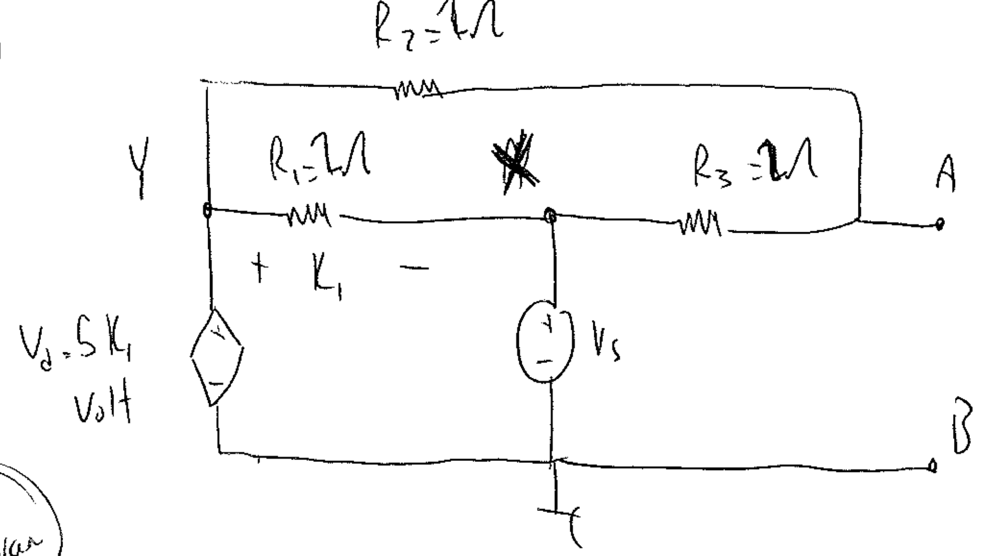
MECE 233 Resit Exam 29-01-2018

Q1



10 puan

For V_{TH} use the same circuit and find $V_{AB} = V_{open-circuit} = V_{TH}$

$X = V_s = 10$ Volt (2)

$Y = 5K_1 = V_d$

(3) $Y - X = K_1$

$5K_1 - 10 = K_1$

$4K_1 = 10$

$K_1 = 2{,}5$

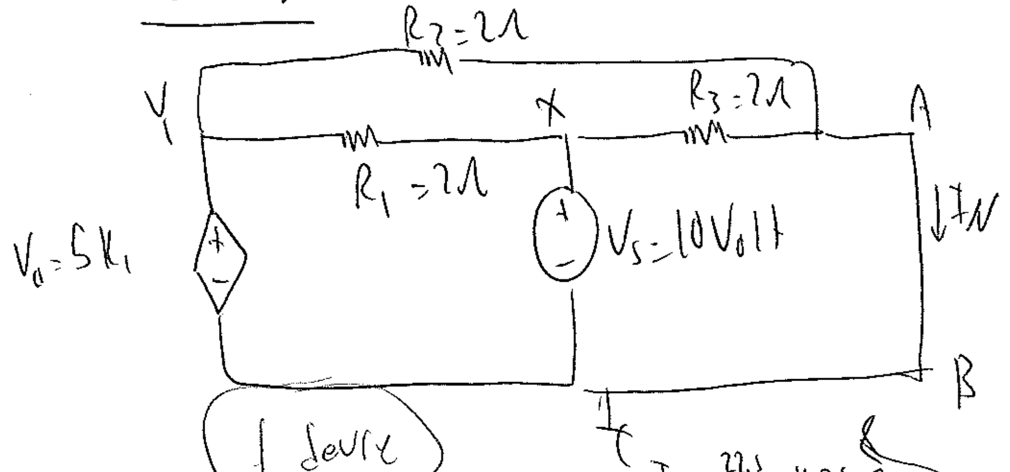
$Y = 5K_1 = 12{,}5$ (1)

$$\frac{Y - A}{R_2} = \frac{A - X}{R_3} \quad (2) \quad \frac{12{,}5 - A}{2} = \frac{A - 10}{2} \quad (2)$$

$2A = 22{,}5$ $A = 11{,}25$ Volt

$B = 0$ $V_{TH} = V_{AB} = V_{open-circuit} = 11{,}25$ Volt

For I_N short circuit A and B terminals $I_N = I_{short-circuit}$



1 devre

$X = 10$ Volt

$Y = 5K_1$

$Y - X = K_1$ (3) $4K_1 = 10$

$5K_1 - 10 = K_1$ $K_1 = 2{,}5$

$Y = 12{,}5$

$A = B = 0$ (4)

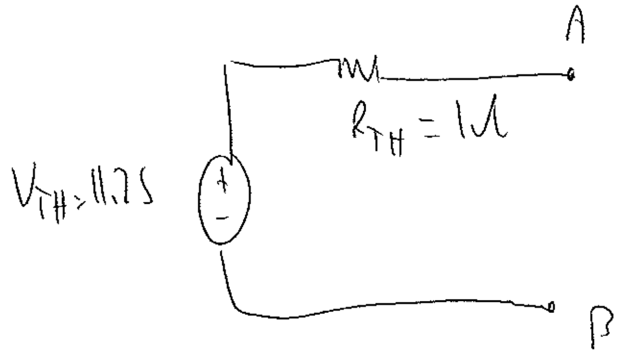
$$I_N = \frac{Y - A}{R_2} + \frac{X - A}{R_3} = \frac{12.5 - 0}{2} + \frac{10 - 0}{2}$$

$I_N = \frac{22.5}{2} = 11.25$ A

(Q1) $I_N = 11.25$ $\quad V_{TH} = 11.25$ (1)

$$R_{TH} = \frac{V_{TH}}{I_N} = \frac{11.25}{11.25} = 1\Omega \quad (1)$$

Thevenin Circuit



(Q2) $\ddot{x} + 4x = \sin(t)$ $\longrightarrow$ char equation $s^2 + 4 = 0$ (1) $\quad s_{1,2} = \mp 2j$ (1) natural frequencies

Prosedür 8

(a) $x_h(t) = K_1 \sin(2t) + K_2 \cos(2t)$ (2)

(b) $x_p(t) = M_1 \cos(t) + M_2 \sin(t)$ (2)

$$\frac{d^2}{dt^2} x_p(t) + 4x_p(t) = \sin(t) \quad (2)$$

$$-M_1 \cos(2t) - M_2 \sin(2t) = \sin(t) \qquad M_1 = 0 \quad M_2 = -1$$

$$x_p(t) = -\sin(t) \quad (1)$$

(c) $x(t) = x_h(t) + x_p(t) = K_1(\sin(2t)) + K_2 \cos(2t) - \sin(t)$ (1)

(d) $x(0) = 5 \qquad x(0) = K_1 \times 0 + K_2 \times 1 + 0 = 5 \qquad K_2 = 5$

$$x(t) = K_1 \sin(2t) + 5\cos(2t) - \sin(t) \quad (4)$$

$$\dot{x}(t) = 2K_1 \cos(2t) - 5 \times 2 \sin(2t) - \cos(t)$$

$$\dot{x}(0) = 2K_1 - 1 = 2 \qquad K_1 = \frac{3}{2} \qquad x(t) = \frac{3}{2}\sin(2t) + 5\cos(2t) - \sin(t)$$

(1) 8

(Q2) $\ddot{x}+4x = \sin(t)$ $\qquad s^2+4=0 \quad s_{1,2}=\mp 2j$ (2)

(a) $x_h = K_1 \sin(2t) + K_2 \cos(2t)$ (2)

(b) $x_p = M_1 \cos(t) + M_2 \sin t$ (2) $\qquad x_p' = -M_1 \sin(t) + M_2 \cos(t)$

$$\frac{d^2}{dt^2} x_p + 4x_p = \sin t \qquad x_p'' = -M_1 \cos(t) - M_2 \sin(t)$$

$$\left[-M_1 \cos(t) + (-M_2) \sin(t)\right] + 4\left(M_1 \cos(t) + M_2 \sin(t)\right) = \sin(t)$$

$$3M_1 \cos(t) + 3M_2 \sin(t) = \sin(t) \qquad M_1 = 0$$

(2) $\qquad M_2 = \frac{1}{3}$ //

$$x_p = +\frac{1}{3} \sin(t)$$ (1)

(c) $x(t) = x_h(t) + x_p(t) = K_1 \sin(2t) + K_2 \cos(2t) - \frac{1}{3} \sin(t)$ (1)

(d) $2 = x(0) = K_1 \sin(0) + K_2 \cos(0) - \frac{1}{3} \sin(0)$

$K_2 = 5$ $\qquad$ prosedür 5

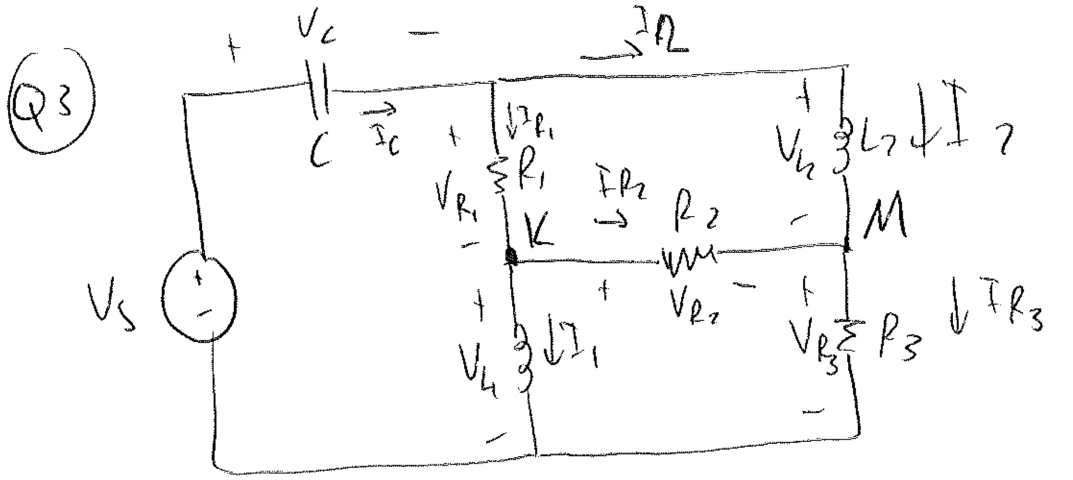
$$\dot{x}(t) = 2K_1 \cos(2t) - 2K_1 \sin(2t) - \frac{1}{3} \cos(t)$$

$$2 = \dot{x}(0) = 2K_1 - \frac{1}{3} \qquad 2K_1 = 2 + \frac{1}{3} \qquad 2K_1 = \frac{7}{3} \qquad K_1 = \frac{7}{6}$$ //

$$x(t) = \frac{7}{6} \sin(2t) + 5\cos(2t) - \frac{1}{3} \sin(t)$$

5 puan

(Q3)



$R_1 = R_2 = R_3 = 1\Omega$

$L_1 = L_2 = 1H$

$C = 2F$

$$V_s = V_c + V_{R_1} + V_{L_1}$$

$$V_s = V_c + I_{R_1} R_1 + L_1 \frac{dI_1}{dt}$$

$$V_s = V_c + V_{L_2} + V_{R_3}$$

$$V_s = V_c + L_2 \frac{dI_2}{dt} + I_{R_3} R_3$$

$$I_{R_1} = I_C - I_2$$

$$V_s = V_c + (I_C - I_2) R_1 + L_1 \frac{dI_1}{dt}$$

$$V_s = V_c + \left(C\frac{dV_c}{dt} - I_2\right) R_1 + L_1 \frac{dI_1}{dt}$$

$$V_s = V_c + \left[2\frac{dV_c}{dt} - I_2\right) \times 1 + \frac{dI_1}{dt}$$

$$I_{R_3} = I_C - I_1$$

$$V_s = V_c + L_2 \frac{dI_2}{dt} + R_3 (I_C - I_1)$$

$$V_s = V_c + L_2 \frac{dI_2}{dt} + R_3 \left[C\frac{dV_c}{dt} - I_1\right]$$

$$V_s = V_c + \frac{dI_2}{dt} + 1 \times \left[2\frac{dV_c}{dt} - I_1\right]$$

$$I_C = I_{R_1} + I_2 = I_1 + I_{R_2} + I_2$$

$$I_C = I_1 + I_2 + I_{R_2}$$

$$I_{R_2} = \frac{K - M}{R_2} = \frac{V_{L_1} - M}{R_2}$$

$$M = V_s - V_C - V_{L_2}$$

$$C\frac{dV_c}{dt} = I_1 + I_2 + \frac{V_{L_1} - (V_s - V_c + V_{L_2})}{R_2}$$

$$2\frac{dV_c}{dt} = I_1 + I_2 + \frac{L_1\frac{dI_1}{dt} + L_2\frac{dI_2}{dt} + V_c - V_s}{1}$$

$$2\frac{dV_c}{dt} = I_1 + I_2 + \frac{dI_1}{dt} + \frac{dI_2}{dt} + V_c - V_s$$

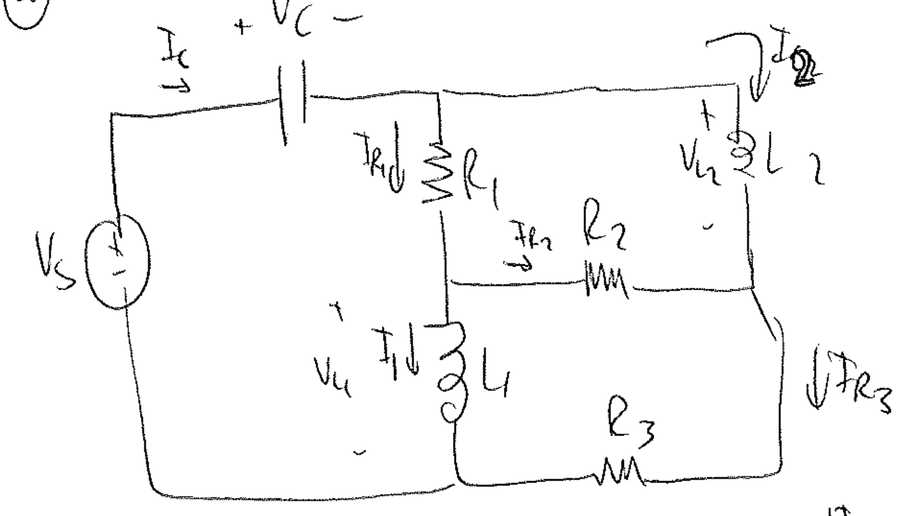
C=2 farad

$L_1 = 1H$, $L_2 = 1H$

$R_1 = 1\Omega$ $R_2 = 1\Omega$ $R_3 = 1\Omega$

C=2 Farad

(a)



$$I_{R_1} = \frac{V_s - V_C - V_{L1}}{R_1} = \frac{V_s - V_C - L_1\frac{dI_1}{dt}}{R_1} = \frac{V_s - V_C - \frac{dI_1}{dt}}{1} = \boxed{V_s - V_C - \frac{dI_1}{dt} = I_{R_1}}$$

1 puan

$I_C = I_{R_1} + I_2$ 1 puan

$$\frac{V_{L1} - (V_s - V_C - V_{L2})}{R_2} = I_{R_2}$$

1 puan

$$C\frac{dV_C}{dt} = V_s - V_C - \frac{dI_1}{dt} + I_2$$

$$\boxed{2\frac{dV_C}{dt} = V_s - V_C - \frac{dI_1}{dt} + I_2}$$

* 2 puan

$$\frac{L_1\frac{dI_1}{dt} - (V_s - V_C - L_2\frac{dI_2}{dt})}{R_2} = I_{R_2}$$

$$\boxed{\frac{dI_1}{dt} + \frac{dI_2}{dt} - V_s + V_C = I_{R_2}}$$

2 puan

$I_{R_1} = I_1 + I_{R_2}$ 1 puan

$$V_s - V_C - \frac{dI_1}{dt} = I_1 + \frac{dI_1}{dt} + \frac{dI_2}{dt} - V_s + V_C$$

$$\boxed{2V_s = 2\frac{dI_1}{dt} + I_1 + \frac{dI_2}{dt} + 2V_C}$$

** 2 puan

$$I_{R_3} = \frac{V_s - V_C - V_{L2}}{R_3} = \frac{V_s - V_C - L_2\frac{dI_2}{dt}}{R_3}$$

$$I_{R_3} = \frac{V_s - V_C - \frac{dI_2}{dt}}{1}$$

1 puan

$I_1 + I_{R_3} = I_C$ 1 puan

$$I_1 + V_s - V_C - \frac{dI_2}{dt} = C\frac{dV_C}{dt}$$

$$\boxed{2\frac{dV_c}{dt} = V_s - V_c - \frac{dI_2}{dt} + I_1}$$

2 puan

gidiş 8

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$*$ and $***$

$$V_s - V_c - \frac{dI_2}{dt} + I_1 = V_s - V_c - \frac{dI_1}{dt} + I_2 \Rightarrow \frac{dI_1}{dt} + I_1 = \frac{dI_2}{dt} + I_2$$

$$\frac{dI_1}{dt} = \frac{dI_2}{dt} + I_2 - I_1 \quad \text{and} \quad \frac{dI_2}{dt} = \frac{dI_1}{dt} + I_1 - I_2$$

↓ put in $**$ ↓ put in $**$

$$2V_s = 2\left[\frac{dI_2}{dt} + I_2 - I_1\right] + I_1 + \frac{dI_2}{dt} + 2V_c \qquad 2V_s = 2\frac{dI_1}{dt} + I_1 + \left(\frac{dI_1}{dt} + I_1 - I_2\right) + 2V_c$$

$$2V_s = 3\frac{dI_2}{dt} + 2I_2 - I_1 + 2V_c \qquad 2V_s = 3\frac{dI_1}{dt} + 2I_1 - I_2 + 2V_c$$

2 puan 2 puan

$$\boxed{\frac{dI_2}{dt} = \frac{2}{3}V_s - \frac{2}{3}I_2 + \frac{1}{3}I_1 - \frac{2}{3}V_c} \qquad \boxed{\frac{dI_1}{dt} = \frac{2}{3}V_s - \frac{2}{3}I_1 + \frac{1}{3}I_2 - \frac{2}{3}V_c}$$

$$2\frac{dV_c}{dt} = V_s - V_c - \frac{dI_1}{dt} + I_2 = V_s - V_c - \left[\frac{2}{3}V_s - \frac{2}{3}I_1 + \frac{1}{3}I_2 - \frac{2}{3}V_c\right] + I_2$$

2 puan

$$\boxed{2\frac{dV_c}{dt} = \frac{1}{3}V_s - \frac{1}{3}V_c + \frac{2}{3}I_1 + \frac{2}{3}I_2} \qquad \frac{dV_c}{dt} = \frac{1}{6}V_s - \frac{1}{6}V_c + \frac{1}{3}I_1 + \frac{1}{3}I_2$$

2 puan

$$\begin{bmatrix} \frac{dI_1}{dt} \\ \frac{dI_2}{dt} \\ \frac{dV_c}{dt} \end{bmatrix} = \begin{bmatrix} -\frac{2}{3} & \frac{1}{3} & -\frac{2}{3} \\ \frac{1}{3} & -\frac{2}{3} & -\frac{2}{3} \\ \frac{1}{3} & \frac{1}{3} & -\frac{1}{6} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ V_c \end{bmatrix} + \begin{bmatrix} \frac{2}{3} \\ \frac{2}{3} \\ \frac{1}{6} \end{bmatrix} V_s$$

(b)

$$\frac{dV_c}{dt} = \frac{1}{3} I_1 + \frac{1}{3} I_2 - \frac{1}{6} V_c + \frac{1}{6} V_s$$

$$\frac{d^2V_c}{dt^2} = \frac{1}{3}\frac{dI_1}{dt} + \frac{1}{3}\frac{dI_2}{dt} - \frac{1}{6}\frac{dV_c}{dt} + \frac{1}{6}\frac{dV_s}{dt}$$

$$\frac{d^3V_c}{dt^3} = \frac{1}{3}\frac{d^2I_1}{dt^2} + \frac{1}{3}\frac{d^2I_2}{dt^2} - \frac{1}{6}\frac{d^2V_c}{dt^2} + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} = \frac{1}{3}\left[\frac{d^2I_1}{dt^2} + \frac{d^2I_2}{dt^2}\right] + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} = \frac{1}{3}\left[-\frac{1}{3}\frac{dI_1}{dt} - \frac{1}{3}\frac{dI_2}{dt} - \frac{4}{3}\frac{dV_c}{dt} + \frac{4}{3}\frac{dV_s}{dt}\right] + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} + \frac{4}{9}\frac{dV_c}{dt} = -\frac{1}{9}\left[\frac{dI_1}{dt} + \frac{dI_2}{dt}\right] + \frac{4}{9}\frac{dV_s}{dt} + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{d^2I_1}{dt^2} = -\frac{2}{3}\frac{dI_1}{dt} + \frac{1}{3}\frac{dI_2}{dt} - \frac{2}{3}\frac{dV_c}{dt} + \frac{2}{3}\frac{dV_s}{dt}$$

$$\frac{d^2I_2}{dt^2} = \frac{1}{3}\frac{dI_1}{dt} - \frac{2}{3}\frac{dI_2}{dt} - \frac{2}{3}\frac{dV_c}{dt} + \frac{2}{3}\frac{dV_s}{dt}$$

$$\frac{d^2I_1}{dt^2} + \frac{d^2I_2}{dt^2} = -\frac{1}{3}\frac{dI_1}{dt} - \frac{1}{3}\frac{dI_2}{dt} - \frac{4}{3}\frac{dV_c}{dt} + \frac{4}{3}\frac{dV_s}{dt}$$

$$L_1\frac{dI_1}{dt} + L_2\frac{dI_2}{dt} = V_{L_1} + V_{L_2} = \frac{dI_1}{dt} + \frac{dI_2}{dt}$$

1 1

$$V_s - V_c = V_{L_2} - V_{R_2} + V_{L_1}$$

$$V_s - V_c + V_{R_2} = V_{L_1} + V_{L_2} = L_1\frac{dI_1}{dt} + L_2\frac{dI_2}{dt}$$

$$V_s - V_c + R_2[I_c - I_2 - I_1] = V_{L_1} + V_{L_2} = \frac{dI_1}{dt} + \frac{dI_c}{dt}$$

1Ω

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} + \frac{4}{9}\frac{dV_c}{dt} = -\frac{1}{9}\left[V_s - V_c + 1\left[C\frac{dV_c}{dt} - I_2 - I_1\right]\right] + \frac{4}{9}\frac{dV_s}{dt} + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} + \frac{4}{9}\frac{dV_c}{dt} + \frac{1}{9}V_C = -\frac{1}{9}V_s - \frac{2}{9}\frac{dV_c}{dt} + \frac{1}{9}[I_1+I_2] + \frac{4}{9}\frac{dV_s}{dt} + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} + \frac{6}{9}\frac{dV_c}{dt} + \frac{1}{9}V_C = -\frac{1}{9}V_s + \frac{1}{9}(I_1+I_2) + \frac{4}{9}\frac{dV_s}{dt} + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{dV_c}{dt} = \frac{1}{3}[I_1+I_2] - \frac{1}{6}V_c + \frac{1}{6}V_s$$

$$\boxed{I_1+I_2 = 3\frac{dV_c}{dt} + \frac{1}{2}V_C - \frac{1}{2}V_s}$$

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} + \frac{6}{9}\frac{dV_c}{dt} + \frac{1}{9}V_C = -\frac{1}{9}V_s + \frac{1}{9}\left[3\frac{dV_c}{dt} + \frac{1}{2}V_c - \frac{1}{2}V_s\right] + \frac{4}{9}\frac{dV_s}{dt} + \frac{1}{6}\frac{d^2V_s}{dt^2}$$

$$\frac{d^3V_c}{dt^3} + \frac{1}{6}\frac{d^2V_c}{dt^2} + \frac{1}{3}\frac{dV_c}{dt} + \frac{1}{18}V_C = -\frac{1}{6}V_s + \frac{4}{9}\frac{dV_s}{dt} + \frac{1}{6}\frac{d^2V_s}{dt^2}$$