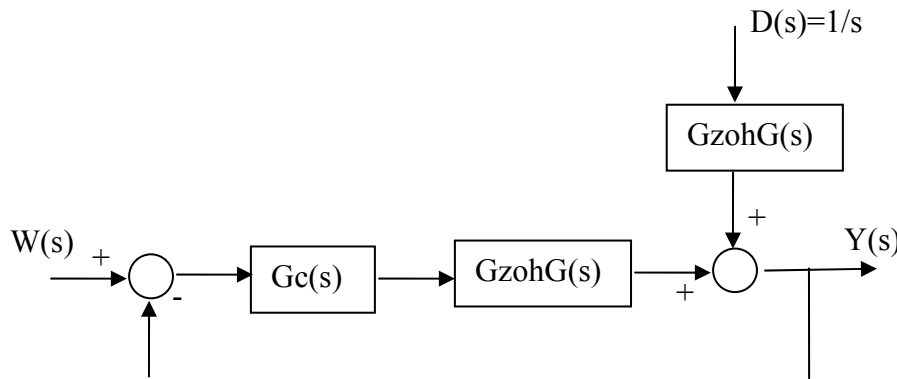


$$T_s = 10 \text{ msec}$$

1. a) Re-write the problem so it is completely in the s-domain
- b) Make the disturbance zero and let  $G_c(s) = K$ . Find the sensitivity of  $Y(s)/W(s)$  to the gain  $K$  for both the open-loop and unity feedback case when the nominal value is  $K=100$  and the input is a unit step.
- c) Predict how the steady-state response will change if  $K$  increases by 10% for both the open-loop and closed-loop configurations.
  
2. a) Let the disturbance be a unit step (constant). Design a Robust digital compensator,  $G_c(z)$ , which will meet the following specifications
  1. Closed-loop system is stable
  2.  $t_s$  due to a step is less than 2 seconds
  3.  $e_{ss}$  due to a step is zero
  4.  $M_p < 5\%$  (remember Mohannad's 4.32% means  $\zeta = 0.707$ )
  5. Steady-state error due to the constant disturbance  $d(t)=u(t)$  is minimized
- b) Use Simulink to verify your design (in the s-plane using  $G_c(s)$ ). Initially, set the disturbance to zero and measure your transient ( $t_s$  and  $M_p$ ) and steady-state error specs. Then, set the disturbance to a unit step and verify that its effect is negligible
- c) Your book discusses the case when your disturbance occurs at the output. I made the statement in class that the model we use is the same as the model in the book if we simply put  $G_{zoh}G(s)$  as a pre-filter to the output disturbance. Implement the following diagram on Simulink using your values of  $G_{zoh}G(s)$  and  $G_c(s)$  to verify the output is the same as in part b)



- d) Find  $G_c(z)$  using any method you wish (since there is no derivative term, we can use the bilinear transform).