* Correction

- ~~A4 uses~~ [A3 from Subtracting] -> A4 beginning

A4) • Dont Set $a_1 \dots a_4$ equal to ~~derivation~~ partial derivatives -> instead:

From A3 p2 :

$$\dot{Z}_2 = \frac{5}{7m}\left[c\left(\frac{Z_3^2}{(\delta - Z_1)^2} - \frac{Z_3^e}{(\delta - Z_1^e)^2}\right) - k(Z_1 - Z_1^e) - b(Z_2 - Z_2^e)\right]$$

$$= \frac{5c}{7m}(\dots) - \frac{5k}{7m}(Z_1 - Z_1^e) - \frac{5b}{7m}(Z_2 - Z_2^e)$$

* Jump to this Simplification + then continue

=> Insert Linearisation From A4 partial Derivatives.

$$= \frac{5c}{7m}\left(\frac{2Z_3^e}{(\delta - Z_1^e)^2}(\bar{Z}_3) + \frac{2(Z_3^e)^2}{(\delta - Z_1^e)^3}\cdot(\bar{Z}_1)\right) - \frac{5k}{7m}\cdot(\bar{Z}_1) - \frac{5b}{7m}(\bar{Z}_2)$$

$$= \frac{10cZ_3^e}{7m(\delta - Z_1^e)^2}\cdot\bar{Z}_3 + \frac{10c(Z_3^e)^2}{7m(\delta - Z_1^e)^3}\cdot\bar{Z}_1 - \frac{5k}{7m}\bar{Z}_1 - \frac{5b}{7m}\bar{Z}_2$$

$$= \underbrace{\frac{10cZ_3^e}{7m(\delta - Z_1^e)^2}}_{a_1}\cdot\bar{Z}_3 + \underbrace{\frac{5}{7m}\left(\frac{2c(Z_3^e)^2}{(\delta - Z_1^e)^3} - k\right)}_{a_2}\cdot\bar{Z}_1 - \underbrace{\frac{5b}{7m}}_{a_3}\cdot\bar{Z}_2$$

$$= a_1\bar{Z}_3 + a_2\bar{Z}_1 - a_3\bar{Z}_2$$

$$\dot{Z}_3 = \frac{V - Z_3R}{L_0 + L_1 e^{-\alpha(\delta - Z_1)}} - \frac{V^e - Z_3^eR}{L_0 + L_1 e^{-\alpha(\delta - Z_1^e)}}$$

=> insert Linearisation From A4 partial Derivatives

$$= \frac{\bar{V}}{L_0 + L_1 e^{-\alpha(\delta - Z_1^e)}} - \frac{R\bar{Z}_3}{L_0 + L_1 e^{-\alpha(\delta - Z_1^e)}}$$

$$= \frac{1}{L_0 + L_1 e^{-\alpha(\delta - Z_1^e)}}\left(\bar{V} - R\bar{Z}_3\right)$$

$$= a_4\left(\bar{V} - R\bar{Z}_3\right)$$

The Linearized System is

$$\dot{\bar{z}}_1 = \bar{z}_2$$

$$\dot{\bar{z}}_2 = a_1 \bar{z}_3 + a_2 \bar{z}_1 - a_3 \bar{z}_2$$

$$\dot{\bar{z}}_3 = a_4 [\bar{v} - R\bar{z}_3]$$

Ensure to define deviation vars also.

$$\bar{z}_1 = z_1 - z_1^e$$
$$\bar{z}_2 = z_2 - z_2^e = z_2$$
$$\bar{z}_3 = z_3 - z_3^e$$
$$\bar{v} = v - v^e$$

$$a_1 = \frac{10c\, z_3^e}{7m(\delta - z_1^e)^2} \qquad a_2 = \frac{5}{7m}\left(\frac{2c(z_3^e)^2}{(\delta - z_1^e)^3} - k\right)$$

$$a_3 = \frac{5b}{7m} \qquad a_4 = \frac{1}{\lambda_0 + \lambda_1 e^{-\alpha(\delta - z_1^e)}}$$