Only 1st bead

(0)

$$\dot{R}_1 = -\mu_{11} k_1 (R_1 - R_1^0)$$

$$\dot{\Delta}_1 = -\mu_{11} k_1 \Delta_1 - \dot{R}_1^0$$

$$\dot{\Delta}_1 + \mu_{11} \Delta_1 = -\dot{R}_1^0$$

$$\Delta_1 = \left[\frac{-i\omega}{i\omega + \mu_{11} k_1} \right] R_1^0(\omega)$$

$$\rightarrow \quad R_1 = \left[1 - \frac{i\omega}{i\omega + \mu_{11} k_1} \right] R_1^0(\omega)$$

$\cancel{\delta_1 = \tan^{-1}}$

$$\frac{c + id}{a + ib} = \frac{(ac + bd) + i\,(ad - bc)}{a^2 + b^2}.$$

$$\tan^{-1}\left(\frac{ad - bc}{ac + bd} \right).$$

$$\delta_1 = \tan^{-1}\left(\frac{a}{b} \right) = \tan^{-1}\left(\frac{\mu_{11} k_1}{\omega} \right)$$

$$\dot{R}_1 = -\mu_{11} K_1 (R_1 - R_1^0) - \mu_{12} K_2 (R_2 - R_2^0)$$

$$\dot{R}_2 = -\mu_{21} K_1 (R_1 - R_1^0) - \mu_{22} K_2 (R_2 - R_2^0).$$

$$\Delta_1 = R_1 - R_1^0$$

$$\dot{\Delta}_1 = \dot{R}_1 - \dot{R}_1^0 \longrightarrow$$

$$\Delta_2 = R_2 - R_2^0$$

$$\dot{\Delta}_2 = \dot{R}_2$$

$$\dot{\Delta}_1 = -\mu_{11} K_1 \Delta_1 - \mu_{12} K_2 \Delta_2 - \dot{R}_1^0$$

$$\dot{\Delta}_2 = -\mu_{21} K_1 \Delta_1 - \mu_{22} K_2 \Delta_2$$

2nd Bead

$$-\mu_{21} K_1 \Delta_1 = \dot{\Delta}_2 + \mu_{22} K_2 \Delta_2$$

$$-\mu_{21} K_1 \dot{\Delta}_1 = \ddot{\Delta}_2 + \mu_{22} K_2 \dot{\Delta}_2$$

$$\ddot{\Delta}_2 + \mu_{22} K_2 \dot{\Delta}_2 = -\mu_{11} K_1 \left[\dot{\Delta}_2 + \mu_{22} K_2 \Delta_2 \right]$$

$$+ \mu_{21} \mu_{12} K_2 K_1 \Delta_2 + \mu_{21} K_1 \dot{R}_1^o$$

$$\Rightarrow \ddot{\Delta}_2 + (K_1 \mu_{11} + K_2 \mu_{22}) \dot{\Delta}_2 + K_1 K_2 (\mu_{11} \mu_{22} - \mu_{21} \mu_{12}) \Delta_2$$

$$= + \mu_{21} K_1 \dot{R}_1^o$$

$$\Delta_2 = \frac{i\omega \mu_{21} K_1}{(\omega_o^2 - \omega^2) + i 2\lambda\omega} R_1^o(\omega)$$

$$2\lambda = (K_1 \mu_{11} + K_2 \mu_{22})$$

$$\omega_o^2 = K_1 K_2 (\mu_{11} \mu_{22} - \mu_{21} \mu_{12})$$

$$\delta_2 = \tan^{-1} \left[\frac{ad - bc}{ac + bd} \right] = \tan^{-1} \left(\frac{a}{b} \right)$$

$$= \tan^{-1} \left(\frac{\omega_o^2 - \omega^2}{2\lambda\omega} \right)$$

1st bead

$$-\mu_{12} k_2 \Delta_2 = \dot{\Delta}_1 + \mu_{11} k_1 \Delta_1 + \dot{R}_1^{\circ}$$

$$-\mu_{12} k_2 \dot{\Delta}_2 = \ddot{\Delta}_1 + \mu_{11} k_1 \dot{\Delta}_1 + \ddot{R}_1^{\circ}$$

$$\ddot{\Delta}_1 + \mu_{11} k_1 \dot{\Delta}_1 + \ddot{R}_1^{\circ} = \mu_{12}\mu_{21} k_1 k_2 \Delta_1$$

$$- \mu_{22} k_2 \left[\dot{\Delta}_1 + \mu_{11} k_1 \Delta_1 + \dot{R}_1^{\circ} \right]$$

$$\Rightarrow \ddot{\Delta}_1 + (\mu_{11} k_1 + \mu_{22} k_2) \dot{\Delta}_1 + k_1 k_2 (\mu_{11}\mu_{22} - \mu_{12}\mu_{21}) \Delta_1$$

$$= -\mu_{22} k_2 \dot{R}_1^{\circ} - \ddot{R}_1^{\circ}$$

$$\Delta_1 = \left[\frac{-i\omega \mu_{22} k_2 + \omega^2}{(\omega_0^2 - \omega^2) + i 2\lambda\omega} \right] R_1^{\circ}(\omega)$$

$$\delta_1 = \tan^{-1}\left[\frac{ad - bc}{ac + bd} \right] = \tan^{-1}\left[- \frac{\omega \mu_{22} k_2 (\omega_0^2 - \omega^2) + 2\lambda\omega \cdot \omega^2}{(\omega_0^2 - \omega^2)\omega^2 - 2\lambda\omega^2 \mu_{22} k_2} \right]$$

$$R_1 - R_1^{\circ}(\omega) = \left[\quad \cdots\cdots \quad \right] R_1^{\circ}(\omega)$$

$$R_1(\omega) = R_1^{\circ}(\omega) + \left[\qquad \right] R_1^{\circ}(\omega).$$

$$= \left\{ 1 + \left[\quad \right] \right\} R_1^{\circ}(\omega).$$

$$= \frac{(a+c) + i(b+d)}{a+ib}.$$

$$\delta_1 = \tan^{-1}\left[\frac{a(b+d) - b(a+c)}{a(a+c) + b(b+d)} \right].$$