$L_{E2} = \frac{1}{C_m BW}$ $C_{E2} = \frac{C_m BW}{\omega_c^2}$

~~EE231~~

Not used for EE231
EE231 different code
(with EE222, PE101
EE221

~~mid lab end (quest single)~~

Explo

$$X(S) \longrightarrow \boxed{G_1(S)} \xrightarrow{Z(S)} \boxed{G_2(S)} \longrightarrow Y(S)$$

concept

$\rightarrow Y(S) = Z(S) \cdot G_2(S)$

$\rightarrow Z(S) = X(S)\ G_1(S)$

$\rightarrow Y(S) = X(S) \cdot G_1(S) \cdot G_2(S)$

$\rightarrow \boxed{\frac{Y(S)}{X(S)} = G_1(S) \cdot G_2(S)}$

$$\Delta P_{GW1} = \Delta P_{dW1} \times \frac{1}{1+sT_{WD1}} \times K_{W1}$$

$$\boxed{\frac{\Delta P_{GW1}}{\Delta P_{dW1}} = \frac{K_{W1}}{1+sT_{WD1}}} \longrightarrow \text{I}$$

$\Delta P_{GW1} + s\Delta P_{GW1} T_{WD1} = K_{W1} \times \Delta P_{dW1}$

$\Delta P_{GW1} + d(\Delta P_{GW1}) T_{WD1} = K_{W1} \times P_{dW1}$

$$\boxed{d(\Delta P_{GW1}) = \frac{+K_{W1} P_{dW1}}{T_{WD1}} - \frac{\Delta P_{GW1}}{T_{WD1}}}$$

$\dot{\Delta P}_{GW1}$ P_{dW1} ΔP_{GW1}

26

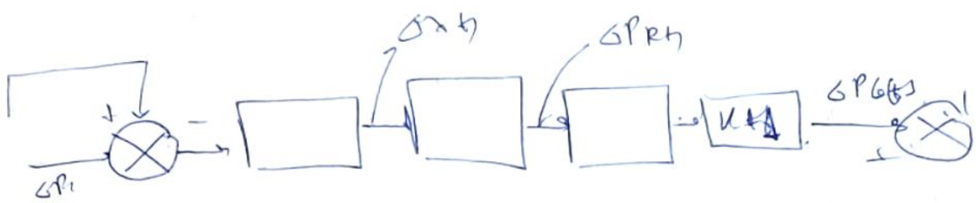
$$[\dot{\Delta P}_{GW1}] = \begin{bmatrix} \frac{K_{W1}}{T_{WD1}} & -\frac{1}{T_{WD1}} \end{bmatrix} \begin{bmatrix} \Delta P_{dW1} \\ \Delta P_{GW1} \end{bmatrix} \quad 26$$

ΔP_d will belongs to C

ΔP_{GW1} belongs to A

$+ \frac{\omega_c^2}{C_m BW}$

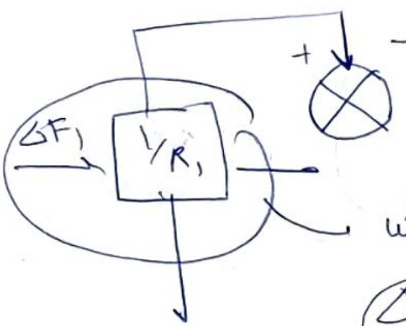
(II)



$$\boxed{\frac{\Delta P_{Gt1}}{\Delta P_{Rt1}} = \frac{1 + S K_{r1} T_{r1}}{1 + S T_{r1}} \times K_{t1}} \rightarrow \text{(II) (a)}$$

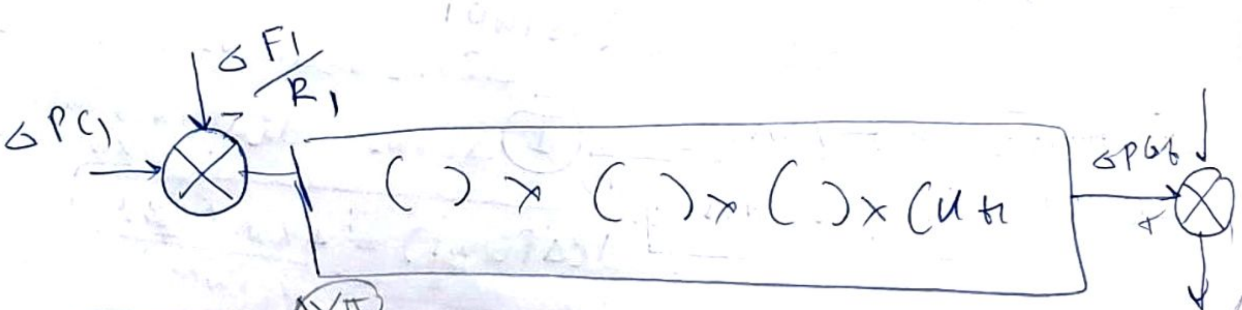
$$\boxed{\frac{\Delta P_{Rt1}}{\Delta X_{t1}} = \frac{1}{1 + S T_{t1}}} \rightarrow \text{(II) (b)}$$

$$\boxed{\left(\Delta P_{C1} - \frac{\Delta F_1}{R_1}\right) \cdot \left(\frac{1}{1 + S T_{g1}}\right) = \Delta X_{t1}} \rightarrow \text{(III) (c)}$$



what does this mean ??

$\frac{\Delta F_1}{R_1}$ — is all input ?



$$\Delta P_{Rt1} \rightarrow \boxed{\frac{1}{1 + S T_{r1}}} \xrightarrow{\Delta X_{II}} \boxed{K_{t1} + K_{t1} K_{r1} T_{r1} S} \rightarrow \Delta P_{Gt1}$$

$$\frac{\Delta P_{Gt1}}{\Delta X_{II}} = K_{t1} + K_{t1} K_{r1} T_{r1} S \Rightarrow \Delta P_{Gt1} = \Delta X_{II} K_{t1} + \Delta X_{II} K_{t1} K_{r1} T_{r1} S$$

$$\boxed{d(\Delta X_{II}) = \frac{\Delta P_{Gt1}}{K_{t1} \cdot K_{r1} \cdot T_{r1}} - \frac{\Delta X_{II}}{K_{r1} T_{r1}}}$$

$\Delta P_{Gt1} + \boxed{\Delta P_{Gt1}\ T_{r1}\ S} = (\Delta P_{Rt1} + S K_{r1} T_{r1} \Delta P_{Rt1})\, K_{t1}$

$\Rightarrow \Delta P_{Gt1} + d(\Delta P_{Gt1}) T_{r1} = \Delta P_{Rt1} K_{t1} + K_{r1} T_{r1} K_{t1}\, d(\Delta P_{R1})$ — ①

O/P I/P

$\Rightarrow \Delta P_{Rt1} + \Delta P_{Rt1} S T_{t1} = \Delta X_{t1}$

$\Rightarrow \Delta P_{Rt1} + d(\Delta P_{Rt1}) T_{t1} = \Delta X_{t1}$ — ②

$\Rightarrow [\Delta P(1) R_1 - \Delta F_1] = \Delta X_{t1} [R_1 + R_1 S T_{g1}]$ — ③

$\Rightarrow \Delta P(1) R_1 - \Delta F_1 = \Delta X_{t1} R_1 + d(\Delta X_{t1}) R_1 T_{g1}$

② $\Rightarrow$ $\boxed{d(\Delta P_{Rt1}) = \frac{\Delta X_{t1}}{T_{t1}} - \frac{\Delta P_{Rt1}}{T_{t1}}} \rightarrow \boxed{\Delta \dot{P}_{Rt1}}, \boxed{\Delta X_{t1}}, \boxed{\Delta P_{Rt1}}$

③ $\Rightarrow$ $d(\Delta X_{t1}) R_1 . T_{g1} = (\Delta P(1) R_1 - \Delta F_1 - \Delta X_{t1} R_1$

$\boxed{d(\Delta X_{t1}) = \frac{\Delta P(1)}{T_{g1}} - \frac{\Delta F_1}{R_1 . T_{g1}} - \frac{\Delta X_{t1}}{T_{g1}}} \rightarrow \boxed{\Delta \dot{X}_{t1}}\ \boxed{\Delta X_{t1}}\ \boxed{\Delta P(1)}\ \boxed{\Delta F_1}$

$\frac{\Delta X_{II}}{\Delta P_{Rt1}} = \frac{1}{1+ST_{r1}} \Rightarrow \Delta X_{II} + \Delta X_{II} S T_{r1} = \Delta P_{Rt1}$

$\Rightarrow \boxed{d(\Delta X_{II}) = \frac{\Delta P_{Rt1}}{T_{r1}} - \frac{\Delta X_{II}}{T_{r1}}}$

(or)

$\Delta P_{Rt1} \rightarrow \boxed{K_{t1} + K_{t1} K_{r1} T_{r1} S} \xrightarrow{\Delta X_{II-2}} \boxed{1/_{1+ST_{r1}}} \rightarrow \Delta P_{G1}$

$\frac{\Delta P_{Gt1}}{\Delta X_{II-2}} = \frac{1}{1+ST_{r1}} \Rightarrow \Delta X_{II-2} = \Delta P_{Gt1} + S T_{r1} \Delta P_{Gt1}$

$\boxed{d(\Delta P_{Gt1}) = \frac{+\Delta X_{II-2}}{T_{r1}} - \frac{\Delta P_{Gt1}}{T_{r1}}}$

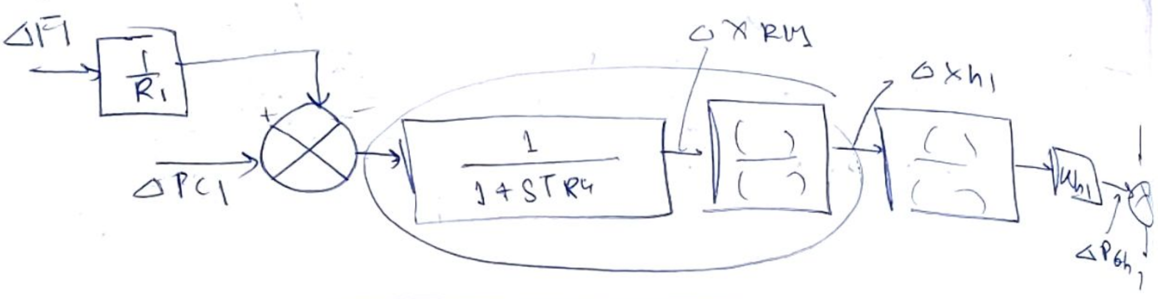
$\frac{\Delta X_{II-2}}{\Delta P_{Rt1}} = K_{t1} + K_{t1} K_{r1} T_{r1} S \Rightarrow \Delta X_{II-2} = K_{t1} \Delta P_{Rt1} + \Delta P_{Rt1} K_{t1} K_{r1} T_{r1} S$

$d(\Delta P_{Rt1})\ K_{t1} K_{r1} T_{r1}$

$\boxed{d(\Delta P_{Rt1}) = \frac{\Delta X_{II-2}}{K_{r1} K_{t1} T_{r1}} - \frac{\Delta P_{Rt1}}{K_{r1} T_{r1}}}$ → ⑪ after few pages

cont!

III



$$\boxed{\frac{\Delta P_{Gh1}}{\Delta X_{h1}} = (K_{h1})\frac{(1-ST_{W1})}{(1+0.5ST_{W1})}} \quad \text{— III (a)}$$

$$\boxed{\frac{\Delta X_{h1}}{\Delta X_{RH1}} = \frac{1+ST_{R1}}{1+ST_{GH1}}} \quad \text{— III (b)}$$

$$\Delta X_{RH1} = \left(\Delta P_{C1} - \frac{\Delta F_1}{R_1}\right) \times \left(\frac{1}{1+ST_{RH1}}\right) \quad \text{— III (c)}$$

$$\Delta X_{RH1}\, R_1 [1+ST_{RH1}] = (R_1 \Delta P_{C1} - \Delta F_1)$$

$$\Delta X_{RH1} \cdot R_1 + \underbrace{\Delta X_{RH1} \cdot S}_{d(\Delta X_{RH1})} \cdot T_{RH1} \cdot R_1 = R_1 \Delta P_{C1} - \Delta F_1$$

$$\boxed{d(\Delta X_{RH1}) = \frac{\Delta P_{C1}}{T_{RH1}} - \frac{\Delta F_1}{T_{RH1} \cdot R_1} - \frac{\Delta X_{RH1}}{T_{RH1}}} \quad \text{— III (c)}$$

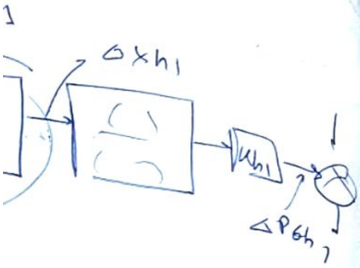
$\boxed{\Delta \dot{X}_{RH1}}$ $\boxed{\Delta X_{RH1}}$ $\boxed{\Delta P_{C1}}$ $\boxed{\Delta F_1}$

III (a) $\Rightarrow$ $\Delta P_{Gh1}(1+0.5ST_{W1}) = (\Delta X_{h1})(K_{h1})(1-ST_{W1})$

$\Rightarrow \Delta P_{Gh1} + \frac{1}{2} T_{W1} \underbrace{\Delta \dot{P}_{Gh1}}_{\boxed{O/P}} = (\Delta X_{h1})(K_{h1}) - T_{W1} \cdot K_{h1} \underbrace{\Delta \dot{X}_{h1}}_{\boxed{O/P}}$

$$\Rightarrow \Delta \dot{P}_{Gh1} = \frac{(\Delta X_{h1}) K_{h1}}{(T_{W1}/2)} - \frac{(T_{W1})(K_{h1}) \Delta \dot{X}_{h1}}{\left(\frac{T_{W1}}{2}\right)} - \frac{\Delta P_{Gh1}}{\left(\frac{T_{W1}}{2}\right)}$$

$\boxed{\Delta \dot{P}_{Gh1}}$ $\boxed{\Delta X_{h1}}$ $\boxed{\Delta \dot{X}_{h1}}$ $\boxed{\Delta P_{Gh1}}$



II (a)

III (c)

$$\frac{1}{1+sT_{RH1}}$$

F_1

$\boxed{\Delta \dot{X}_{Rh1}}$

$\boxed{\Delta X_{Rh1}}$

$\boxed{\Delta F_1}$

$-sT_{w1})$

$T_{w1} \cdot K_{h1}\ \Delta \dot{x}_{h1}$ o/p

$$\Delta \dot{x}_{h1} - \frac{\Delta P_{Gh1}}{\left(\frac{T_{w1}}{2}\right)}$$

III (b) $\underbrace{\Delta X_{h1}}_{O/P} + \Delta \dot{x}_{h1} \cdot T_{GH1} = \Delta X_{RH1} + \underbrace{\Delta \dot{X}_{RH1}}_{I/P} T_{R1}$

$$\Delta \dot{x}_{h1} = \frac{\Delta X_{RH1}}{T_{GH1}} + \frac{\Delta \dot{X}_{RH1} \cdot T_{R1}}{T_{GH1}} - \frac{\Delta X_{h1}}{T_{GH1}}$$

$$\Delta \dot{x}_{h1} = \frac{\Delta X_{RH1}}{T_{GH1}} - \frac{\Delta X_{h1}}{T_{GH1}} + \frac{T_{R1}}{T_{GH1}}\left[\frac{\Delta P_{C1}}{T_{RH1}} - \frac{\Delta F_1}{T_{RH1} \cdot R_1} - \frac{\Delta X_{RH1}}{T_{RH1}}\right]$$

$$= \Delta X_{RH1}\left[\frac{1}{T_{GH1}} - \frac{T_{R1}}{T_{GH1}} \times \frac{1}{T_{RH1}}\right] + \left[\frac{\Delta P_{C1}}{T_{RH1}} - \frac{\Delta F_1}{T_{RH1} \cdot R_1}\right]\frac{T_{R1}}{T_{GH1}} - \frac{\Delta X_{h1}}{T_{GH1}}$$

III (a) $\ominus \frac{T_{w1} K_{h1}}{\left(\frac{T_{w1}}{2}\right)}\left[\Delta X_{RH1}\left(\ -\ \right) + \frac{T_{R1}}{T_{GH1}}\left[(\ ) - (\ )\right] - \frac{\Delta X_{h1}}{T_{GH1}}\right]$

$$\Delta \dot{P}_{Gh1} = \Delta X_{h1}\left[\frac{K_{h1}}{T_{w1}/2} + \frac{\cancel{T_{w1}} K_{h1}}{\cancel{T_{w1}}/2}\frac{1}{T_{GH1}}\right]$$

$$\ominus\left[\frac{\cancel{T_{w1}} K_{h1}}{\frac{\cancel{T_{w1}}}{2}} \times \left(\frac{1}{T_{GH1}}\right) - \frac{\cancel{T_{w1}} K_{h1}}{\frac{\cancel{T_{w1}}}{2}} \times \frac{T_{R1}}{T_{GH1}} \times \frac{1}{T_{RH1}}\right]\Delta X_{RH1}$$

$$\ominus \frac{\cancel{T_{w1}} K_{h1}}{(\cancel{T_{w1}}/2)}\ \frac{T_{R1}}{T_{GH1}}\left[\frac{\Delta P_{C1}}{T_{RH1}} - \frac{\Delta F_1}{T_{RH1} \cdot R_1}\right] - \frac{\Delta P_{Gh1}}{\left(\frac{T_{w1}}{2}\right)}$$

$x_8 = \Delta X_{h1}$

$x_9 = \Delta X_{RH1}$

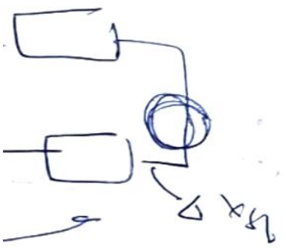
$x_7 = \Delta P_{Gh1}$

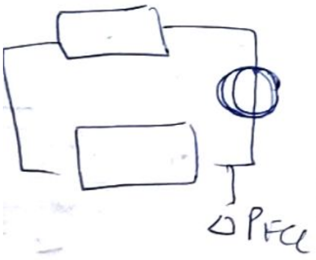
$$\begin{array}{c} 7 \\ 8 \\ 9 \end{array}\begin{bmatrix} \Delta \dot{P}_{Gh1} \\ \Delta \dot{x}_{h1} \\ \Delta \dot{X}_{RH1} \end{bmatrix} = \begin{array}{c}\begin{array}{ccc} 7 & 8 & 9 \end{array} \\ \begin{bmatrix} -2/T_{w2} & \left(\frac{2K_{h1}}{T_{w1}} + \frac{2K_{h1}}{T_{GH1}}\right) & \left(\frac{2K_{h1} T_{R1}}{T_{GH1} T_{RH1}} - \frac{2K_{h1}}{T_{GH1}}\right) \\ 0 & -\frac{1}{T_{GH1}} & \left(\frac{1}{T_{GH1}} - \frac{T_{R1}}{T_{GH1} \cdot T_{RH1}}\right) \\ 0 & 0 & -\frac{1}{T_{RH1}} \end{bmatrix}\end{array}\begin{bmatrix} \Delta P_{Gh1} \\ \Delta x_{h1} \\ \Delta X_{RH1} \end{bmatrix}$$

$$+ \begin{bmatrix} \frac{T_{R1}\, 2K_{h1}}{T_{RH1} T_{GH1}} \\ \frac{T_{R1}}{T_{RH1} \cdot T_{GH1}} \\ \frac{T_{R1}}{T_{RH1}} \end{bmatrix}\Delta P_{C1} + \Delta F_1\begin{bmatrix} \left(\frac{2K_{h1} T_{R1}}{T_{RH1} T_{GH1} R_1}\right) \\ -\frac{T_{R1}}{T_{RH1} T_{GH1} R_1} \\ -\frac{T_{R1}}{T_{RH1} R_1} \end{bmatrix}$$

ΔP_{Gg1} ΔP_{FC1}

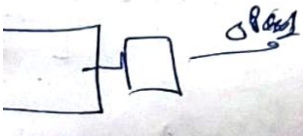
ΔP_{VP1} ΔX_{g1}





$$\frac{X}{X_1} = \frac{1+Sx_1}{1+Sy_1}$$

$$\frac{1+\frac{2T_{CR1}}{T_{F1}} + T_{CR1S}}{1+ST_{F1}}$$



$$\cancel{\frac{\Delta P_{Gg1}}{\Delta P_{VM}} = \left(\frac{K_{g1}}{1+ST_{CD1}}\right) \times \left(\frac{1+T_{CR1S}+\frac{2T_{CR1}}{T_{F1}}}{1+ST_{F1}}\right)}$$ III (a)

$$\cancel{\Delta P_{VP1} = \left(\left(\frac{1}{C_1+SG_1}\right)\times 1\right)\times\left(\Delta P_{C1} - \frac{\Delta F_1}{R_1}\right)}$$

$$\cancel{\frac{x_1}{y_1} + \frac{1-\frac{x_1}{y_1}}{1+Sy_1} \quad \frac{\frac{x}{y_1}+Sx_1+1-\frac{x_1}{y_1}}{1+Sy_2}} = \frac{1+Sx_1}{1+Sy_1}$$

$$\cancel{\frac{x}{y} + \frac{1-\frac{x}{y}}{1+Sy}}$$

$$\frac{1+\left(\frac{T_{CR1}}{T_{F1}}\right)}{1+ST_{F1}} - \left(\frac{T_{CR1}}{T_{F1}}\right) = 1 + \frac{\cancel{\frac{T_{CR1}}{T_{F1}}} - \cancel{\frac{T_{CR1}}{T_{F1}}} - ST_{CR1}}{1+ST_{F1}}$$

$$= \frac{1-ST_{CR1}}{1+ST_{F1}}$$

B/W $\Delta X_1(I/P)$ & $\Delta P_{G1}(O/P)$

$$\boxed{\frac{\Delta P_{Gg1}}{\Delta Z_1} = \frac{K_{g1}}{1+ST_{CD1}}} \Rightarrow \Delta P_{Gg1} + (T_{CD1})(\Delta \dot{P}_{Gg1}) = (K_{g1})\Delta Z_1$$

$$\Rightarrow \boxed{\Delta \dot{P}_{Gg1} = (\Delta Z_1)\frac{K_{g1}}{T_{CD1}} - \frac{\Delta P_{Gg1}}{T_{CD1}}} \quad (1)$$

Tutorials (?) / LHU

$Y_1 = G_1 \cdot X$; $Y_2 = G_2 \cdot X$

$$\Rightarrow \boxed{\frac{\Delta Z_1}{\Delta P_{VP1}} = \frac{1-ST_{CR1}}{1+ST_{F1}}} \Rightarrow \text{FSC1} \rightarrow \text{||el combined}$$

2a

$$\Delta Z_1 + \Delta \dot{Z}_1 T_{F1} = \Delta P_{VP1} - \Delta \dot{P}_{VP1} T_{CR1}$$

||el block of FSC1

$$\boxed{\frac{\Delta P_{FC1}}{\Delta P_{VP1}} = \frac{1+\left(\frac{T_{CR1}}{T_{F1}}\right)}{1+ST_{F1}}} \Rightarrow \Delta P_{FC1} + (\Delta \dot{P}_{FC1})T_{F1} = \Delta P_{VP1} + \Delta P_{VP1}\left(\frac{T_{CR1}}{T_{F1}}\right)$$ (2b)

$$\boxed{(\Delta \dot{P}_{FC1}) = \frac{\Delta P_{VP1}}{T_{F1}} + \Delta P_{VP1}\left(\frac{T_{CR1}}{T_{F1}^2}\right) - \frac{\Delta P_{FC1}}{T_{F1}}}$$

$\boxed{\Delta P_{FC1}}$

2b

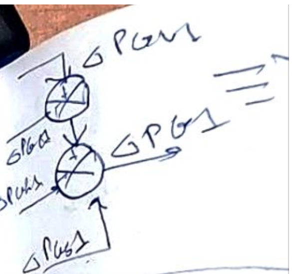
$$\boxed{\Delta Z_1 = \Delta P_{FC1} - \Delta P_{VP1} \times \frac{T_{CR1}}{T_{F1}}} \quad (2c)$$

XXI

$$\boxed{\frac{\Delta P_{VP1}}{\Delta Z_2} = \frac{1}{C_1 + S b_1}} \rightarrow VP1 \quad (3)$$

$$\Delta Z_2 = \Delta P_{VP_1} C_1 + (\Delta \dot{P}_{VP_1}) b_1$$

$$\Delta \dot{P}_{VP1} = \frac{\Delta Z_2}{b_1} - \Delta P_{VP1} C_1 / b_1 \quad (3)$$



$$\boxed{\frac{\Delta Z_2}{\left(\Delta P_{G1} - \frac{\Delta F_1}{R_1}\right)} = \frac{1 + S X_1}{1 + S Y_1}} \Rightarrow \Delta Z_2 + (\Delta \dot{Z}_2) Y_1 = I + \dot{I} X_1$$

$\rightarrow I$ 4a.

GT S G-I combined

Jelale wary

R2

$\int ACE = 1 d \cdot t$

$\Delta F_1 \cdot \beta_1 + \Delta P_{\text{tie}}$ 1

1st block (GT S G-I)

$$I \frac{(1 - X_1/Y_1)}{1 + S Y_1} = \Delta X_{g1} \Rightarrow I - I(X_1/Y_1) = \Delta X_{g1} + (\Delta \dot{X}_{g1})$$

$$(\Delta \dot{X}_{g1}) = -\frac{\Delta X_{g1}}{Y_1} + \left(1 - \frac{X_1}{Y_1}\right) \times \frac{1}{Y_1} \left[\Delta P_{C1} - \frac{\Delta F_1}{R_1}\right] \quad (4b)$$

$$\boxed{I(X_1/Y_1) + \Delta X_{g1} = \Delta Z_2} \quad (4c)$$

---

(1) & (2c) $\Rightarrow$

$$\Delta \dot{P}_{Gg1} = \left[\Delta P_{FC1} - \Delta P_{VP1}\left(\frac{T_{CR1}}{T_{F1}}\right)\right] \times \frac{K_{g1}}{T_{CD1}} - \frac{\Delta P_{GS1}}{T_{CD1}} \quad (1')$$

$\Delta \dot{P}_{Gg1}$

ΔP_{VP_1}

(3) & (4c) $\Rightarrow$

$$\Delta \dot{P}_{VP1} = -\frac{\Delta P_{VP1} \cdot C_1}{b_1} + \frac{\Delta X_{g1}}{b_1} + \frac{X_1}{b_1 Y_1}\left[\Delta P_{C1} - \frac{\Delta F_1}{R_1}\right] \quad (3')$$

(1') (3') (2b) (4b)

$\Delta \dot{P}_{VP1}$

$$\begin{bmatrix} \Delta \dot{P}_{Gg1} \\ \Delta \dot{P}_{FC1} \\ \Delta \dot{P}_{VP1} \\ \Delta \dot{X}_{g1} \end{bmatrix} = \begin{bmatrix} -\frac{1}{T_{CD1}} & \frac{K_{g1}}{T_{CD1}} & -\frac{(T_{CR1})(K_{g1})}{(T_{F1})(T_{CD1})} & 0 \\ 0 & -\frac{1}{T_{F1}} & \frac{1}{T_{F1}} + \frac{T_{CR1}}{T_{F12}} & 0 \\ 0 & 0 & -C_1/b_1 & 1/b_1 \\ 0 & 0 & 0 & -1/Y_1 \end{bmatrix}$$

10,10 · 10,11 · 10,12 · 11,11 · 12,12 · 12,12 · 12,13 · 13,13

$$+ \begin{bmatrix} 0 \\ 0 \\ \frac{X_1}{b_1 Y_1} \\ \frac{1}{Y_1} - \frac{X_1}{Y_1^2} \end{bmatrix} \Delta P_{C1} + \begin{bmatrix} 0 \\ 0 \\ -\frac{X_1}{b_1 Y_1} \\ -\left(\frac{1}{Y_1} - \frac{X_1}{Y_1^2}\right) \end{bmatrix} \frac{\Delta F_1}{R_1}$$

b12,1 · b13,1 · a12,1 · a13,1

$1 + (\Delta P_{JP1}) b_1$

$\Delta P_{JP1} / b_1$ (3)

$+ \dot{J} X_1$

ΔP_{GW1}

ΔP_{G1}

$$\boxed{\Delta P_{GW1} + \Delta P_{GT1} + \Delta P_{Gh1} + \Delta G_{GS1} = \Delta P_{GL}}$$

Wale way role

$$\frac{\Delta F_1}{\Delta P_{G1} - \Delta P_{d1} - \Delta P_{tie12}} = \frac{K_{P1}}{1 + sT_{P1}} \quad (R1)$$

(R2)

$$\frac{ACE_1 \, d1}{\Delta F_1 B_1 + \Delta P_{tie12}} = \frac{1}{s}$$

$$\frac{\Delta P_{tie12}}{\Delta F_1 - \Delta F_2} = \frac{2\pi T_{12}}{s} \quad (R3)$$

$\Delta X_{g1} + (\Delta \dot{X}_{g1})$

$$\Delta P_{c1} - \frac{\Delta F_1}{R_1}$$

(6)

$$\frac{X_{g1}}{T_{CD1}} - \frac{\Delta P_{GS1}}{T_{CD1}}$$

$$\left(\frac{1}{X_1}\right)\left[\Delta P_{c1} - \frac{\Delta F_1}{R_1}\right]$$

(1)	10,12	0
DL)		
	12,12	0
		12,13
	12,12	$1/b_1$
	13,13	$-1/Y_1$

$\frac{1}{R_1}$

13,1

II (contd)

$\Delta X_{t1}, \Delta P_{Rt1}, \Delta P_{Gt1}$

$$\Delta \dot P_{Gt1} = \frac{\Delta P_{Rt1} K_{t1}}{T_{gr1}} + \frac{K_{gr1} \cancel{T_{gr1}} K_{t1} \Delta \dot P_{Rt1}}{T_{gr1}} - \frac{\Delta P_{Gt1}}{T_{gr1}}$$

$$\Delta \dot P_{Gt1} = \left(\frac{\Delta P_{Rt1} K_{t1} - \Delta P_{Gt1}}{T_{gr1}}\right) + (K_{gr1} K_{t1}) \left[\frac{\Delta X_{t1}}{T_{t1}} - \frac{\Delta P_{Rt1}}{T_{t1}}\right]$$

$$= \Delta P_{R1}\left[\frac{K_{t1}}{T_{gr1}} - \frac{K_{gr1}K_{t1}}{T_{t1}}\right] - \frac{\Delta P_{Gt1}}{T_{gr1}} + \frac{K_{gr1}K_{t1}\Delta X_{t1}}{T_{t1}} \quad (1')$$

$$\begin{array}{c} 4 \\ 5 \\ 6 \end{array}\begin{bmatrix} \Delta \dot P_{Gt1} \\ \Delta \dot P_{Rt1} \\ \Delta \dot X_{t1} \end{bmatrix} = \begin{array}{c} \begin{array}{ccc} 4 & 5 & 6 \end{array} \\ \begin{bmatrix} -\frac{1}{T_{gr1}} & \frac{K_{t1}}{T_{gr1}} - \frac{K_{gr1}K_{t1}}{T_{t1}} & \frac{K_{gr1}K_{t1}}{T_{t1}} \\ 0 & -\frac{1}{T_{t1}} & \frac{1}{T_{t1}} \\ 0 & 0 & -\frac{1}{T_{S1}} \end{bmatrix} \end{array} \begin{bmatrix} \Delta P_{G1} \\ \Delta P_{R1} \\ \Delta X_{t1} \end{bmatrix}$$

$$+ \begin{bmatrix} 0 \\ 0 \\ \frac{1}{T_{g1}} \end{bmatrix} \Delta P_{C1} + \begin{bmatrix} 0 \\ 0 \\ -\frac{1}{R_1 T_{g1}} \end{bmatrix} \Delta F_1 \leftarrow a_{61}$$

ΔP_{Gt1} output

shouldn't be present in A-matrix itself

$\Longrightarrow \Delta F_1$ is also an output at later stage

9

$[U]^T = \Delta P_{C1}\ \Delta P_{C2}$ $\boxed{B - 27 \times 2}$

$$\begin{array}{l} \\ \Delta P_{C1} \quad \boxed{\Delta \dot{X}_{t1}} \\ b_{61} \end{array} \begin{bmatrix} 0 \\ 0 \\ \frac{1}{T_{g1}} \end{bmatrix}$$

$$\begin{bmatrix} \frac{-2T_{R1}K_{h1}}{T_{GH1}T_{RH1}} \\ \frac{T_{R1}}{T_{GH1}T_{RH1}} \\ \frac{1}{T_{RH1}} \end{bmatrix} \begin{array}{l} b_{71} \quad \boxed{\Delta \dot{P}_{Gh1}} \\ P_{G1} \\ b_{81} \quad \boxed{\Delta \dot{X}_{h1}} \\ b_{91} \quad \boxed{\Delta \dot{X}_{RH1}} \end{array}$$

$$\begin{bmatrix} 0 \\ 0 \\ \frac{X_1}{b_1 X_1} \\ \frac{1}{X_1} - \frac{X_1}{X_1^2} \end{bmatrix} \begin{array}{l} \Delta P_{C1} \\ \\ b_{121} \quad \boxed{\Delta \dot{P}_{V1}} \\ b_{131} \quad \boxed{\Delta \dot{X}_{g1}} \end{array}$$

V.O 2-I $\Delta P_{C2} - \left(\frac{\Delta F_2}{R_2}\right) \times \frac{1}{1+sT_{g2}} = \Delta X_{t2}$

$(\Delta P_{C2} R_2 - \Delta F_2) = R_2 \Delta X_{t2}(1 + sT_{g2})$

$= R_2 \Delta X_{t2} + R_2 (\Delta \dot{X}_{t2}) T_{g2}$

$$\boxed{(\Delta \dot{X}_{t2})_{16} = \frac{\Delta P_{C2}}{T_{g2}} - \frac{\Delta F_2}{R_2 T_{g2}} - \frac{\Delta X_{t2}}{T_{g2}}}$$

ΔX_{t2} - 16
ΔP_{Gh2} - 17
ΔX_{h2} - 18
ΔX_{RH2} - 19
ΔP_{V2} - 22
ΔX_{g2} - 23

2-II $(\Delta \dot{X}_{RH1}) = \Delta P_{C1}$ — /// be to 1-III

2-III /// be to 1-IV

1- $\Delta \dot{F}_1$
2- $\Delta \dot{P}_{tie12}$
3- $\Delta \dot{F}_2$
4- $\Delta \dot{P}_{Gt1}$
5- $\Delta \dot{P}_{Rt1}$
6- $\boxed{\Delta \dot{X}_{t1}}$
7- $\boxed{\Delta \dot{P}_{Gh1}}$
8- $\boxed{\Delta \dot{X}_{h1}}$
9- $\boxed{\Delta \dot{X}_{RH1}}$
10- $\Delta \dot{P}_{Gg1}$
11- $\Delta \dot{P}_{FC1}$
12- $\boxed{\Delta \dot{P}_{vm1}}$
13- $\boxed{\Delta \dot{X}_{g1}}$
14- $\Delta \dot{P}_{Gt2}$
15- $\Delta \dot{P}_{Rt2}$
16- $\boxed{\Delta \dot{X}_{t2}}$
17- $\boxed{\Delta \dot{P}_{Gh2}}$
18- $\boxed{\Delta \dot{X}_{h2}}$
19- $\boxed{\Delta \dot{X}_{RH2}}$
20- $\Delta \dot{P}_{Gg2}$
21- $\Delta \dot{P}_{FC2}$
22- $\boxed{\Delta \dot{P}_{vm2}}$
23- $\boxed{\Delta \dot{X}_{g2}}$
24- $\int ACE_1 dt$
25- $\int ACE_2 dt$
26- ΔP_{Gw1}
27- ΔP_{Gw2}

=

1
0
0
...
0
$\frac{1}{T_{g1}} = 12.5$
$\frac{-2K_{h1}T_{R1}}{T_{GH1}T_{RH1}} = -0.0937$ ~~-0.0932~~
$\frac{T_{R1}}{T_{GH1}T_{RH1}} = 0.2343$
$\frac{1}{T_{RH1}} = 0.024$
0
0
$X_1/b_1Y_1 = 12$
$\frac{1}{Y_1} - \frac{X_1}{Y_1^2} = 4$
0
0
0
...
0

2
0
0
...
0
12.5 $\quad 1/T_{g2}$
$-0.0937 \quad -2K_{h1}T_{R2}/T_{GH2}T_{RH2}$
$0.2343 \quad T_{R2}/T_{GH2}T_{RH2}$
$0.024 \quad 1/T_{RH2}$
0
0
$12 \quad X_2/b_2Y_2$
$4 \quad \frac{1}{Y_2} - \frac{X_2}{Y_2^2}$
0
...
0

[B] $\leftarrow$ $\boxed{27 \times 2}$

$\times \begin{bmatrix} \Delta P_{L1} \\ \Delta P_{L2} \end{bmatrix}$

$\boxed{2 \times 1}$

[U]

$y = Cx$

$\Rightarrow \frac{\Delta P_{Gw1}}{\Delta P_{dw1}}$

$\Delta \dot{P}_{Gw1}$

$\Rightarrow \Delta F_1 =$
Power eqs.

$\Delta F_1 + ($

$\Rightarrow \Delta \dot{F}_1$

$[\Delta \dot{F}_1] = ($

[B]

$\boxed{27 \times 2}$

$X \begin{bmatrix} \Delta P_{c1} \\ \Delta P_{c2} \end{bmatrix}$

$\boxed{2 \times 1}$

$[u]$

$y = CX \quad X = \begin{bmatrix} \Delta F_1 \\ \Delta P_{tie12} \\ \vdots \\ \Delta P_{GW2} \end{bmatrix} \begin{matrix} -1 \\ -2 \\ \\ -27 \end{matrix}$

$\boxed{X = 29 \times 1}$

$C = \boxed{4 \times 29}$

$\Rightarrow \dfrac{\Delta P_{GW1}}{\Delta P_{dW1}} = \dfrac{K_{W1}}{1+sT_{WD1}} \Rightarrow \Delta P_{GW1} + (\Delta \dot{P}_{GW1}) T_{WD1} = (\Delta P_{dW1}) K_{W1}$

$\Delta \dot{P}_{GW1} = \dfrac{(\Delta P_{dW1}) K_{W1}}{T_{WD1}} - \dfrac{\Delta P_{W1}}{T_{WD1}}$

$\boxed{\begin{bmatrix} \Delta \dot{P}_{GW1} \\ 26 \end{bmatrix} = \begin{bmatrix} \dfrac{K_{W1}}{T_{WD1}} \end{bmatrix} [\Delta P_{dW1}] + \begin{bmatrix} \dfrac{-1}{T_{WD1}} \end{bmatrix} \Delta P_{W1}}$

$\Rightarrow \Delta F_1 = \left(\dfrac{K_{P1}}{1+sT_{P1}} \right) \times [\Delta P_{G1} - \Delta P_{d1} - \Delta P_{tie12}]$

Power sys I

$\Delta F_1 + (\Delta \dot{F}_1) T_{P1} = \Delta P_{G1} K_{P1} - \Delta P_{d1} K_{P1}$

$\Rightarrow \Delta \dot{F}_1 = \dfrac{\Delta P_{G1} K_{P1}}{T_{P1}} - \dfrac{\Delta P_{d1} K_{P1}}{T_{P1}} - \dfrac{\Delta F_1}{T_{P1}}$

$P_{GW1}\; P_{Gt1} + P_{Gh1}\; P_{Cg1}$

$$[\Delta \dot{F}_1] = \begin{bmatrix} \dfrac{-1}{T_{P1}} & \dfrac{K_{P1}}{T_{P1}} & \dfrac{K_{P1}}{T_{P1}} & \dfrac{K_{P1}}{T_{P1}} & \dfrac{K_{P}}{T_{P1}} & \dfrac{-K_{P1}}{T_{P1}} \end{bmatrix} \begin{bmatrix} \Delta F_1 \\ \Delta P_{GW1} \\ \Delta P_{Gt1} \\ \Delta P_{h1} \\ \Delta P_{c1} \\ P_{tie12} \end{bmatrix}$$

(column labels: 1, 26, 5, 7, 10)

$+ \begin{bmatrix} \dfrac{-K_{P1}}{T_{P1}} \end{bmatrix} \Delta F_1$

Trb1

$_2 Trh_2$

$$\frac{\Delta P_{GW2}}{\Delta P_{dW2}} = \frac{K_{W2}}{1+sT_{WD2}} \rightarrow \Delta P_{GW2} + (\Delta \dot{P}_{GW2}) T_{WD2} = K_{W2} P_{dW2}$$

$$\Delta \dot{P}_{GW2} = \left(\frac{K_{W2}}{T_{WD2}}\right) \Delta P_{dW2} - \frac{\Delta P_{GW2}}{T_{WD2}}$$

$$\overset{27}{[\Delta \dot{P}_{GW2}]} = \left[\frac{-1}{T_{WD2}}\right] \overset{27}{[\Delta P_{GW2}]} + \left[\frac{K_{W2}}{T_{WD2}}\right] \underset{\searrow 4}{\Delta P_{dW2}}$$

$$(\Delta F_2) = \frac{K_{P2}}{(1+sT_{P2})} \left[-\alpha_{12} \Delta P_{tie12} - \Delta P_{d2} + \Delta P_{G2}\right]$$

$$\Delta F_2 + (\Delta \dot{F}_2)(T_{P2})$$

$$[\Delta \dot{F}_2] = \left(-\frac{\alpha_{12}}{T_{P2}}\right) \Delta P_{tie12} - \left(\frac{K_{P2}}{T_{P2}}\right) \Delta P_{d2} + \frac{\Delta P_{G2}\, K_{P1}}{T_{P2}}$$

$$\underset{\rightarrow 3}{(\Delta \dot{F}_2)} = \left[-\frac{\alpha_{12} K_{P2}}{T_{P1}} \quad \frac{K_{P1}}{T_{P2}}\right] \begin{bmatrix} \Delta P_{tie12} \rightarrow 2 \\ \Delta P_{G2} \end{bmatrix} \; G_t, G_h, G_g, G_W$$

$\boxed{K_{3,2}}$

$$+ \left[\frac{-K_{P2}}{T_{P2}}\right] \underset{\searrow 2}{\Delta P_{d2}}$$

$$Z_{1,1} = \frac{-K_{P1}}{T_{P1}};\; Z_{3,2} = \frac{-K_{P2}}{T_{P2}};\; Z_{26,3} = \frac{K_{W1}}{T_{WD1}};\; Z_{27,4} = \frac{K_{W2}}{T_{WD2}}$$

$$\begin{array}{r} 1 \\ 2 \\ 3 \\ \\ 26 \\ 27 \end{array} \begin{bmatrix} \boxed{\Delta \dot{F}_1} \\ \Delta \dot{P}_{tie12} \\ \boxed{\Delta \dot{F}_2} \\ \vdots \\ \Delta \dot{P}_{GW1} \\ \Delta \dot{P}_{GW2} \end{bmatrix} = \begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} -K_1/T_{P1} & & & \\ & -K_{P2}/T_{P2} & & \\ & & & \\ & & K_{W1}/T_{WD1} & \\ & & & K_{W2}/T_{WD2} \end{bmatrix} \end{array} \begin{bmatrix} \Delta P_{d1} - 1 \\ \Delta P_{d2} - 2 \\ \vdots \\ \Delta P_{dW1} - 3 \\ \Delta P_{dW2} - 4 \end{bmatrix}$$

$Y = CX \rightarrow \boxed{X =}$

$$\overset{N\times 1}{[\;]} = [\;$$

Y

$$\begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ \vdots \\ Y_{26} \\ Y_{27} \end{bmatrix} = \begin{bmatrix} 1 \\ \\ \\ \\ \\ \end{bmatrix}$$

27×1

$Y = C$

$y = CX \rightarrow \boxed{X = 27 \times 1}$

$\boxed{C = K \times 27}$

$\boxed{Y = K \times 1}$

$$\underset{K\times 1}{\underbrace{\begin{bmatrix} \ \\ \ \\ \ \end{bmatrix}}_{Y}} = \underset{K\times 27}{\underbrace{\begin{bmatrix} \ & & & \\ & & & \\ & & & \end{bmatrix}}_{C}} \underset{27\times 1}{\underbrace{\begin{bmatrix} \ \\ \ \\ \ \\ \ \end{bmatrix}}_{X}}$$

$$\underset{27\times 1}{\begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ \vdots \\ Y_{26} \\ Y_{27} \end{bmatrix}} = \underbrace{\underset{27\times 27}{\begin{bmatrix} 1 & 0 & \cdots & & 0 \\ 0 & 1 & \cdots & & 0 \\ 0 & 0 & 1 & \cdots & 0 \\ \vdots & & & & \\ 0 & \cdots & & 1 & 0 \\ 0 & \cdots & & & 1 \end{bmatrix}}}_{C} \underset{27\times 1}{\begin{bmatrix} \Delta F_1 \\ \Delta P_{tiele} \\ \Delta F_2 \\ \vdots \\ \Delta P_{GW_1} \\ \Delta P_{GW_2} \end{bmatrix}}$$

$$Y = CX$$

All outputs have been used as outputs for identifying correct conditions. Note: here is [illegible]

$a_{1,1} = -\frac{1}{20} = -0.05$; $a_{1,2} = -\frac{KP_1}{TP_1} = \frac{120}{20} = -6$; $a_{1,4} = \frac{KP_1}{TP_1} =$

$a_{1,26} = \frac{KP_1}{TP_1} = \frac{120}{20} = 6$; $a_{2,1} = 2\pi T_{12} = 2 \times 3.14 \times 0.0433$
$= 0.272$; $a_{2,3} = -2 \times 3.14 \times$ $= -0.27$

$a_{3,14} = \frac{KP_2}{TP_2} = \frac{120}{20} = 6$; $a_{3,17} = \frac{KP_2}{TP_2} = \frac{120}{20} = 6$; $a_{3,26} = \frac{KP_2}{TP_2} =$

$a_{4,5} = \frac{KH_1}{Tr_1} - \frac{Kr_1 KH_1}{TH_1} = \left(\frac{0.6}{10} - \frac{0.3 \times 0.6}{0.3}\right) = \boxed{-0.54}$; $a_{4,6} = \frac{Kr_1 KH_1}{TH_1} = \frac{0.3 \times 0.6}{0.3} = \boxed{0.6}$; $a_{5,5} = -\frac{1}{T}$

$a_{6,6} = -\frac{1}{Tg_1} = -\frac{1}{0.08} = -12.5$; $a_{7,1} = \frac{2Kb_1 TR_1}{TGH_1 R_1 TRM_1} = \frac{2 \times 2 \times 5}{0.513 \times 2.4 \times 416} = 0.039$ 39000 ; $\frac{-2}{1} = -2$

$a_{8,1} = -\frac{TR_1}{TGH_1 R_1 TRM_1} = \frac{-5}{.513 \times 2.4 \times 416} = \cancel{-0.09}\ -0.0976$; $a_{8,8} = -\frac{1}{TGH_1} = -\frac{1}{0.513} = -1.949$; $a_{8,9} = \frac{1}{TGH_1} = \frac{1}{.513}$

$a_{10,10} = -\frac{1}{TCD_1} = \frac{1}{.2} = -5$; $a_{10,11} = \frac{Kg_1}{TCD_1} = \frac{.1}{.2} = 0.5$; $a_{10,12} = -$

$a_{12,1} = \frac{-X_1}{b_1 R_1 Y_1} = \frac{-0.6}{0.05 \times 2.4 \times 1} = \cancel{-0.5}\ \boxed{-5}$; $a_{12,12} = -\frac{C_1}{b_1} = -\frac{1}{0.05} = -20$; $a_{12,13} = \frac{1}{}$

6 ;

$\times 0.0433$

$\alpha_1 K_{h1}$

T_{t1}

$= 0.3 \times 0.6$

0.3

$= \boxed{0.6}$

$2 \times .2 \times 5$

$.513 \times 2.4 \times 41.6$

$\frac{1}{T_{GH1}} = \frac{-1}{0.513}$

$.49$

$\frac{.1}{.2} = .5$

$\frac{1}{.1} = \frac{1}{0.05}$

$= 20$

$a_{1,4} = \frac{K_{P1}}{T_{P1}} = \frac{120}{20} = 6$;

$a_{2,3} = 2 \times 3.14 \times 0.0433$;

$= -0.272$

$a_{3,26} = \frac{K_{P2}}{T_{P2}} = 6$

$a_{5,5} = -\frac{1}{T_{t1}} = -\frac{1}{.3}$;

$= -3.33$

$-2 = a_{7,7} = -\frac{2}{T_{W1}} =$

$1 = \boxed{-2}$

$a_{7,7} = -2$

$a_{8,9} = \frac{1}{T_{GH1}} - \frac{T_{R1}}{T_{GH1} \, T_{RH1}}$

$= \frac{1}{.513} - \frac{5}{.513 \times 41.6} = \cancel{\boxed{1.72}}$ 1.715

$a_{10,12} = -\frac{K_{G1} \, T_{CR1}}{T_{F1} \, T_{CD1}} = -\frac{(1)(.01)}{(.23)(.2)}$

$= \cancel{-0.217}$ $\boxed{-0.0217}$ $\cancel{-0.043}$

$a_{12,13} = \frac{1}{G_1} = \frac{1}{0.05}$

$= 20$

$a_{1,7} = \frac{K_{P1}}{T_{P1}} = \frac{120}{20} = 6$;

$a_{3,2} = -\frac{\alpha_1 2 K_{P2}}{T_{P2}} = -6$

$= 6$

$a_{3,27} = \frac{K_{P2}}{T_{P2}} = 6$

$a_{5,6} = \frac{1}{T_{t1}} = \frac{1}{.3} = 3.33$

$= 2 \times \frac{.2}{1} + 2 \times \frac{.2}{.513}$

$a_{7,8} = \frac{2 K_{h1}}{T_{W1}} + \frac{2 K_{h1}}{T_{GH1}}$

$= 1.1797$

$a_{9,1} = \frac{-1}{R_1 T_{RH1}}$

$= \frac{-1}{2.4 \times 41.6} = -0.01$

-1000

; $a_{11,11} = \frac{-1}{T_{F1}} = \frac{-1}{.23}$

$\cancel{-4.35}$ $\cancel{-0.043}$

-4.348

$a_{13,1} = \frac{X_1}{R_1 Y_1^2} - \frac{1}{R_1 Y_1}$

$= \frac{.6}{2.4 \times 1^2} - \frac{1}{2.4 \times 1}$

$= -0.167$

$a_{1,10} = \frac{K_{P1}}{T_{P1}} = \frac{120}{20} = 6$

$a_{3,3} = -\frac{1}{20} = -0.05$

$a_{4,4} = -\frac{1}{T_{T1}} = -\frac{1}{10} = -0.1$

$a_{5,1} = \frac{-1}{R_1 T_{g1}} = \frac{-1}{2.4 \times 0.08} = -5.21$

$-5\ 210000$

$a_{7,9} = \frac{2K_{h1} T_{R1}}{T_{GH1} T_{RH1}} - \frac{2K_{h1}}{T_{GH1}} = \frac{2 \times (.2) \times (5)}{(0.513)(41.6)} - \frac{2 \times (.2)}{0.513}$

$= 0.094 - 0.78$

$= -0.686$

$a_{9,9} = \frac{-1}{T_{RH1}} = -\frac{1}{41.6} = -0.024$

$a_{11,12} = \frac{1}{T_{F1}} + \frac{T_{CR1}}{T^2_{F1}} = \frac{1}{.23} + \frac{0.01}{(.23)^2} = 4.35 + 0.19$

$= \cancel{4.54}$

4.536

$a_{13,13} = -\frac{1}{Y_1} = -1$

$a_{14,14} = a_{4,4} = -0.1$, $a_{14,15} = a_{4,5} = -0.54$

$a_{16,3} = a_{6,1} = -0.521$, $a_{16,16} = a_{6,6} = -125$

$a_{17,19} = a_{7,9} = -0.686$, $a_{18,3} = a_{8,1} = \cancel{-0.098}$ -0.0976

$a_{19,19} = a_{9,9} = -0.024$, $a_{20,20} = a_{10,10} = -0.5$

$a_{22,22} = a_{12,12} = 454$ 1.536 , $a_{22,3} = a_{12,1} = -5$

$a_{23} = a_{13,3} = -1$, $a_{24,1} = B_1 = 0.425$

$a_{26,26} = -\frac{1}{T_{WD1}} = -\frac{1}{5} = -0.2$, $a_{27,27} = -\frac{1}{T_{WD2}} = -0.2$

$a_{14,16} =$

$a_{17,3} =$

$a_{18,18}$

$a_{20,21} =$

$a_{22,27} =$

$a_{24,2}$

$\cancel{0.098}$
0.0976

$= \ominus 0.5$

S

$= \ominus 0.2$

$a_{14,16} = a_{4,6} = 0.6$; $a_{15,15} = a_{5,5} = \ominus 3.33$

$a_{17,3} = a_{7,1} = 0.039$; $a_{17,17} = -2$

$a_{18,18} = a_{8,8} = \ominus 1.949$; $a_{18,19} = a_{8,9} = 1.715$ $\cancel{1.72}$

$a_{20,21} = a_{10,11} = 0.5$; $a_{20,22} = a_{10,12} = \cancel{\ominus 0.013}$ $\ominus 0.0217$

$a_{22,22} = a_{12,12} = \ominus 20$; $a_{22,23} = a_{12,13} = 20$

$a_{24,2} = 1$ $\quad a_{25,2} = a_{12} = -1.0$