EEE 202 HW #5 SOLUTIONS

13.29

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

$$\Rightarrow f(t) = 0.5e^{-2t} + 2\,\mathrm{Re}\,(0.5-0.25j)\,e^{-(1-j)t}, \quad \text{for } t \geq 0$$

$$= 0.5e^{-2t} + 2\,\mathrm{Re}\left(0.559\, e^{j(\underbrace{-26.6^\circ}_{-0.464\,\text{rad}})}\right) e^{-t} e^{jt}, \quad \text{for } t \geq 0$$

$$= 0.5e^{-2t} + 1.118\, e^{-t}\cos\left(t + (-26.6^\circ)\right) \quad \text{for } t \geq 0$$

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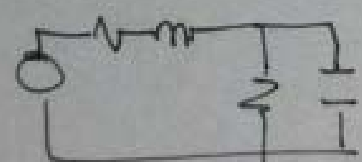
b. $$F(s) = \frac{(s+2)^2}{s^2+4s+5} \overset{PFE}{=} \frac{0.5j}{s+2-j} + \frac{-0.5j}{s+2+j} + 1$$

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

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

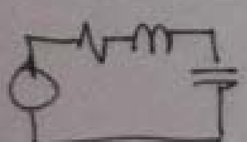
13.55 1). $t<0$:



$$\Rightarrow I_L(0) = \frac{12}{1+5} = 2\,(A)$$

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

2) $t>0$:



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

$$v_c(t) = v_c(0) + \frac{1}{C}\int_0^t i(\tau)\,d\tau$$

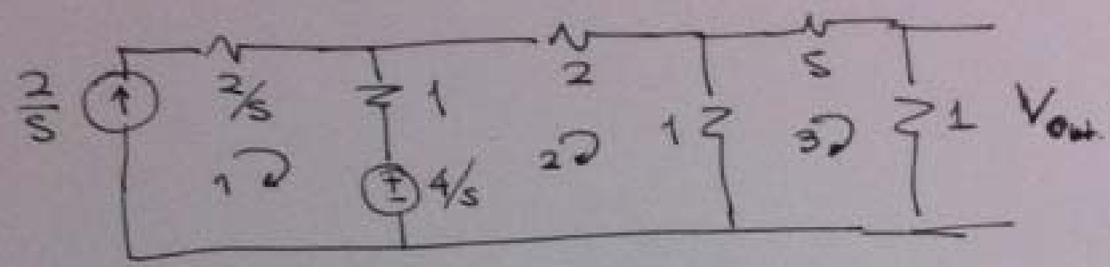
Taking $\mathcal{L}$: $$-\frac{12}{s} + RI(s) + LsI(s) - Li(0) + \frac{1}{Cs}I(s) + \frac{v_c(0)}{s} = 0$$

SUBSTITUTING $\Rightarrow$ $$(s^2+2s+1)\,I(s) = 2(s+2)$$

$$\Rightarrow I(s) = \frac{2(s+2)}{s^2+2s+1} = \frac{2}{s+1} + \frac{2}{(s+1)^2}$$

$$\Rightarrow i(t) = 2e^{-t} + 2te^{-t}, \quad \text{for } t \geq 0.$$

14.13 Converting to Laplace domain,



$I_1 = 2/s$

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

$I_3 - I_2 + sI_3 + I_3 = 0$

$V_0 = R_0 I_3 = I_3$

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

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

$\Rightarrow (4(2+s) - 1)\, I_3 = 6/s \rightarrow I_3 = \frac{6/4}{(s+7/4)\,s} \overset{\text{PFE}}{=}$

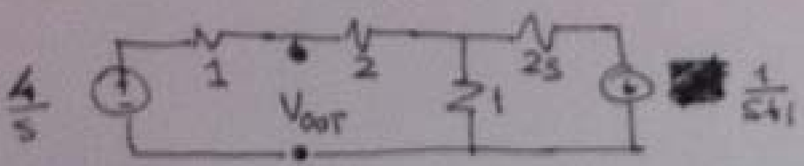
$= \frac{6/7}{s} + \frac{-6/7}{s+7/4}$

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

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

(or $6/7\,(1 - e^{-7/4})$, for $t \geq 0$.)

14.28 Converting to Laplace domain,



Loop analysis:

$$\begin{cases} -\frac{4}{s} + I_1 + 2I_1 + I_1 - I_2 = 0 \\ I_2 = \frac{1}{s+1} \end{cases}$$

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

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

Z_{THEV} :

$= 1 \,||\, 2+1 = 3/4$

$\Rightarrow$ Thevenin Equiv. $V_c(s) = \frac{15/4}{s} - \frac{1}{4(s+1)}$

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

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

$\Rightarrow I_c(s) = \frac{s}{s+4/3} - \frac{1}{3}\frac{s}{(s+4/3)(s+1)} \overset{PFE}{=} \frac{11/3}{s+4/3} - \frac{1}{s+1}$

$\Rightarrow i_c(t) = \frac{11}{3}e^{-4/3t} - e^{-t}$, for $t \geq 0$