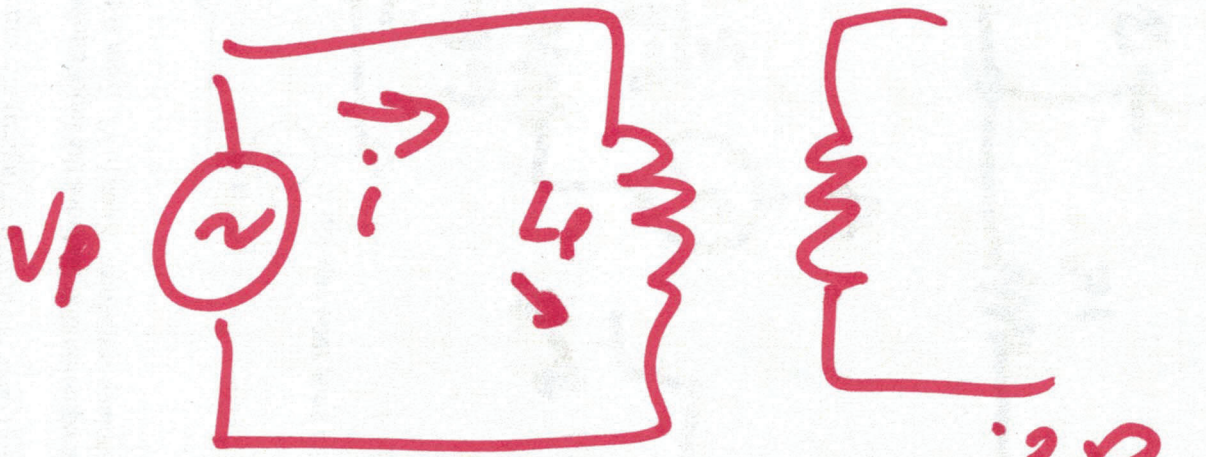
EE 221 Circuits II

May 3, 2023

Lecture 27



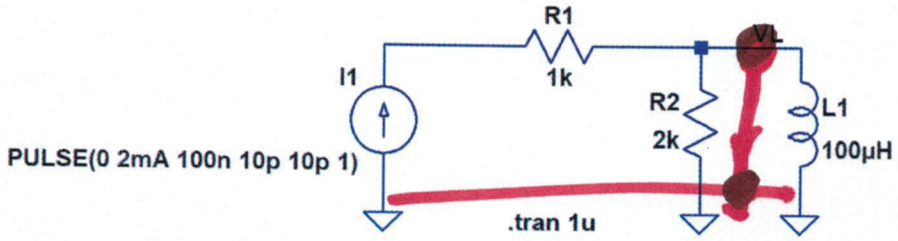
$$i_p = \frac{V_p}{j\omega L}$$

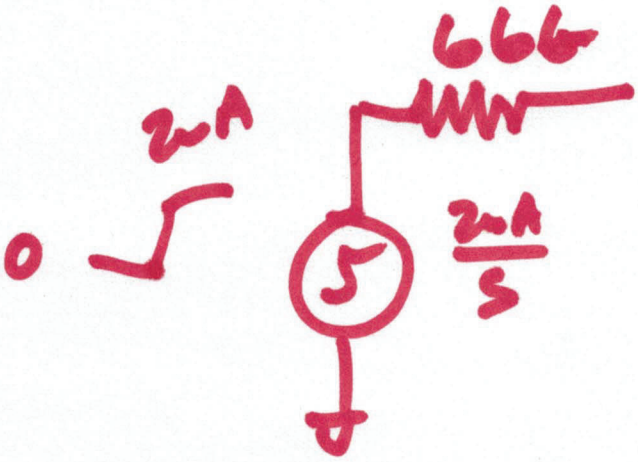
$$P = i^2 R$$

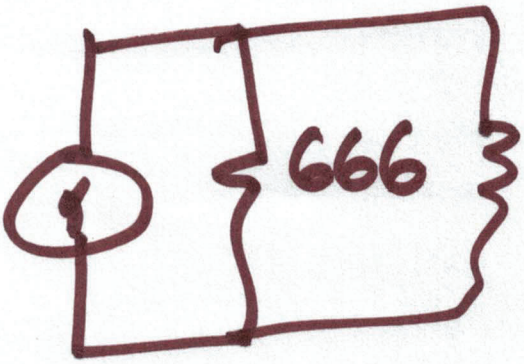
Practice Final Exam – EE 221 Circuits II NAME: _____
University of Nevada, Las Vegas

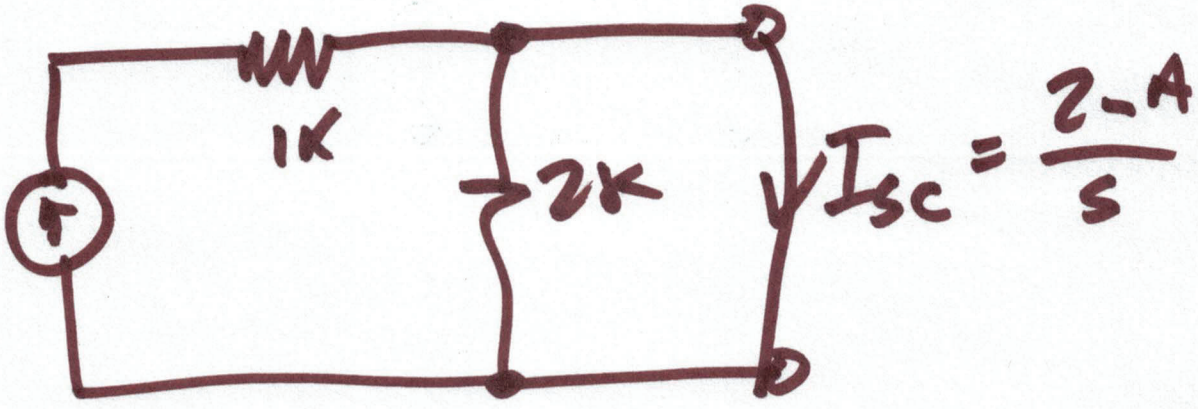
Closed book and notes. No extra paper, do your work on this exam, use the back if needed. **Show your work for credit and be neat! Place a box around each of your answers.** No Laplace transform table is allowed or (again) any other extra material (scratch paper).

1. Find VL (an equation that includes the input current pulse's delay) in the following circuit using the Laplace transform. Sketch VL from 0 to 1 us ensuring you label the axis. (15 points)









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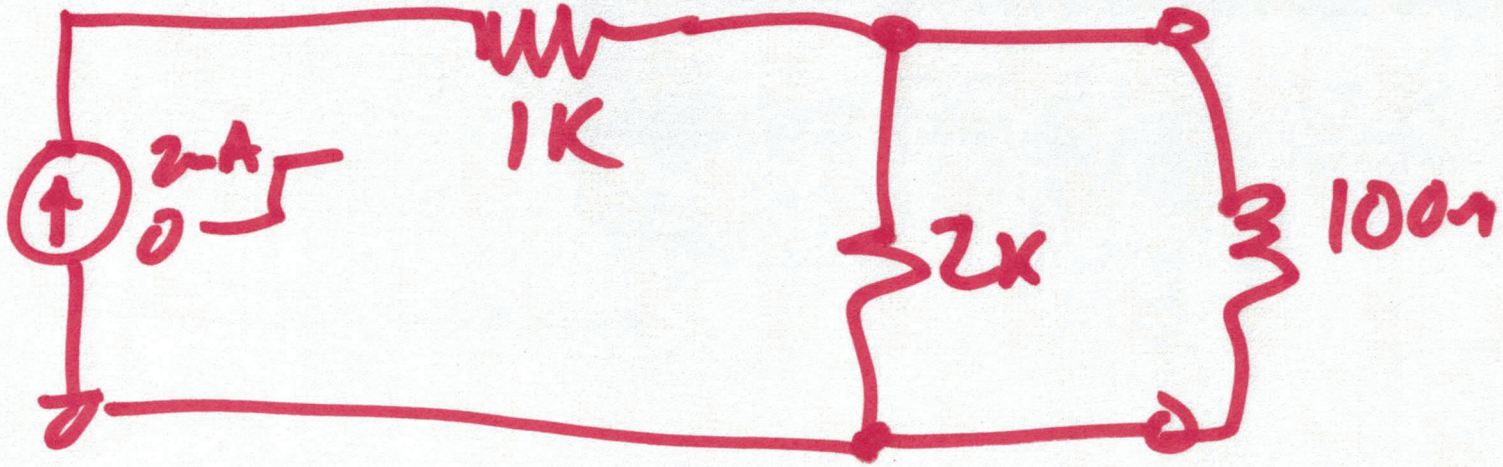
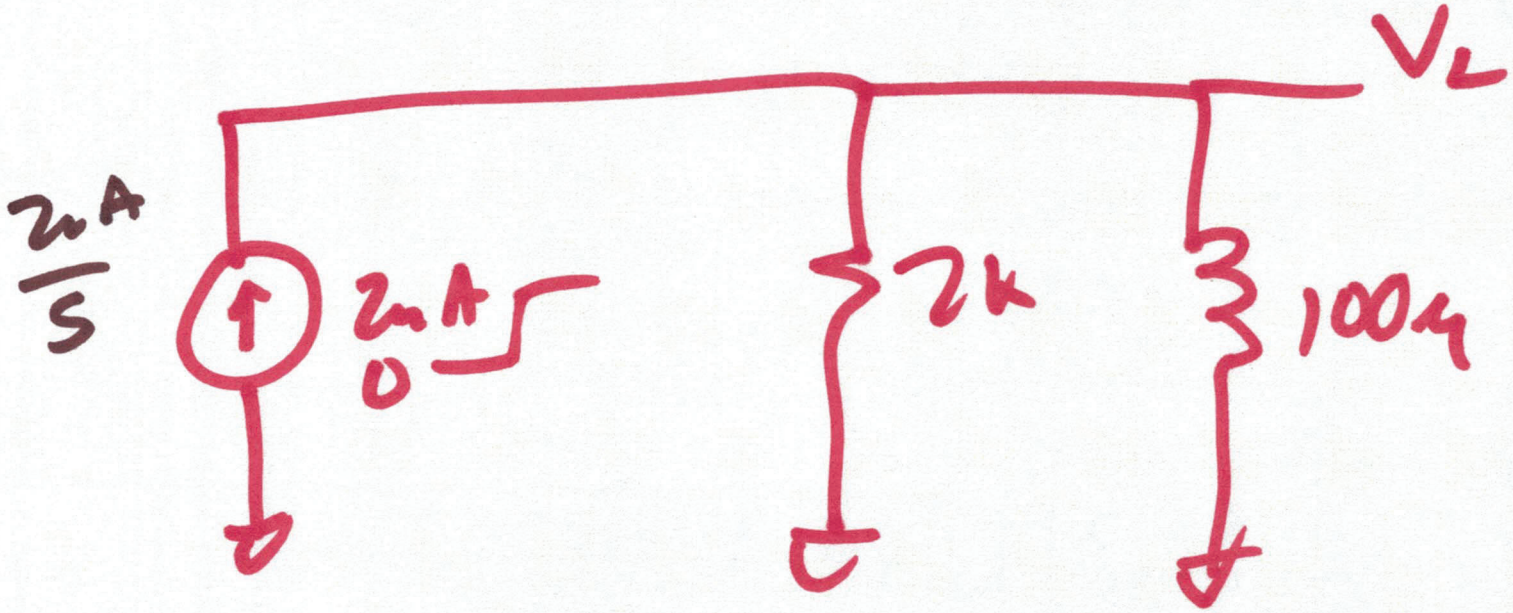




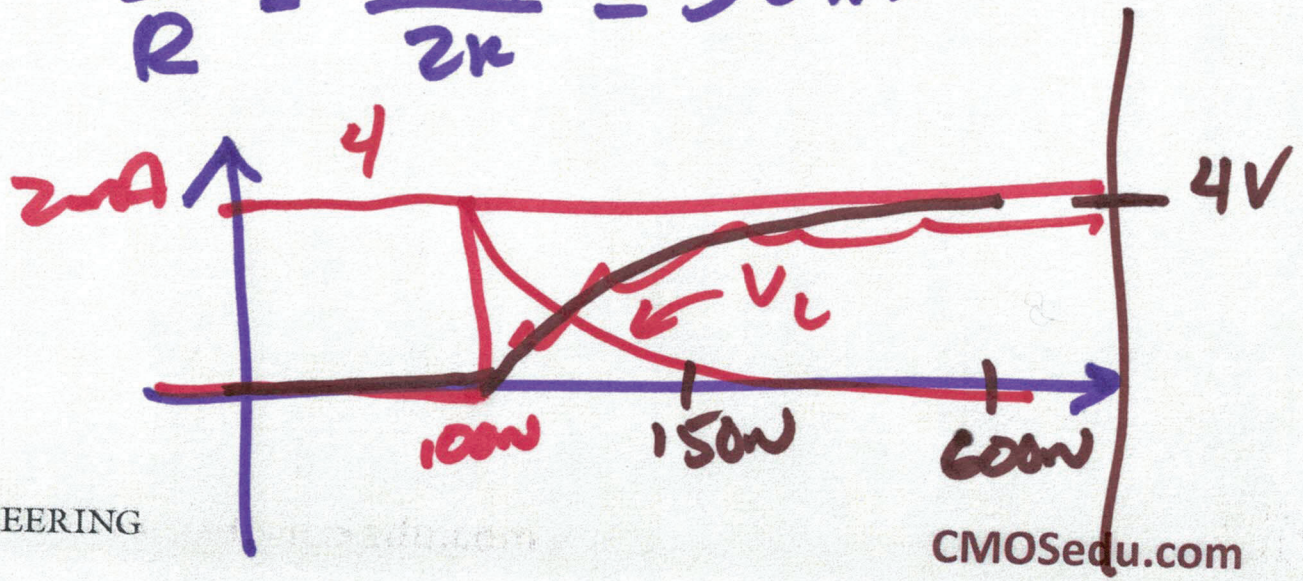
$$V_L = \frac{2mA}{S} \cdot \frac{2K \cdot S \cdot 100K}{2K + S \cdot 100K}$$

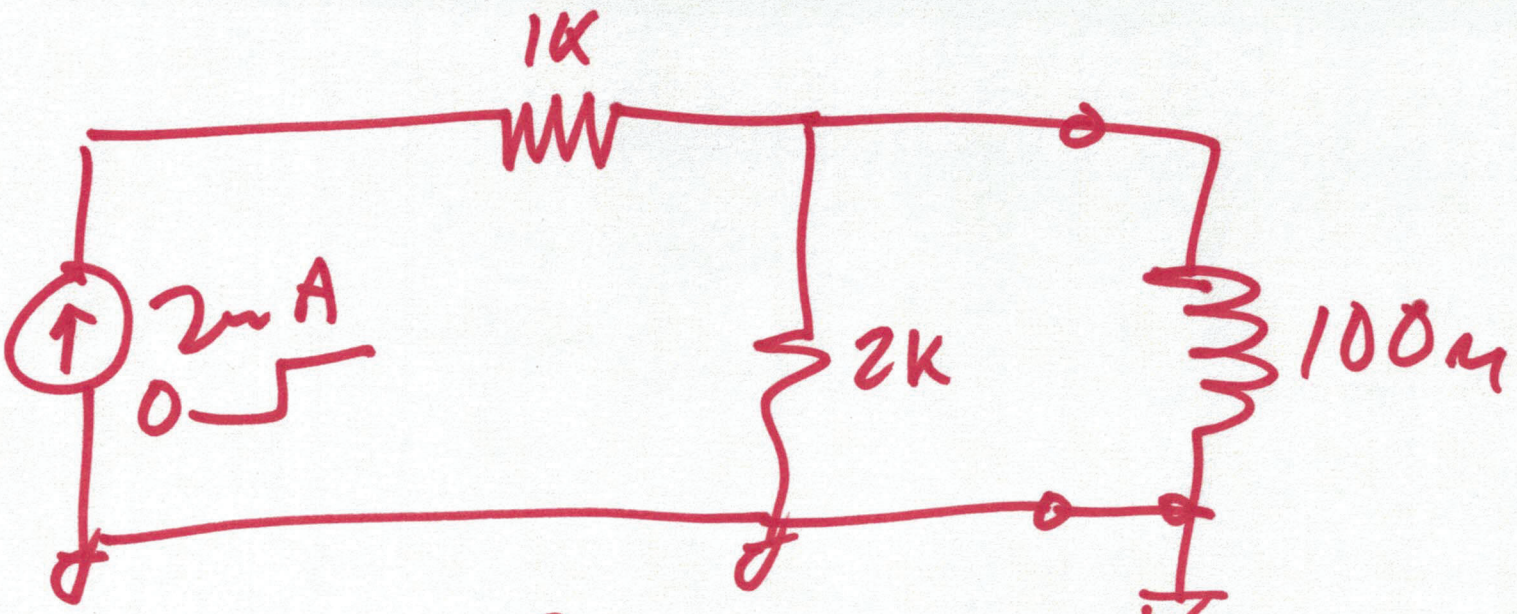
$$V_L = 2mA \cdot \frac{2k}{s + \frac{2k}{100\mu}}$$

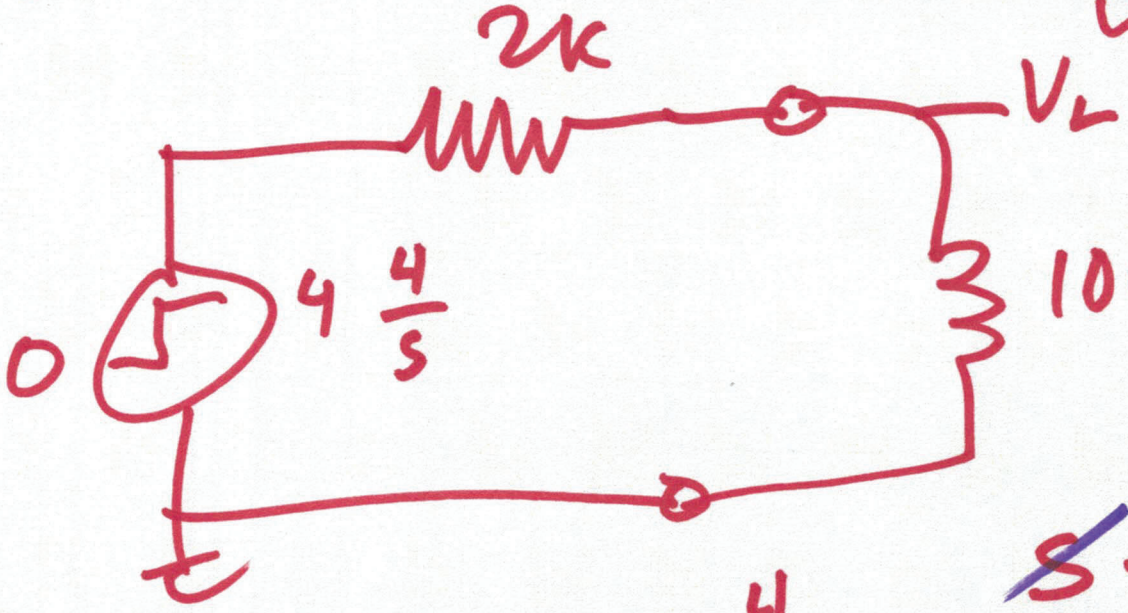
$$V_L(t) = 4V\, e^{-t/\frac{100\mu}{2k}}\, u(t)$$

$$V_L(t) = 4\, e^{-(t-100n)/\frac{100\mu}{2k}} \cdot u(t-100ns)$$

$$\frac{L}{R} = \frac{100\mu}{2k} = 50\,ns$$

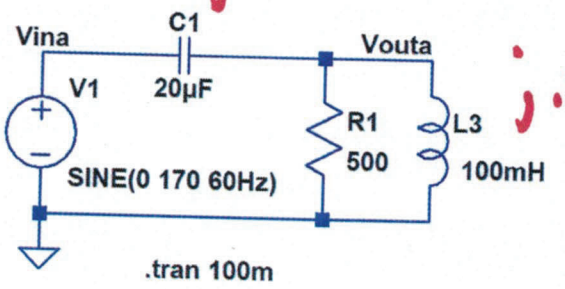






$$V_L = \frac{4}{s} \cdot \frac{s \cdot 100M}{s100M + 2K}$$

2. Assuming the circuit seen below is operating in steady-state, use AC analysis to determine Vouta. Sketch Vouta and Vina on the same plot ensuring to label times (phase shift) and voltages. (15 points)



$j \cdot 2\pi \cdot 60 \cdot 20\mu$

$j \cdot 2\pi \cdot 60 \cdot 0.1$

$$V_{OUTa} = 170\angle 0 \cdot \frac{\frac{500 \cdot j2\pi \cdot 6}{500 + j2\pi 6}}{\frac{500 \cdot j2\pi 6}{500 + j2\pi 6} + \frac{1}{j2\pi 60 \cdot 20\mu}}$$

$$= 170\angle 0 \cdot \frac{500 \cdot 2\pi \cdot 6\angle 90}{500 \cdot 2\pi \cdot 6\angle 90 + \frac{500 + j2\pi 6}{j2\pi 60 \cdot 20\mu}}$$

$500 \cdot 2\pi \cdot 6 = 18.84K$

$$V_{OUTa} = 170\angle 0 \cdot \frac{18.84K\angle 90}{18.84K\angle 90 + 66.8K\angle 85.7}$$

$\frac{500\angle 4.3^\circ}{7.5 \cdot 10^{-3}\angle 90}$

$6.8K\angle -85.7$

7)

$$j18.84k + 5k - j66.6k$$

$$V_{oTa} = \frac{17\angle 0 \cdot 18.84k\angle 90}{j18.84k + 5k - j66.6k}$$

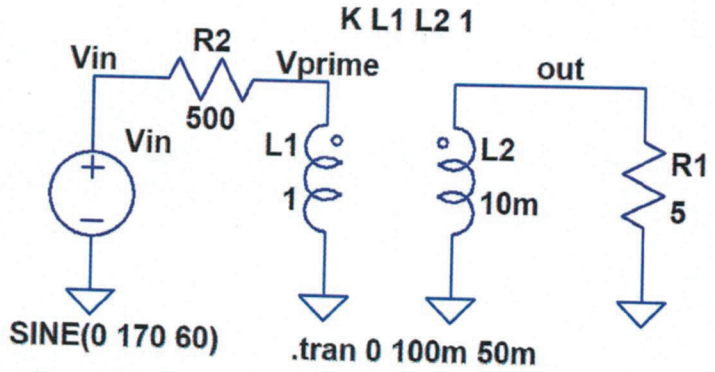
$$5k - j47.8k$$

$$V_{oTa} = \frac{17\angle 0 \cdot 18.84\angle 90}{48.1\angle -84}$$

$$V_{oTa} = 66.6\angle 174^\circ$$

$$= 66.6\sin(377.60 \cdot t + 174)$$

3. Find the voltages and currents in the following circuit. How much power does R1 dissipate? (20 points)



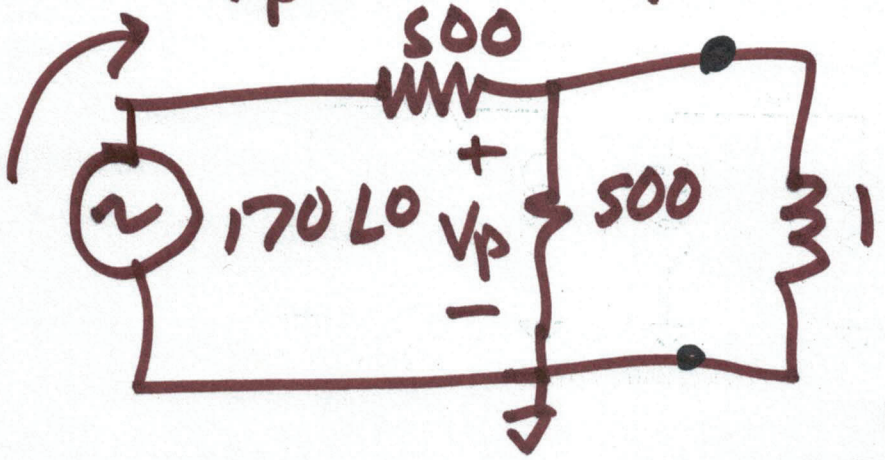
$$\frac{V_2}{I_2} = \frac{V_1 \cdot \frac{N_2}{N_1}}{I_1 \cdot \frac{N_1}{N_2}}$$

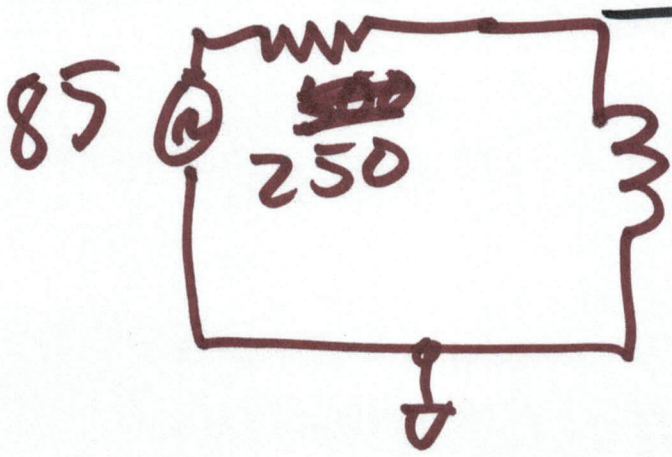
$$\frac{V_1}{I_1} = 5\left(\frac{N_1}{N_2}\right)^2$$

$$= 500$$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \sqrt{\frac{L_1}{L_2}} = \frac{1}{N}$$

$V_p = 170\,V_{peak}$ OR $120\,V_{RMS}$





$= j \cdot 2\pi \cdot 60$

$= j377$

i)

$$V_p = 85 \cdot \frac{j377}{250 + j377}$$

$$= 85 \cdot \frac{377\angle 90}{452\angle 56.5}$$

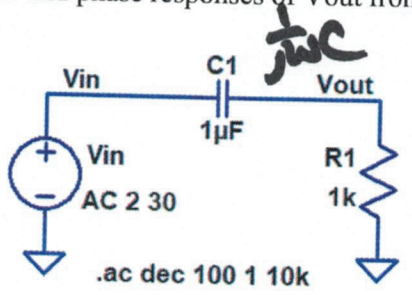
$$V_1 = V_p = 70.9\angle 33.5^\circ$$

$$I_p = \frac{70.9\angle 33.5}{377\angle 90}$$

$$V_2 = V_s = V_p \cdot \sqrt{\frac{L_2}{L_1}} = \frac{70.9\angle 33.5}{10}$$

$$I_2 = \frac{V_s}{5} = \frac{70.9\angle 33.5}{50}$$

4. In the following circuit the input voltage is 2V with a phase shift of 30 degrees. If the input frequency is swept determine equations for the magnitude and phase of the output voltage Vout(f). Plot the magnitude and phase responses of Vout from 1 Hz to 10 kHz. (15 points)



$$V_{OUT} = 2\angle 30 \cdot \frac{10^3 \,/\!/\, \frac{1}{j10^3 \cdot f}}{10^3 + \frac{1}{j2\pi \cdot 10^{-6} f}}$$

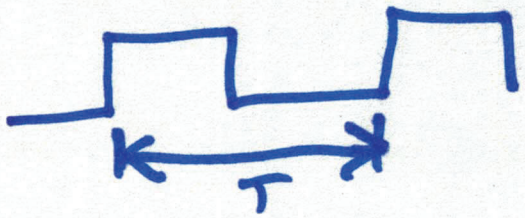
$$= \frac{2\angle 30}{1 + \frac{1}{j2\pi 10^{-3} f}}$$

$$= \frac{2\angle 30 \cdot j2\pi 10^{-3} f}{1 + j2\pi \cdot 10^{-3} f}$$

$$|V_{OUT}| = 2 \cdot 2\pi \cdot 10^{-3} \cdot f$$

11)

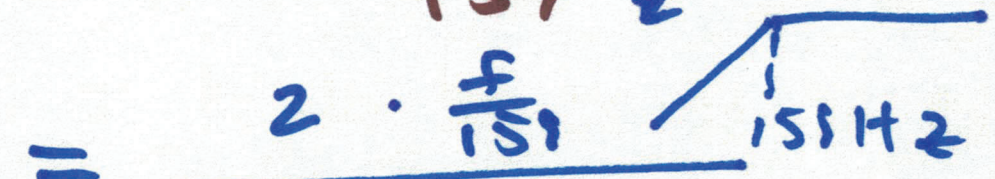
$$\frac{2\angle 30\,(0 + j\,2\pi\cdot 10^{-3} f)}{1 + j\,2\pi\cdot 10^{-3} f}$$



$$f = \frac{1}{T}$$

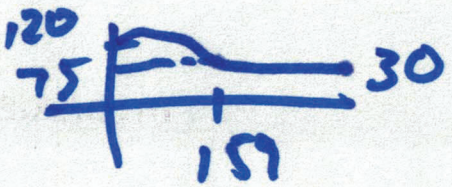
$$f_{3dB} = \frac{1}{2\pi\cdot 10^{-3}} = 159$$

$$\text{Vout} = \frac{2\angle 30\,(0 + j\frac{f}{159})}{1 + j\frac{f}{159}}$$

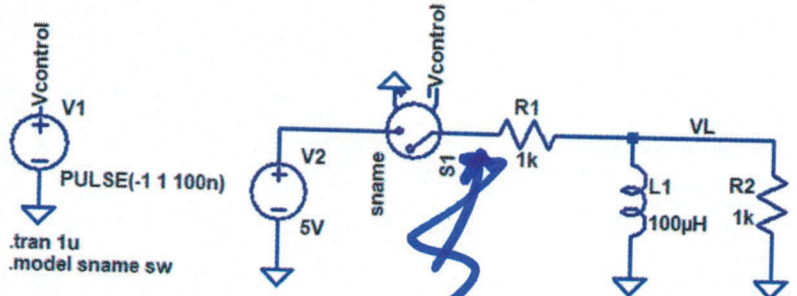


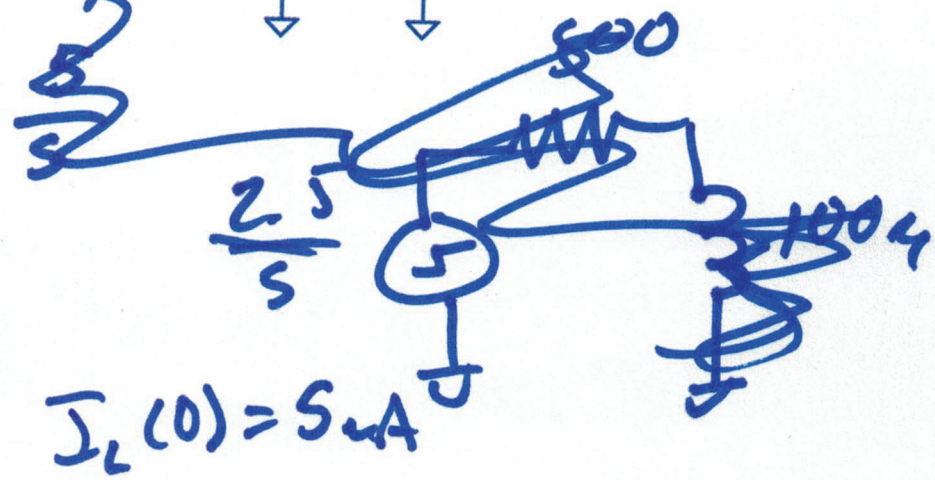
$$|\text{Vout}| = \frac{2\cdot\frac{f}{159}}{\sqrt{1 + \left(\frac{f}{159}\right)^2}}$$

$$\angle \text{Vout} = 30 + 90 - \tan^{-1}\frac{f}{159}$$

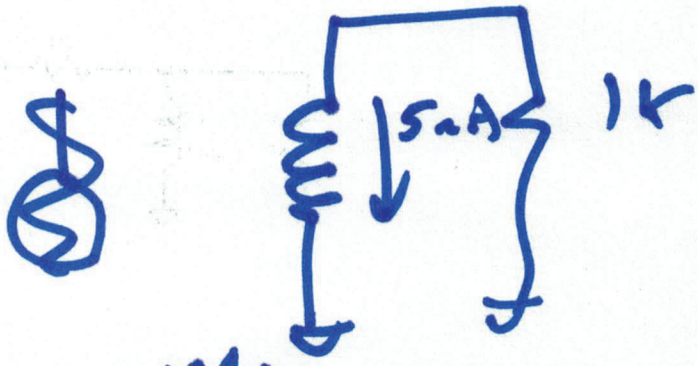


5. Using the Laplace transform show how to find the current through L1 in the following circuit. Ensure you place a box around your answer (the equation in the time domain you've derived using the Laplace transform). Plot this current in the time domain. (15 points)





$I_L(0) = 5\,mA$



$$-I(s)\cdot 1k - I(s)\cdot s\cdot 100\mu + 100\mu\cdot 5mA = 0$$

$$I(s)(1k + s\cdot 100\mu) = 100\mu\cdot 5mA$$

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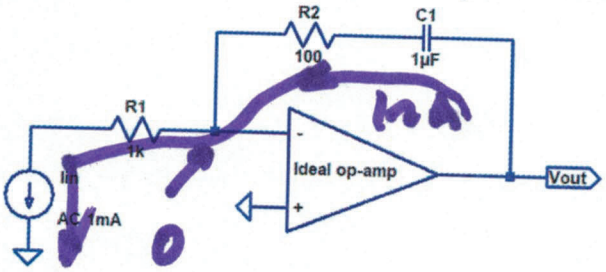
6. Determine the frequency when the output voltage is 1V peak in the following integrator circuit. Again, show your work and place a box around your answer. (20 points)



$$1 = V_{OUT} = 1mA \cdot \left(100 + j \cdot 2\pi \cdot f \cdot 10^{-6}\right)$$

$$1 = 1mA \cdot \left(100 + j\frac{1}{2\pi f \cdot 10^{-6}}\right)$$

$$1k = 100 + j\frac{1}{2\pi f \cdot 10^{-6}}$$

$$1k = 100 + j\left(-\frac{1}{2\pi f \cdot 10^{-6}}\right)$$

$$1k = \sqrt{100^2 + \left(\frac{1}{2\pi f \cdot 10^{-6}}\right)^2}$$

14)