1.)

a.) $(D+2.5)\,y(t) = 0$

$r = -2.5$

$C_1 e^{-2.5t}$

$C_1 e^{0} = 3$

$C_1 = 3$

$y(t) = 3e^{-2.5t}$

2.) $(D^3 + 0.6D^2 + 25.1125D + 2.5063)\,y(t) = 0$

$y_0(0) = 1.5$, $\dot{y}_0(0) = 2$, $\ddot{y}_0(0) = -1$

Use Matlab to solve for Roots

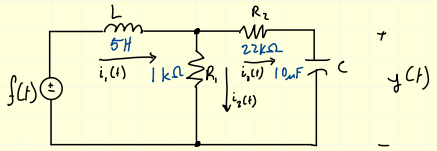
$r = -0.1$
$r = -0.25 + j5$
$r = -0.25 - j5$

-0.1, $-0.25 + j5$, $-0.25 - j5$

$C_1 e^{-0.1t} + C_2 e^{+(-0.25+j5)} + C_3 e^{+(-0.25+j5)}$

using matlab to solve and find equation 1.

$$x_{\Delta t_{i+1}} = \left(\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + \Delta t \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2.5063 & -25.1125 & -0.6 \end{bmatrix} \right) \begin{bmatrix} 1.5 \\ 2 \\ -1 \end{bmatrix}$$



(a)

$$i_1(t) = i_2(t) + i_3(t)$$

$$i_2(t) = \frac{V - y(t)}{R_2} = C\frac{dy(t)}{dt} + y(t)$$

$$i_3(t) = \frac{V}{R_1}$$

$$i_1 = \frac{V}{R_1} + \frac{V - y(t)}{R_2}$$

$$\frac{di_1(t)}{dt} = \frac{1}{R_1}\frac{dV}{dt} + \frac{1}{R_2}\left(\frac{dV}{dt} - \frac{dy(t)}{dt}\right)$$

$$f(t) = L\frac{di_1(t)}{dt} + V$$

$$f(t) = L\left[\frac{1}{R_1}\frac{dV}{dt} + \frac{1}{R_2}\left(\frac{dV}{dt} - \frac{dy}{dt}\right)\right] + V$$

$$f(t) = L\left(\frac{1}{R_1} + \frac{1}{R_2}\right)\frac{dV}{dt} - \frac{L}{R_2}\frac{dy}{dt} + V$$

$$V = y + CR_2\frac{dy}{dt} \Rightarrow \frac{dV}{dt} = \frac{dy}{dt} + CR_2\frac{d^2y}{dt^2}$$

$$f(t) = L\left(\frac{1}{R_1} + \frac{1}{R_2}\right)\left(\frac{dy}{dt} + CR_2\frac{d^2y(t)}{dt^2}\right) - \frac{L}{R_2}\cdot\frac{dy}{dt} + y + CR_2\frac{dy}{dt}$$

use D operators

$$f(t) = DL\left(\frac{1}{R_1} + \frac{1}{R_2}\right) + D^2LCR_2\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - D\frac{L}{R_2} + y + DCR_2$$

$$f(t) = D^2LCR_2\left(\frac{1}{R_1} + \frac{1}{R_2}\right) + D\left(\frac{L}{R_1} + CR_2\right) + y$$

(b)

$L = 5$ H
$C = 10\,\mu$F
$R_2 = 22\,k\Omega$
$R_1 = 1\,k\Omega$

$y(0) = 5$ V
$i_1(0) = 0.2$ A

$$1.1\left(\frac{1}{1k} + \frac{1}{22k}\right)D^2 + (0.005 + 0.22)D + y$$

$$\frac{23}{20{,}000}D^2 + \frac{9}{40}D + y$$

$$\lambda_1 = -4.5503$$
$$\lambda_2 = -191.1019$$

$$C_1e^{-4.5503t} + C_2e^{-191.1019t} = 0$$

$$= 847.83$$

$$V = CR_2\left(\frac{dy(t)}{dt}\right) + y(t)$$

$$i_1(0) = \frac{y(0)}{R_1} + \left(\frac{R_2C}{R_1}C\right)y'(0)$$

$$i_1(0) = 0.2 - \frac{\frac{5}{1000}}{\frac{22{,}000}{1000}}$$

(C)

$$C_1 + C_2 = 5$$
$$-4.5503C_1 + -191.1019C_2 = 847.83$$

$$\begin{bmatrix} 1 & 1 & 5 \\ -4.5503 & -191.1019 & 847.83 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & -181.105 \\ 0 & 1 & -4.5503 \end{bmatrix}$$

$$9.6667e^{-4.5503t} - 4.667e^{-191.1019t}$$

(d)

$$\left(\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + \Delta t\cdot\begin{bmatrix} 0 & 1 \\ -869.57 & -195.651 \end{bmatrix}\right)\cdot\begin{bmatrix} 5 \\ 847.83 \end{bmatrix}$$