

ECE 110 Fall 2015 Test P

Note Title

I) (1) $v_1 = i_1 R$ $i_2 = C \frac{dv_2}{dt}$ $v_3 = L \frac{di_3}{dt}$

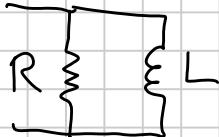
(2) NIA $\frac{1}{2} (v_2^2)$ $\frac{1}{2} L i_3^2$

(3) The voltage drop across a capacitor & the current through an inductor ...

(4) $6 \angle 0^\circ - 4 \angle -90^\circ = 7.21 \angle 33.7^\circ$
 $7.21 \cos(2\pi t + 33.7^\circ)$

(5) $17 \angle -49^\circ + 10 \angle -15^\circ = 25.9 \angle -36.5^\circ$
 $25.9 \cos(2\pi t - 36.5^\circ)$

(6) $Z = R + jX$ $X > 0$ so inductor

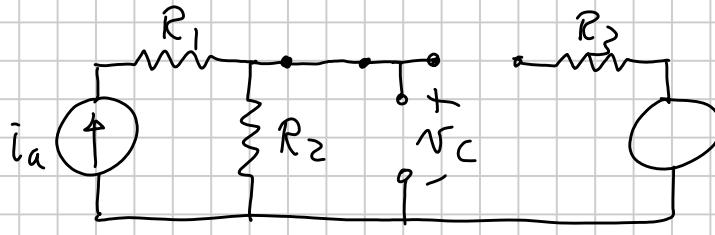


$$Y = \frac{1}{R} + \frac{1}{j\omega L} = .001 - j.002$$

$$R = \frac{1}{.001} = 1000 \Omega \quad L = \frac{1}{.002 \text{ rad/s}} = 1 \text{ H}$$

Check : $Z = \frac{j\omega L R}{j\omega L + R} = \frac{(j)(500)(1)(1000)}{(j)(500)(1) + (1000)} = 200 + j400 \Omega$

DCSS $t < 4\text{ms}$:



$$V_C = i_a R_2 = 6\text{V}$$

$4\text{ms} < t < 10\text{ms}$

$U_{CL, SR_{12}}$:

$$-i_a + \frac{V_C}{R_2} + C \frac{dV_C}{dt} + \frac{V_C + V_b}{R_3} = 0$$

$$C \frac{dV_C}{dt} + \left(\frac{1}{R_2} + \frac{1}{R_3} \right) V_C = i_a - \frac{V_b}{R_3}$$

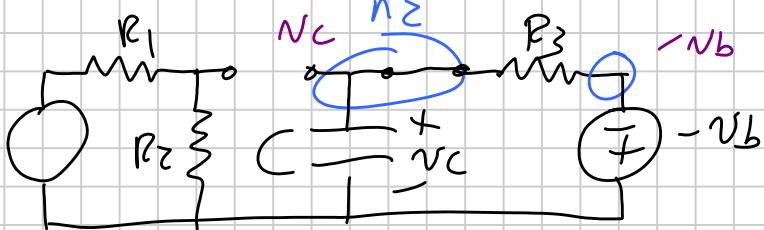
$$\left((3 \cdot 10^{-6}) \frac{dV_C}{dt} + (1 \cdot 10^{-3}) V_C = 3 \cdot 10^{-3} - 5 \cdot 10^{-3} \right) \times 1000$$

$$(3 \cdot 10^{-3}) \frac{dV_C}{dt} + V_C = -2 \quad \tau = 3 \cdot 10^{-3} \quad V_{C,f} = -2$$

$$V_C(t) = V_{C,f} + (V_{C,i} - V_{C,f}) e^{-(t-t_0)/\tau}$$

$$= -2 + 8 e^{-(t-4\text{ms})/3\text{ms}}$$

$t > 10\text{ms}$



$$U_{CL, SR^1} \quad C \frac{dV_C}{dt} + \frac{V_C + V_b}{R_3} = 0$$

$$(R_3 \frac{dV_C}{dt} + V_C = -V_b)$$

$$\tau = CR_3 = 6\text{ms}$$

$$V_{C,f} = -V_b = -10$$

$V_{C,i} = V_C(10\text{ms})$ from

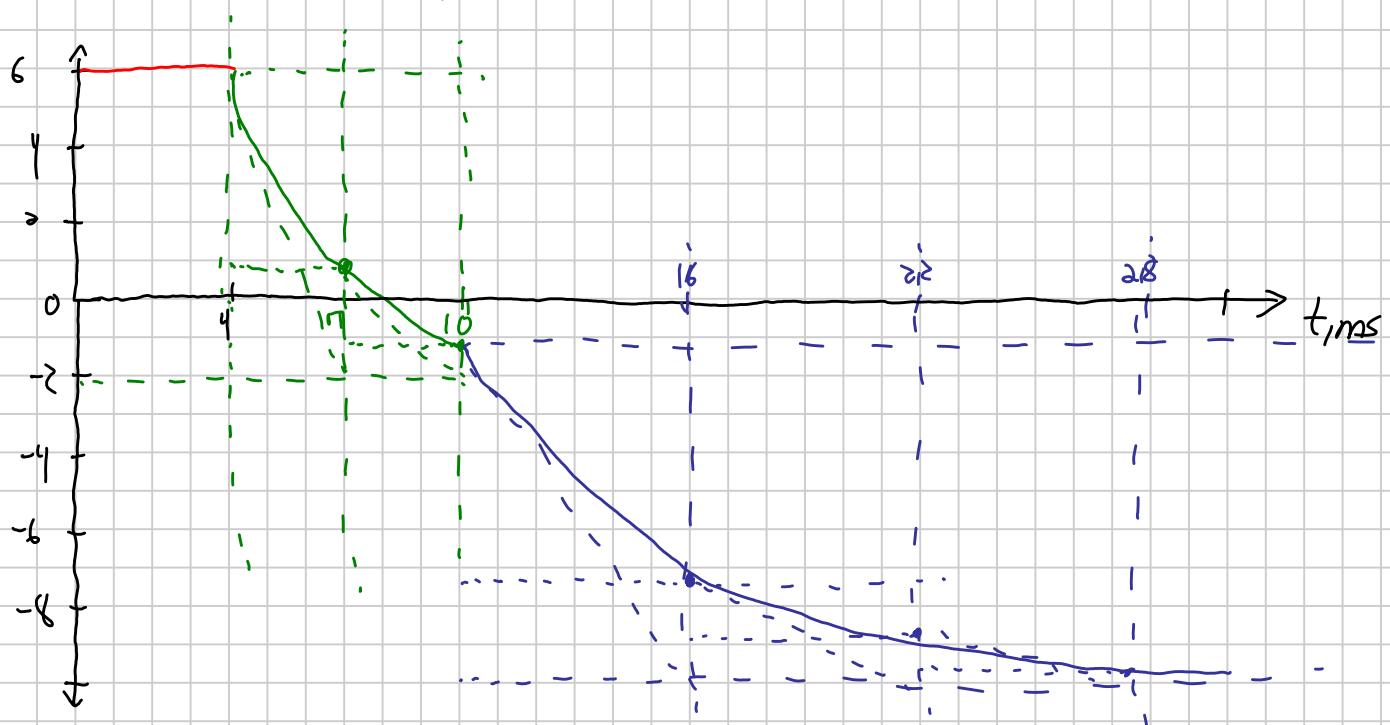
$= -9.17$, so

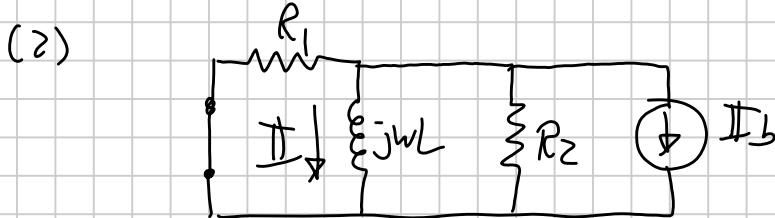
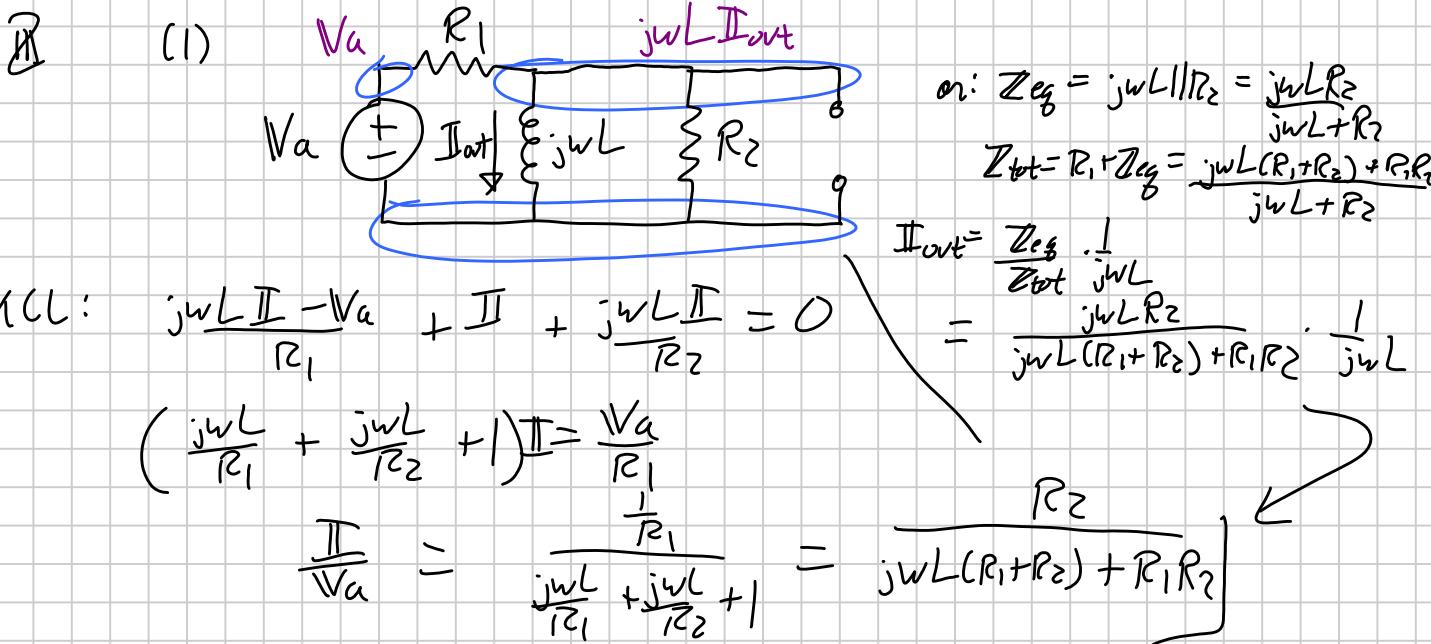
$$V_C(t) = -10 + 9.083 e^{-(t-10\text{ms})/6\text{ms}}$$

Sketch:

$$V_C(t) = \begin{cases} t < 4 \text{ ms} \\ 4 \text{ ms} < t < 10 \text{ ms} \\ t > 10 \text{ ms} \end{cases} \cdot \begin{cases} -2 + 8 e^{-(t-0.004)/0.003} \\ -10 + 9.08 \end{cases} e^{-(t-0.01)/0.006}$$

V





Current Div.

$$I = - \frac{\frac{1}{jwL}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{jwL}} I_b = \underbrace{\frac{-R_1 R_2}{jwL(R_1 + R_2) + R_1 R_2}}_{I_b}$$

(3) $w=0$ $V_a = 5$ $I_{H_a}(j0) = \frac{1}{R_1}$ $I = \frac{5}{R_1} = 5 \text{ mA}$

$$I_b = 7 \quad I_{H_b}(j0) = -1 \quad I = -7 \text{ mA}$$

so for $w=0$, $I = -2 \text{ mA}$ total

$$w = 1 \cdot 10^5 \quad V_a = 10 \angle 0^\circ \quad I_{H_a}(j \cdot 10^5) = 8 \cdot 10^{-4} \angle -36.9^\circ$$

$$I = 8 \cdot 10^{-3} \angle -36.9^\circ$$

(a) $w = 1 \cdot 10^5 \quad I_b = 8 \cdot 10^{-3} \angle 0^\circ \quad I_{H_b}(j \cdot 10^5) = 0.8 \angle 143.1^\circ$

$$I = 6.4 \cdot 10^{-3} \angle 143.1^\circ$$

can add, so $I = 8 \cdot 10^{-3} \angle 36.9^\circ + 6.4 \cdot 10^{-3} \angle 143.1^\circ = 1.6 \angle -36.9^\circ$

$$i(t) = -2 + 1.6 \cos(10^5 t - 36.9^\circ) \text{ mA}$$

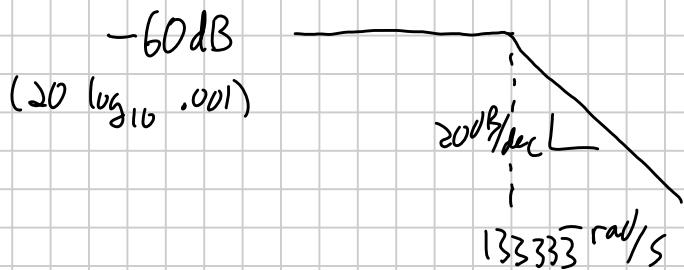
(b) $w = 2 \cdot 10^5 \quad I_b = 8 \cdot 10^{-3} \angle 0^\circ \quad I_{H_b}(j \cdot 2 \cdot 10^5) = 0.555 \angle 123.7^\circ$

$$I = 4.4 \cdot 10^{-3} \angle 123.7^\circ$$

cannot add phasors; $i(t) = -2 + 8 \cos(10^5 t - 36.9^\circ) + 4.4 \cos(2 \cdot 10^5 t + 123.7^\circ) \text{ mA}$

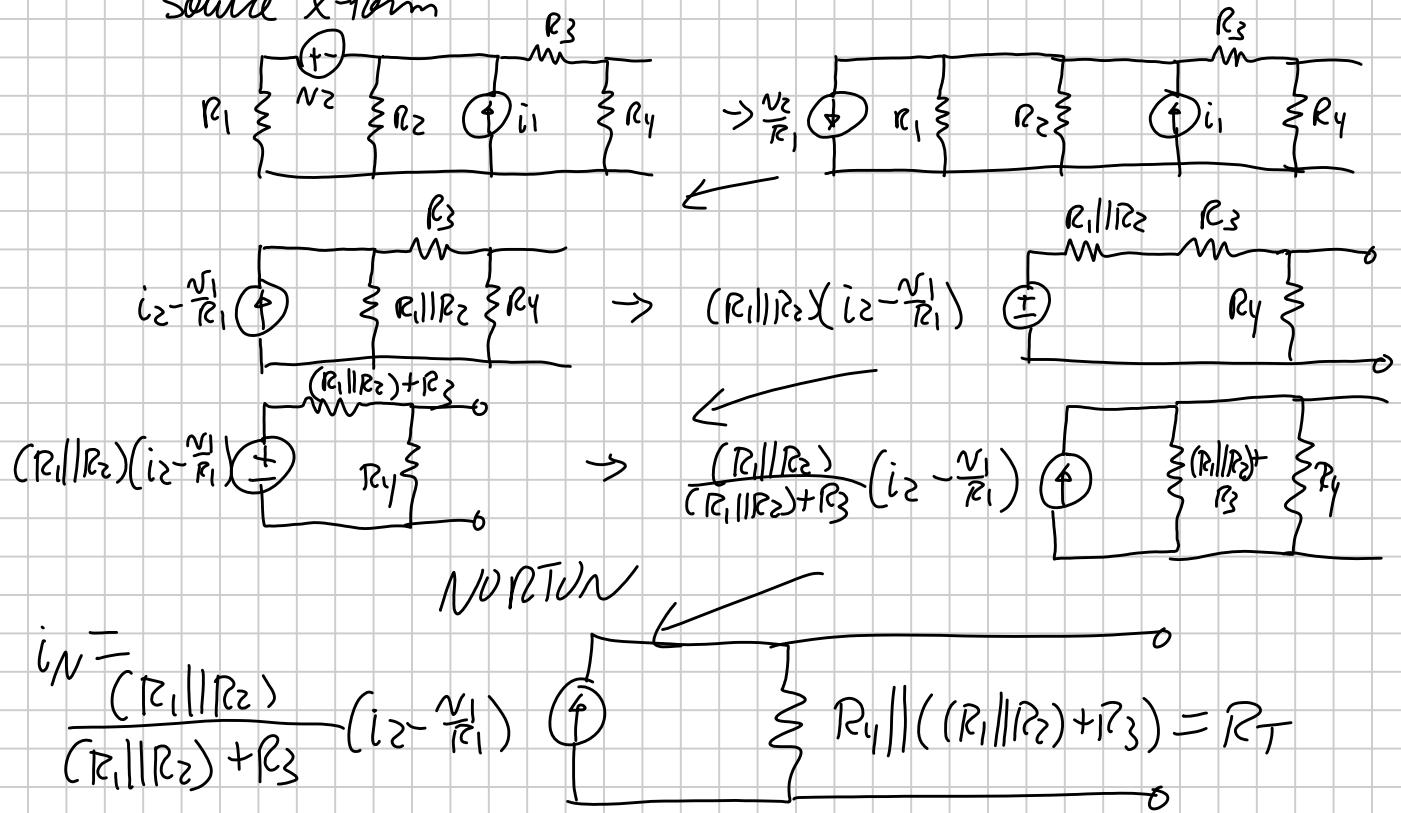
$$(4) \quad \frac{R_2}{j\omega L(R_1+R_2) + R_1R_2} = \text{Low pass ; See BODE}$$

$$(5) \quad = \frac{2000}{j\omega(15) + 2 \cdot 10^6} = \frac{.001}{1 + j(\omega/133333)}$$

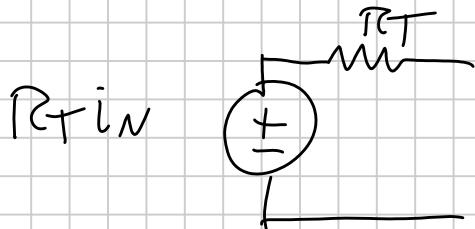


IV) multiple ways to solve;

Source X-form



THEVENIN



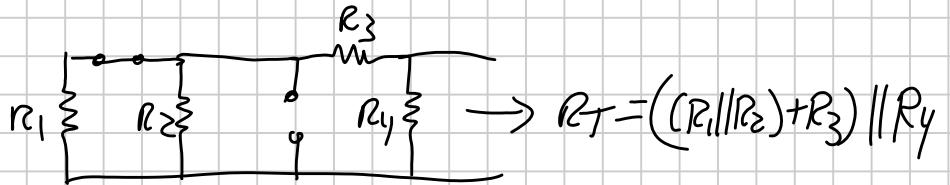
(3)

$$R_L = R_T,$$

$$P_{abs} = \frac{V_N^2}{4R_T} \quad \text{or} \quad \frac{i_N^2 R_T}{L}$$

Alternate:

Find R_{Th} :



$$R_T = ((R_1 \parallel R_2) + R_3) \parallel R_4$$

Find V_{OC} , perhaps w/ superposition

A circuit diagram for finding $V_{OC,2}$. It shows a voltage source V_2 with its positive terminal at the top. Resistors R_1 and R_2 are in the top branch, and R_3 and R_4 are in the bottom branch. The output voltage $V_{OC,2}$ is measured across R_4 .

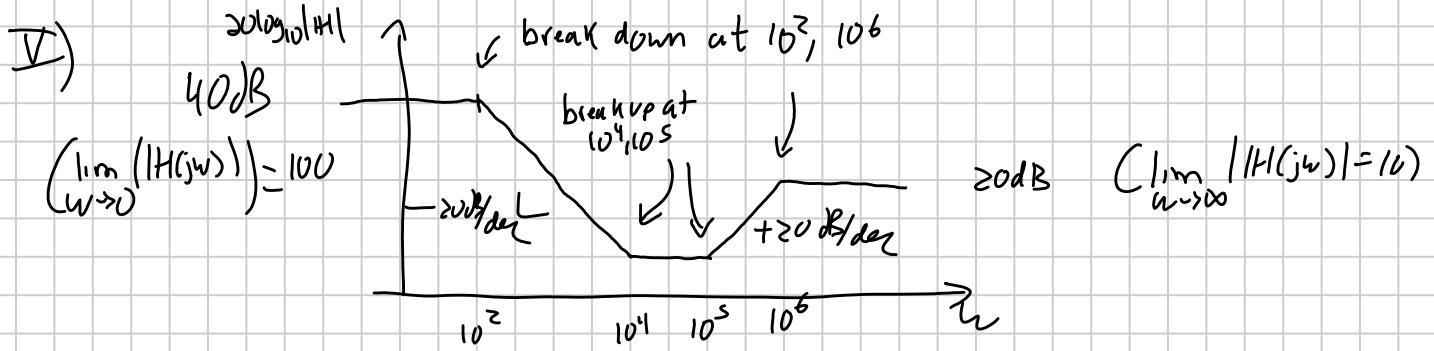
$$V_{OC,2} = -V_2 \frac{R_2 \parallel (R_3 + R_4)}{R_1 + (R_2 \parallel (R_3 + R_4))} \frac{R_4}{R_3 + R_4}$$

A circuit diagram for finding $V_{OC,1}$. It shows a current source i_1 with its arrow pointing upwards. Resistors R_1 and R_2 are in the top branch, and R_3 and R_4 are in the bottom branch. The output voltage $V_{OC,1}$ is measured across R_4 .

$$V_{OC,1} = i_1 \frac{R_1 \parallel R_2}{(R_1 \parallel R_2) + (R_3 + R_4)} R_4$$

$$V_{OC} = V_T = V_{OC,1} + V_{OC,2}$$

$$i_N = \frac{V_{OC}}{R_T}$$



(a)

(b) Low pass

(c) ≈ 100 ; 3dB corner there below max |H|

(d) 100 is the gain

(e)

$$(jw)^2 + 1000100(jw) + 10^8 \Psi = 10((jw)^2 + 110000(jw) + 10^9) \times$$

$$\frac{d^2y}{dt^2} + 1000100 \frac{dy}{dt} + 10^8 y = 10 \frac{d^2x}{dt^2} + 1100000 \frac{dx}{dt} + 10^{10} x$$

2) comes in at 40 dB/dec : $(jw)^2$ {ok if $(1+j(w/10^3))^2$ }

breaks down twice at 10^3 . $\frac{1}{(1+j(w/10^3))^2}$

breaks up at $2 \cdot 10^4$ $(1+j(w/2 \cdot 10^4))$

breaks down at $2 \cdot 10^5$ $\frac{1}{(1+j(w/2 \cdot 10^5))}$

$$\text{so } \frac{K(jw)^2 (1+j(w/2 \cdot 10^4))}{(1+j(w/10^3))^2 (1+j(w/2 \cdot 10^5))}$$

at $w=1 \cdot 10^3$, $|H|=1$ so

$$\frac{(K)(10^3)^2 (1)}{(1)(1)} = 1 \quad K = 10^{-6}$$

check: $\lim_{w \rightarrow 0} |H(jw)| = \frac{(10^{-6})(1)^2 (1/2 \cdot 10^4)}{(1/10^3)^2 (1/2 \cdot 10^5)} = 10^{-6} 10^6 10^{-4} 10^5 = 10^1 \checkmark$

* HPF

$$w_{c0} \approx 2 \cdot 10^5$$

$$\text{gain} = 10 \text{ simo } 20 \text{ dB}$$