DATE: SUBJECT:

Types of Systems

- Electrical systems
- mechanical systems → Linear / Rotational
- Electromechanical systems

Modeling of systems

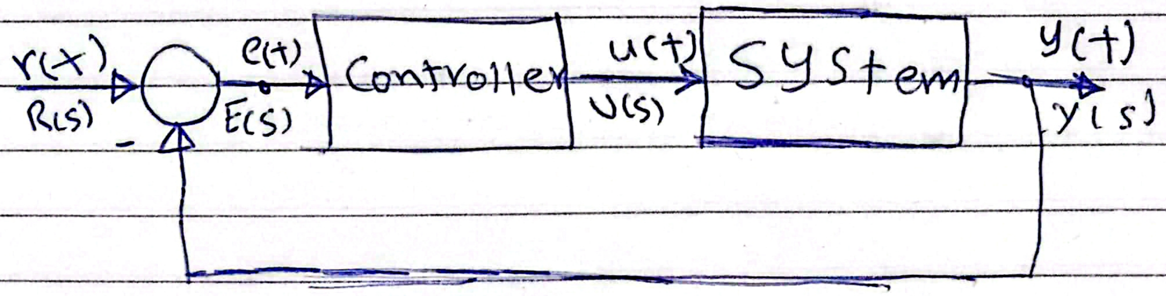
mathimatical	Graphical
- Transfer function	- Block digram
- Differential equation	- Root locus
- state space modeling	- Bode digram
	- state digram

System Analysis

- Stability
- Response time

Controller design:

- PID (Propotional - integral - derivitive) Controller
- Phase lead Compansator
- Phase lag Compansator.



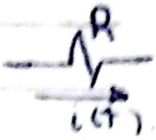
Closed loop system

DATE: SUBJECT:

→ Electrical System :-

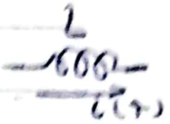
t-domain → $i(t)R = V(t)$, $I(t) = \frac{V(t)}{R}$

s-domain → $I(s)R = V(s)$, $I(s) = \frac{V(s)}{R}$



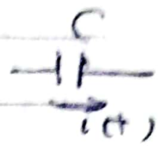
t-domain → $L\frac{di(t)}{dt} = V_L(t)$, $I_L = \frac{1}{L}\int V_L\,dt$

s-domain → $LS\,I(S) = V_L(S)$, $I(S) = \frac{1}{LS}V(S)$

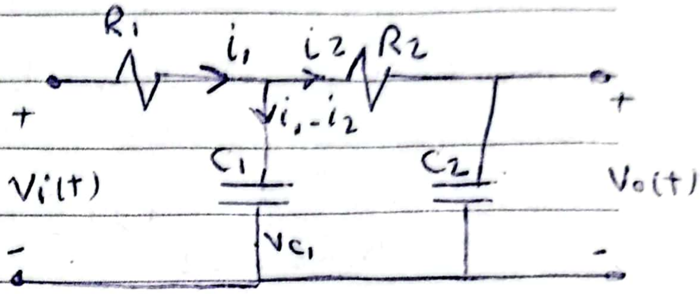


t-domain → $\frac{1}{C}\int i(t)\,dt$, $I_C = C\frac{dv_c}{dt}$

S-domain → $\frac{1}{CS}I(S) = V(S)$, $I_c(s) = CS\,V(S)$



① find differential equation and transfer function:-



* Apply KVL.

$V_i(t) = i_1(t)R_1 + V_{C_1}$ → ①

$V_{C_1} = i_2(t)R_2 + V_o(t)$ → ②

② in ① → $V_i(t) = i_1(t)R_1 + i_2(t)R_2 + V_o(t)$

→ use Current laws

$i_1(t) = C_1\frac{dv_{c_1}}{dt} + i_2$ ③

$i_2(t) = C_2\frac{dv_o}{dt}$ ④

④ in ③ → $i_1(t) = C_1\frac{dv_{c_1}}{dt} + C_2\frac{dv_o}{dt}$

* $V_i(t)$ في $i_2(t)$, $i_1(t)$ نعوض عن

$V_i(t) = R_1C_1\frac{dv_{c_1}}{dt} + R_1C_2\frac{dv_o}{dt} + R_2C_2\frac{dv_o}{dt} + V_o(t)$

$V_i(t) = R_1C_1\frac{d}{dt}\left(R_2C_2\frac{dv_{o}}{dt} + V_o(t)\right) + (R_1C_2 + R_2C_2)\frac{dv_o}{dt} + V_o(t)$

$V_i(t) = R_1R_2C_1C_2\frac{d^2v_o}{dt} + (R_1C_1 + R_1C_2 + R_2C_2)\frac{dv_o}{dt} + V_o$

$R_1R_2C_1C_2\ddot{y}(t) + (R_1C_1 + R_1C_2 + R_2C_2)\dot{y}(t) + y(t) = u(t)$ //

Differential equation

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DATE : ______ SUBJECT : ______

* D.f : الخرج وتفاضلاته في الجزء الأيسر والدخل في الايمن

* يُفضل جعل أعلى درجة تفاضل معاملها يكون بـ 1

$$\ddot{y}(t) + \left(\frac{1}{R_2C_2}+\frac{1}{R_2C_1}+\frac{1}{R_1C_1}\right)\dot{y}(t) + \frac{1}{R_1R_2C_1C_2}\,y(t) = \frac{1}{R_1R_2C_1C_2}\,u(t)$$

* Apply laplace Transform :-

$$T.f = \frac{Y(S)}{U(S)} = \frac{V_o(S)}{V_i(S)}$$

$$S^2 Y(S) + \left(\frac{1}{R_2C_2}+\frac{1}{R_2C_1}+\frac{1}{R_1C_1}\right) S\,Y(S) + \frac{1}{R_1R_2C_1C_2}\,Y(S) = \frac{1}{R_1R_2C_1C_2}\,U(S)$$

$$T.f = \frac{Y(S)}{U(S)} = \frac{1/R_1R_2C_1C_2}{S^2 + \left(\frac{1}{R_2C_2}+\frac{1}{R_2C_1}+\frac{1}{R_1C_1}\right)S + \frac{1}{R_1R_2C_1C_2}}$$

$V_i(t) \rightarrow V_I(S)$

$V_o(t) \rightarrow V_o(S)$

$R(t) \rightarrow R$

$L \rightarrow LS$

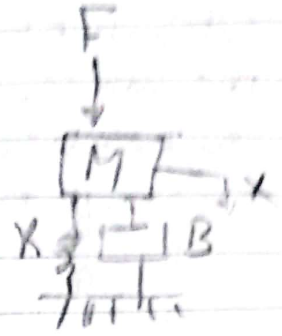
$C \rightarrow \frac{1}{CS}$

لو مش مطلوب D.E ممكن نحول لـ laplace في البداية ونحل عادي ونحصل على T.F.

DATE: SUBJECT:

Mechanical system

(1) Linear system



$$\boxed{\sum F = Ma = M\ddot{x}}$$

$$F - F_s - F_d = M\ddot{x}$$

$$F_s \propto x \longrightarrow F_s = Kx$$

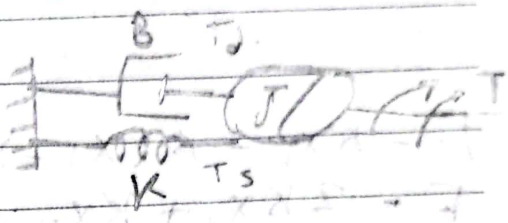
$$F_d \propto \dot{x} \longrightarrow F_d = B\dot{x}$$

$$F - Kx - B\dot{x} = M\ddot{x}$$

$$F = (Ms^2 + Bs + K)x$$

$$\frac{x}{F} = \frac{1}{Ms^2 + Bs + K} : T.F \quad \#$$

(2) Rotational System



عزم القصور الذاتي

عزم الازدواج

$$\sum T = J\ddot{\theta} \longrightarrow$$ العجلة الزاوية

$$T_d = B\dot{\theta} \longrightarrow$$ السرعة الزاوية

$$T_s = K\theta \longrightarrow$$ زاوية الدوران

$$T - T_d - T_s = J\ddot{\theta}$$

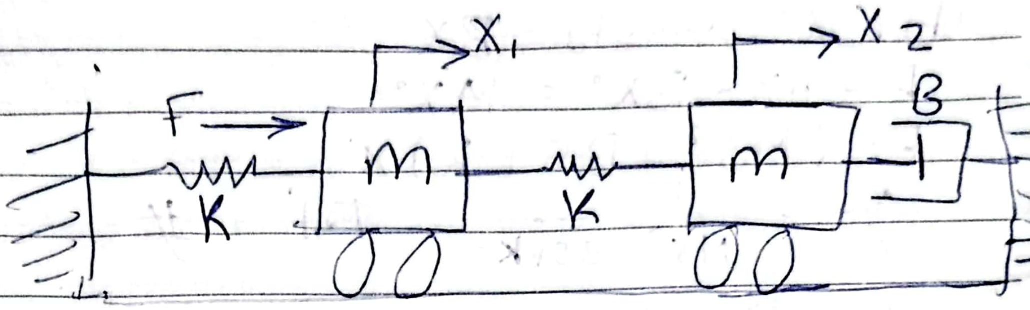
$$T - B\dot{\theta} - K\theta = J\ddot{\theta}$$

$$T = (Js^2 + Bs + K)\theta$$

$$\frac{\theta}{T} = \frac{1}{Js^2 + Bs + K} \quad \#$$

DATE: SUBJECT:

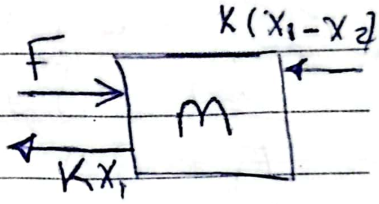
(2) A coupled spring-mass system is shown below the masses and springs are assumed to be equal, obtain the differential equations describing the system and the transfer function.



$F - Kx_1 - K(x_1 - x_2) = m\ddot{x}_1$

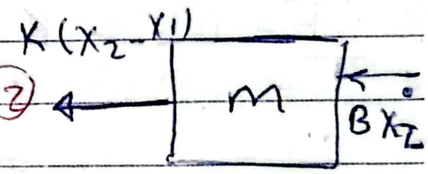
$F - 2Kx_1 + Kx_2 = m\ddot{x}_1$

$m\ddot{x}_1 + 2Kx_1 - Kx_2 = F$ (1)



$-K(x_2 - x_1) - B\dot{x}_2 = m\ddot{x}_2$

$m\ddot{x}_2 + B\dot{x}_2 + Kx_2 - Kx_1 = 0$ (2)



$$T.F = \frac{X(s)}{F(s)}$$

From (1) $(ms^2 + 2K)x_1 - Kx_2 = f$

(2) $(ms^2 + Bs + K)X_2 = KX_1$

$$\frac{(ms^2 + 2K)(ms^2 + Bs + K)X_2}{K} - KX_2 = f$$

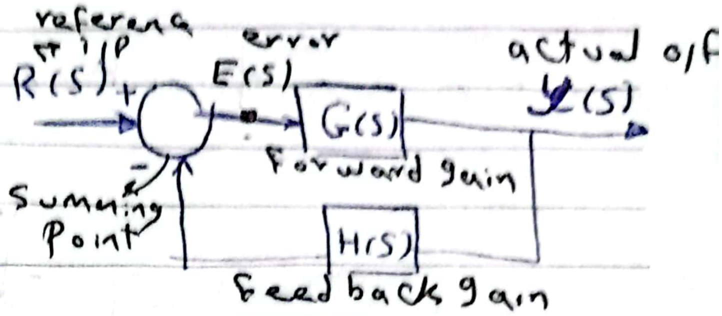
$$\left((ms^2 + 2K)(ms^2 + Bs + K) - K^2\right)X_2 = KF$$

$$\frac{X_2(s)}{F} = \frac{K}{(ms^2 + 2K)(ms^2 + Bs + K) - K^2}$$

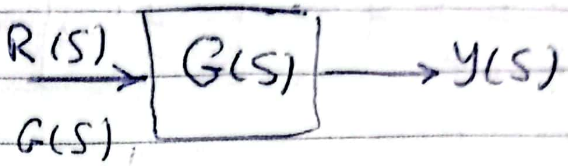
* Block digram

O.L.T.F : $GH(S)$

Closed loop : $\frac{C(S)}{R(S)}$



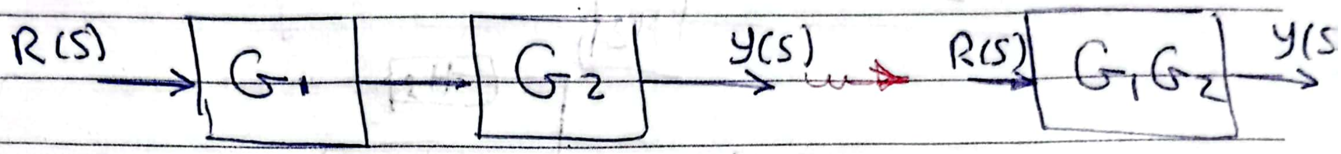
$$G(S) = \frac{Y(S)}{R(S)}$$



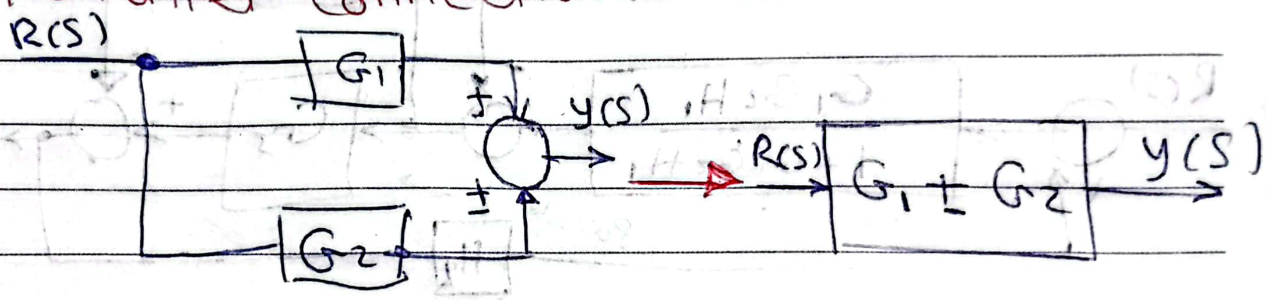
$Y(S) = R(S)\,G(S)$

*Reduction Rules

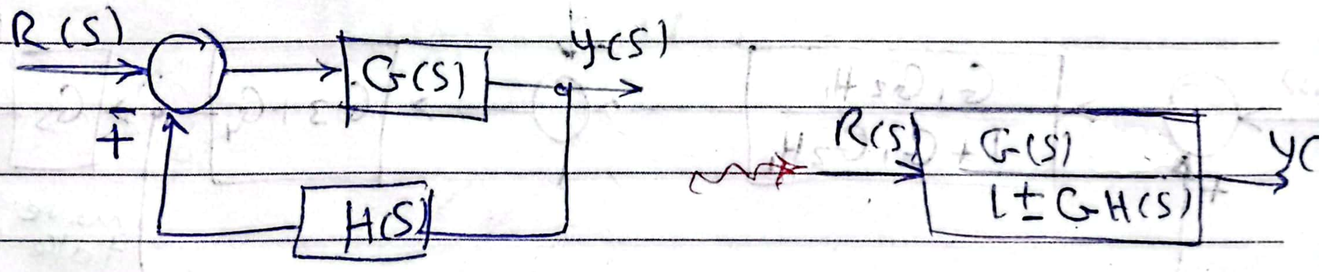
- Series Connection



- Parallel Connection

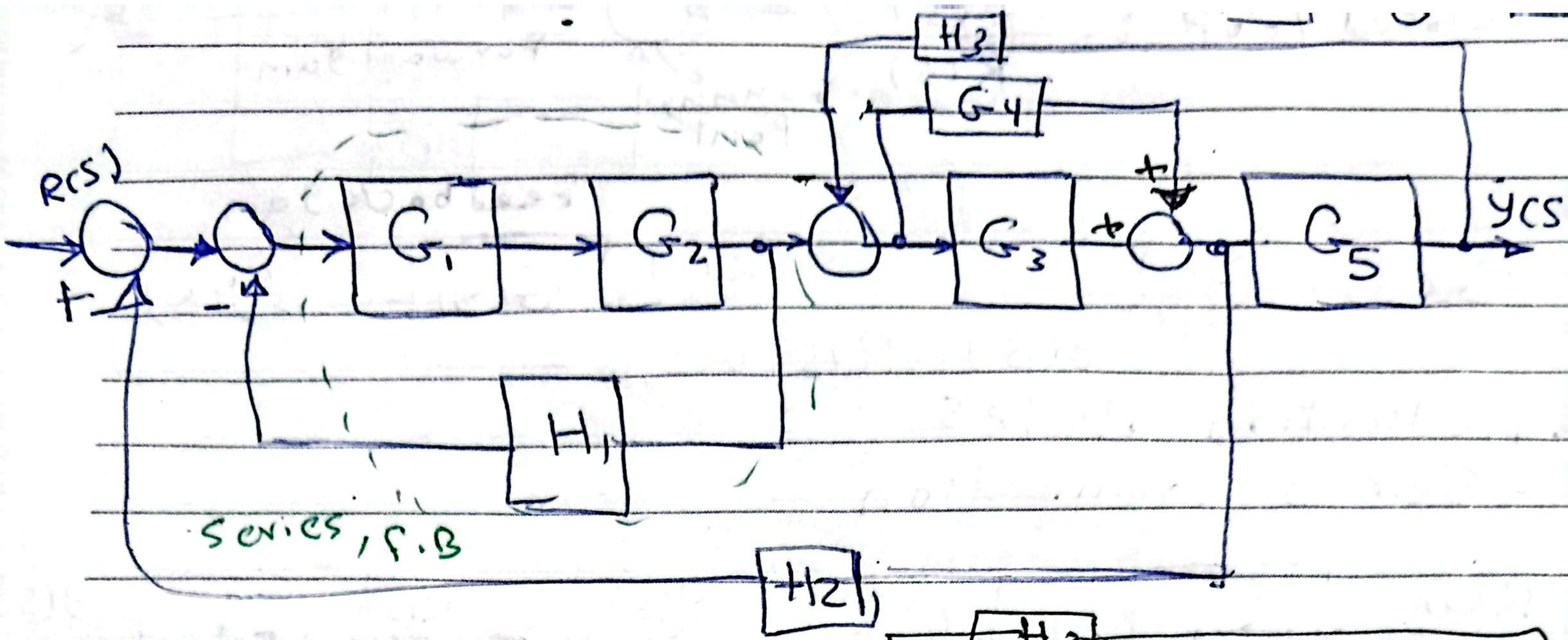


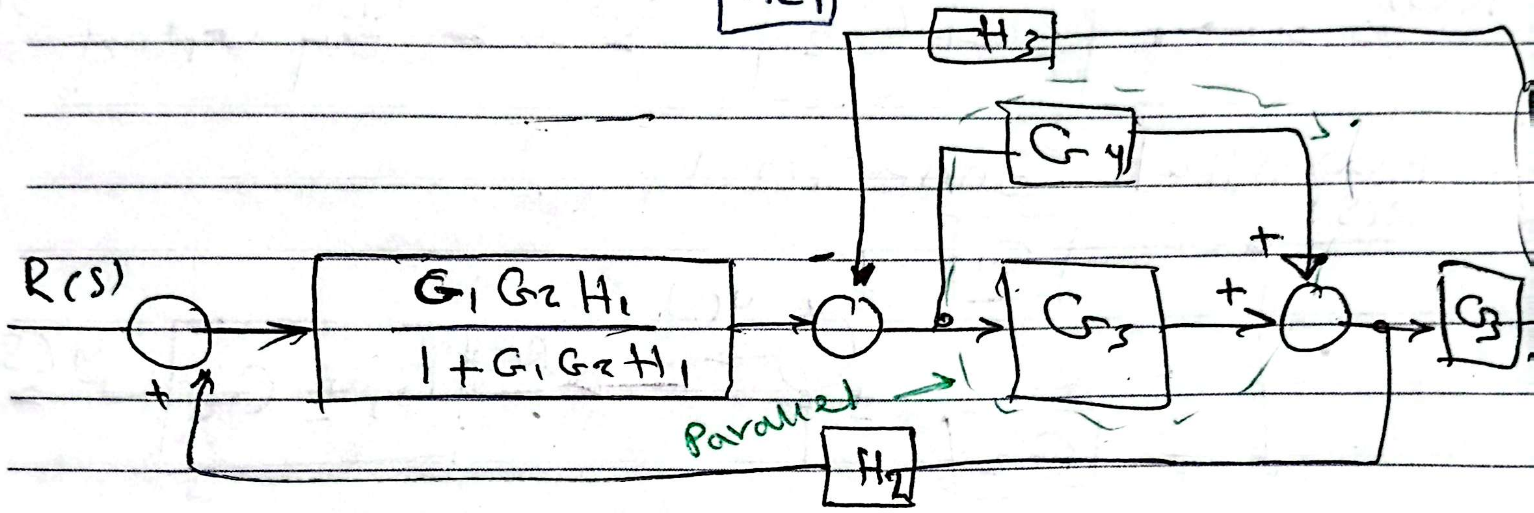
- feed back Connection:

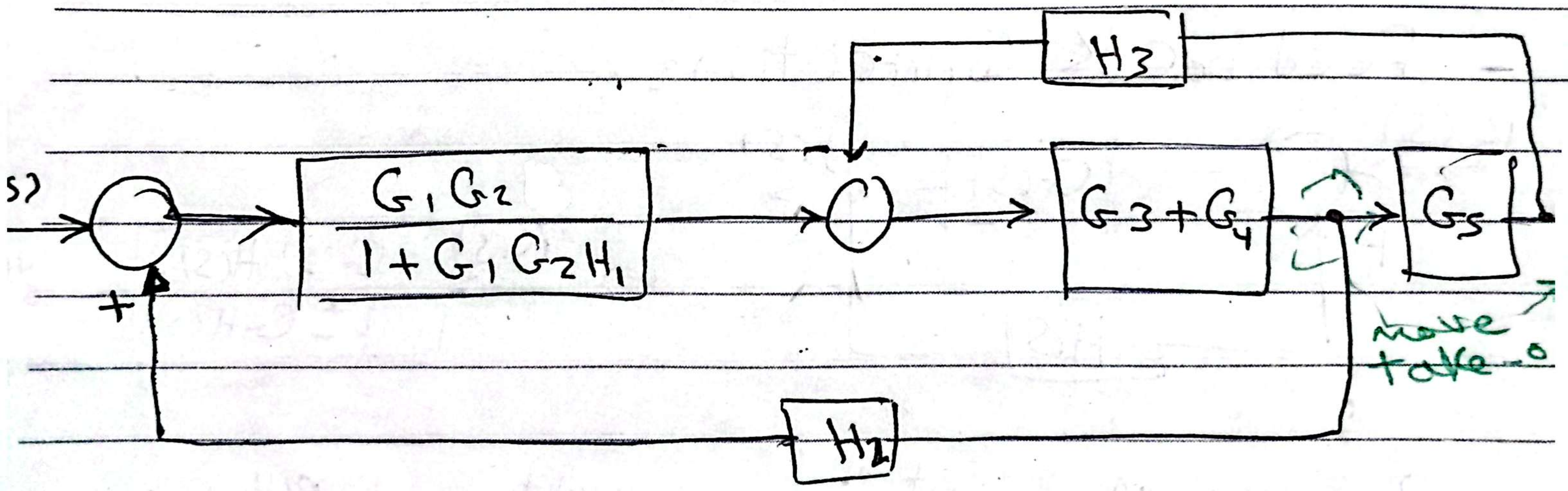


* 2 Summing Point : move right multiPly Gain, left d

2 take off Point : right → divide , left multip







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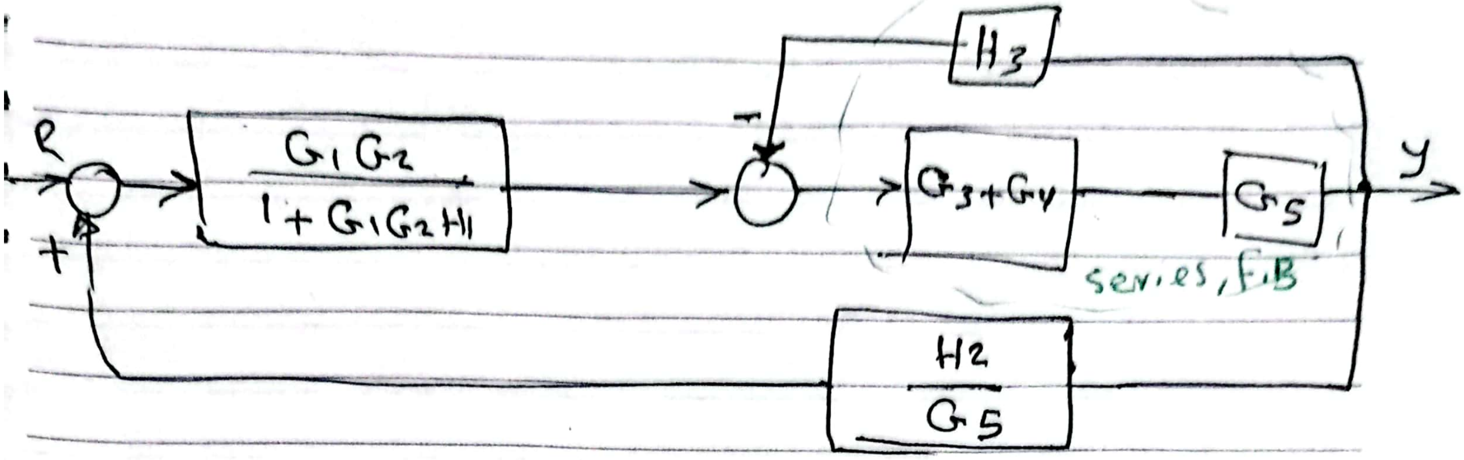
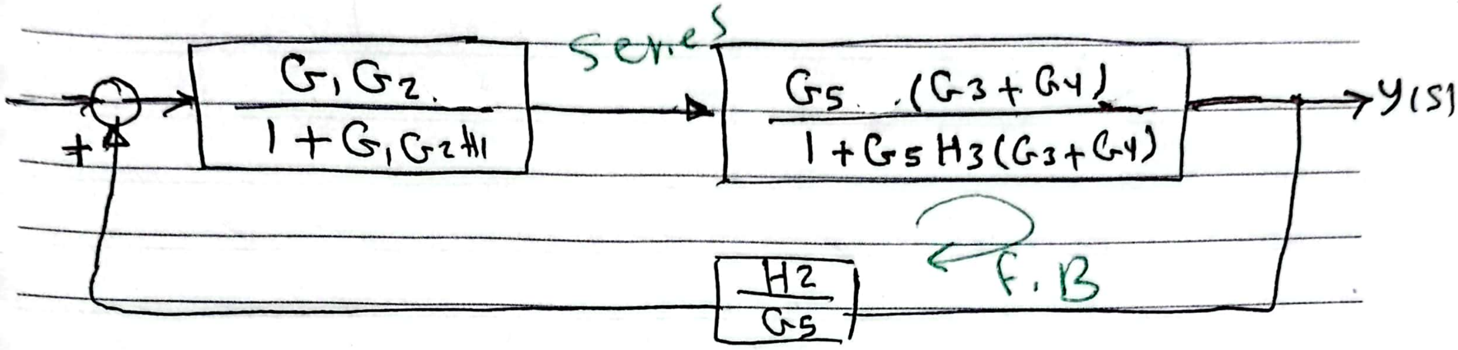
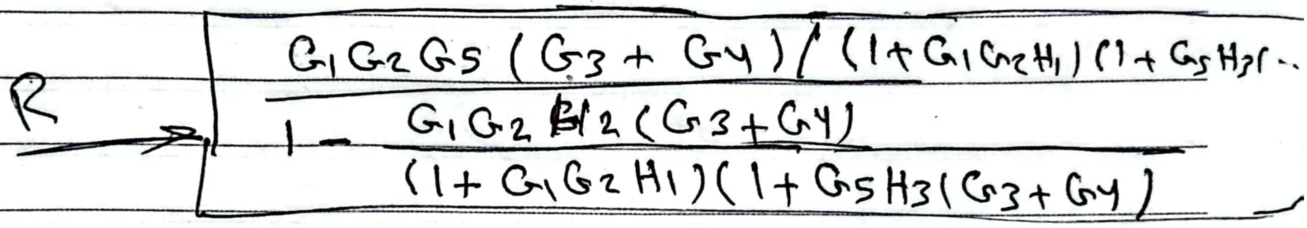
CS CamScanner







$$\frac{Y(S)}{R(S)} = \frac{G_1G_2G_5(G_3+G_4)}{(1+G_1G_2H_1)(1+G_5H_3(G_3+G_4)) - G_1G_2H_2(G_3+}$$

CS CamScanner