



Question 1 (10 points)

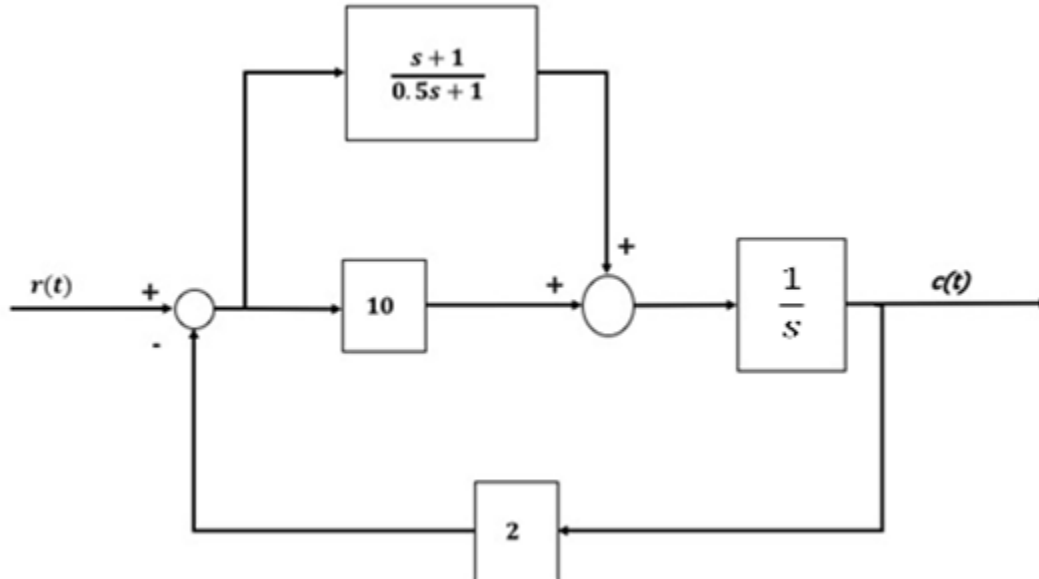
For each of the following control systems, specify whether the system is an open or closed loop control system (1 point each), explaining why (1 point each)

Example: Fan → open (1 point), does not receive feedback about room temperature (1 point)

- a. Air-Conditioning (2 points)
- b. Cruise Control (2 points)
- c. Washing Machine (2 points)
- d. Time-controlled Dryer (2 points)
- e. Camera-controlled Traffic Signal (2 points)

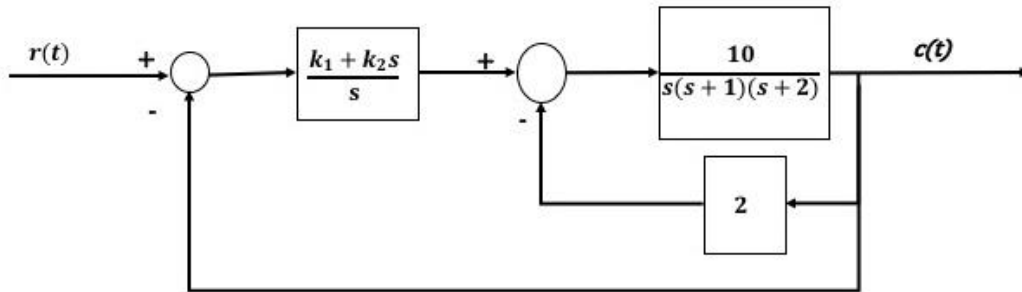
Question 2 (10 points)

Find the closed-loop transfer function for the following system (5 points), then determine and plot the unit-step response of the system (5 points).



Question 3 (10 points)

Find the closed-loop transfer function for the following system (5 points). Also, find $E(s)/R(s)$ and then find the steady-state error value if the input is a ramp function (5 points)



Question 4 (10 points)

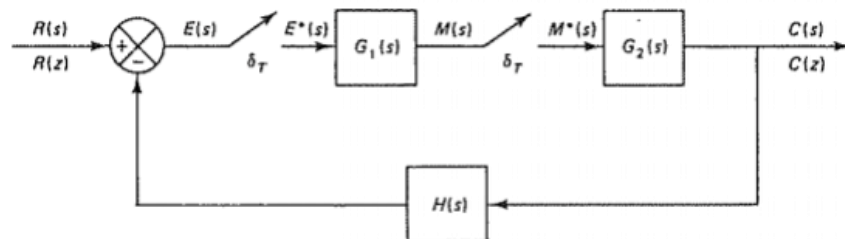
A discrete-time system is represented by the transfer function

$$G(z) = \frac{Y(z)}{X(z)} = \frac{0.75(z+1)}{z^2 - 0.7z + 0.12}$$

- Determine the corresponding difference equation (5 points)
- Determine and plot the unit-step response of the system (5 points)

Question 5 (10 points)

Simplify the block diagram below and find $C(z)$



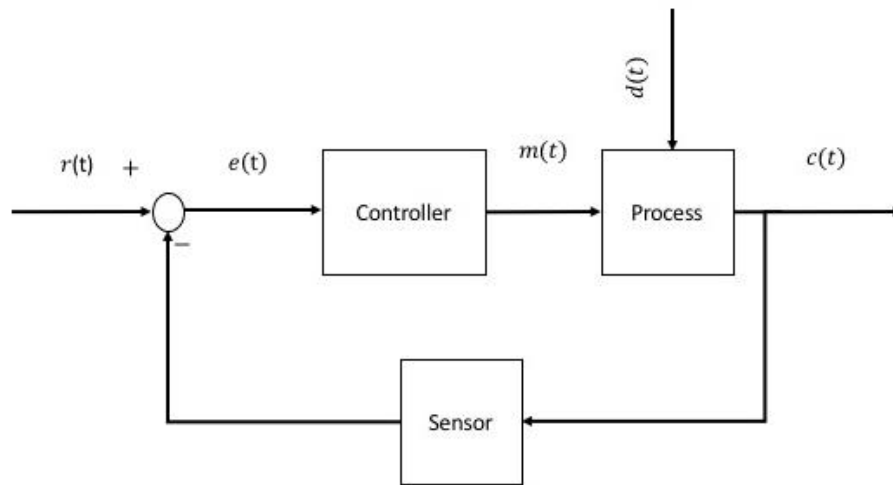
Question 6 (10 points)

Find the stability constraints on K_p and K_i for the following characteristic equation, and plot the stability region (on a $K_p - K_i$ plane)

$$F(z) = z^2 + (cK_pT + cK_iT - 2)z + (1 - cK_pT) = 0$$

Bonus Question (10 Points)

For each of the systems in question 1, identify the signals of the system as shown in the block diagram below



Hint: For an open-loop system, the sensor and the error signal do not exist