13.29

a. $F(s) = \dfrac{(s+1)(s+3)}{(s+2)(s^2+2s+2)}$  PFE  $= \dfrac{0.5}{s+2} + \dfrac{0.75-0.25j}{s+1-j} + \dfrac{0.75+0.25j}{s+1+j}$

⟹ $f(t) = 0.5e^{-2t} + 2\,Re\,(0.5-0.25j)\,e^{-(1-j)t}$,  for $t>0$

$= 0.5e^{-2t} + 2\,Re\,(0.559\,e^{j(-26.6°)})\,e^{-t}\,e^{jt}$;  for $t\geq0$

    $\underbrace{\quad\quad}_{-0.464\,rad}$

$= 0.5e^{-2t} + 1.118\,e^{-t}\cos(t+(-26.6°))$   for $t\geq 0$

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b.  $F(s) = \dfrac{(s+2)^2}{s^2+4s+5}$  PFE  $= \dfrac{0.5j}{s+2-j} + \dfrac{-0.5j}{s+2+j} + 1$

⟹ $f(t) = \delta(t) + 2\,Re\,0.5j\,e^{(-2+j)t}$

    $= \delta(t) + e^{-2t}\cos(t+90°)$

---

13.55

1).  $t<0$:



KCL:  $-12+Ri + L\dfrac{di}{dt} + v_c = 0$

$I(0) = \dfrac{12}{1+5} = \dfrac{12}{6} = 2\,(A)$
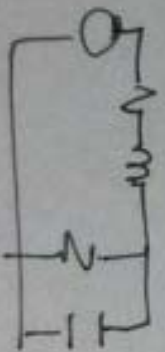
$v_c(t) = v_c(0) + \dfrac{1}{c}\int_0^t i(\tau)d\tau.$

$v_c(0) = 12\cdot\dfrac{5}{5+1} = 10\,(V).$

2) $t>0$:



KCL:  $-12+Ri + L\dot{i} + v_c = 0$

$\to \quad i(0) = \dfrac{12}{1+5} = 2\,(A)$

$v_c(0) = 12\cdot\dfrac{5}{5+1} = 10\,(V).$

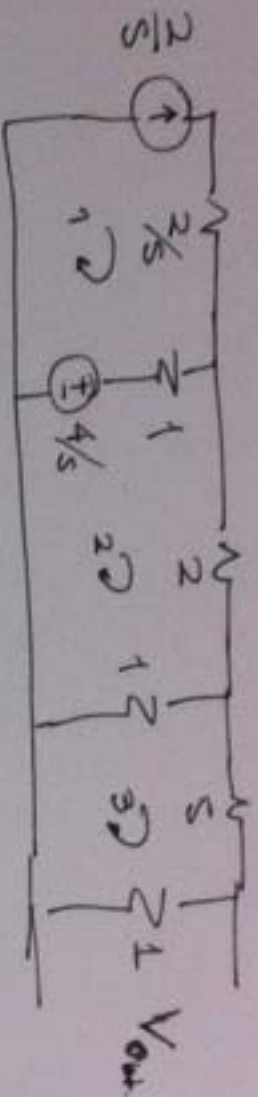Taking $\mathcal{L}$:  $-\dfrac{12}{s} + RI(s) + Ls\,I(s) - Li(0) + \dfrac{1}{Cs}I(s) + \dfrac{v_c(0)}{s} = 0$

substituting  ⟹
$(s^2+2s+1)\,I(s) = 2(s+2)$

$\to I(s) = \dfrac{2(s+2)}{s^2+2s+1} = \dfrac{2}{s+1} + \dfrac{2}{(s+1)^2}$

$\to i(t) = 2e^{-t} + 2te^{-t}$,  for $t\geq0$.

## P4.13 Converting to Laplace domain,



$I_1 = 2/s$

$-\dfrac{4}{s} + I_2 - I_1 + 2I_2 + I_2 - I_3 = 0$

$I_3 - I_2 + sI_3 + I_3 = 0$

$V_0 = R_0 I_3 = I_3$

$\Rightarrow -\dfrac{6}{s} + 4I_2 - I_3 = 0 \Rightarrow 4I_2 - I_3 = 6/s$

$(2+s)I_3 - I_2 = 0$

$\Rightarrow (4(2+s) - 1) I_3 = \dfrac{6}{s} \to I_3 = \dfrac{6/4}{(s+7/4)\,s}$   PFE

$= \dfrac{6/7}{s} + \dfrac{-6/7}{s+7/4}$

$i_3(t) = \dfrac{6}{7} u(t) - \dfrac{6}{7} e^{-7/4\,t}\, u(t)$

$\Rightarrow v_0(t) = \dfrac{6}{7}\left(1 - e^{-7/4}\right) u(t)$

$\left(\text{or } \dfrac{6}{7}\left(1 - e^{-7/4}\right), \text{ for } t \geq 0.\right)$
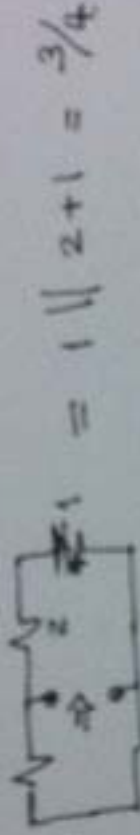
## 14.28 Converting to Laplace domain,
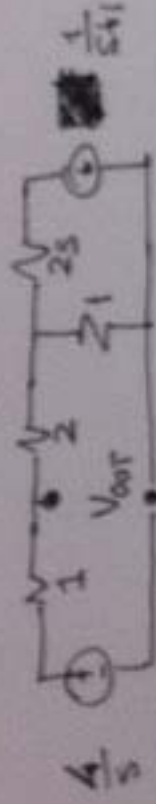


Loop analysis:

$$\left\{ \begin{array}{l} -\frac{4}{s} + I_1 + 2I_1 + I_1 - I_2 = 0 \\ I_2 = \frac{1}{s+1} \end{array} \right.$$

$$\Rightarrow I_1 = \frac{1}{4}\left(\frac{1}{s} + \frac{1}{s+1}\right)$$

$$V_{OUT} = \frac{4}{s} - RI_1 = \frac{4}{s} - \left(\frac{1}{4}\left(\frac{1}{s} + \frac{1}{s+1}\right)\right) = \frac{15/4}{s} - \frac{1/4}{s+1}$$

$R_{THEV}$:



$$Z_1 = 1 \| 2 + 1 = \frac{3}{4}$$

$\Rightarrow$ Thévenin equiv.

$$V_{th}(s) = \frac{15/4}{s} - \frac{1/4}{(s+1)} \qquad V_L$$



$$R_{th} = \frac{3}{4}$$

Adding the capacitor, $t = \frac{V_L(s)}{\frac{3}{4} + \frac{1}{s}} = \frac{4}{3} \frac{1}{s + 4/3} \cdot \left[\frac{15}{4} - \frac{5}{4(s+1)}\right]$

$$= \frac{11/3}{s+4/3} - \frac{1}{s+1}$$

$$\Rightarrow I(s) = \frac{s}{s+4/3} - \frac{1}{3}\frac{s}{(s+4/3)(s+1)}$$

$$\Rightarrow i(t) = \frac{11}{3}e^{-4/3 t} - e^{-t} \quad ; \quad \text{for } t \geq 0$$