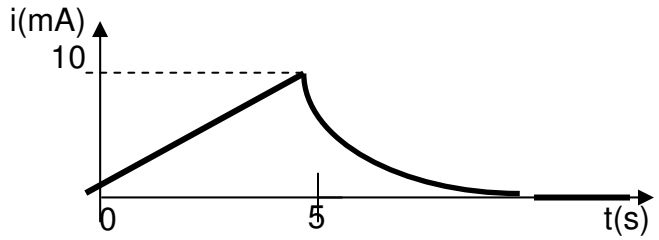
ECE204—AC Circuits
Review for Test 1 with answers

1. The current through a 0.1H inductor is plotted in the figure below:
   $i(t) = 2t$ mA , for $0 \le t \le 5$ s.
   $i(t) = 10e^{-(t-5)}$ mA, for $5 \le t < \infty$.

a) Derive the expression for the voltage across the inductor v(t) for $0 \le t < \infty$.

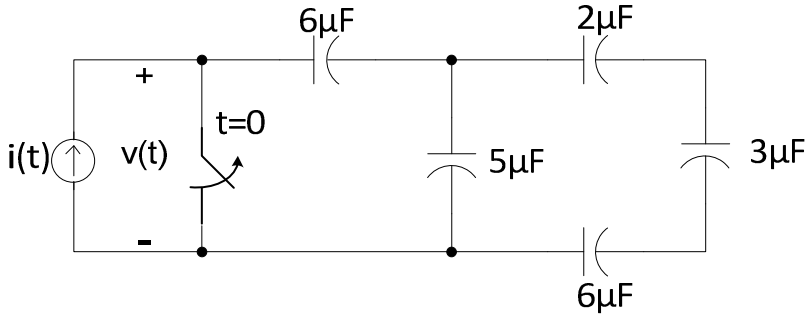


Ans: v(t) = 200μV for 0 < t < 5s; v(t)=-$e^{-(t-5)}$ mV for 5s < t

b) Calculate the energy stored in the inductor at *t = 3s*.

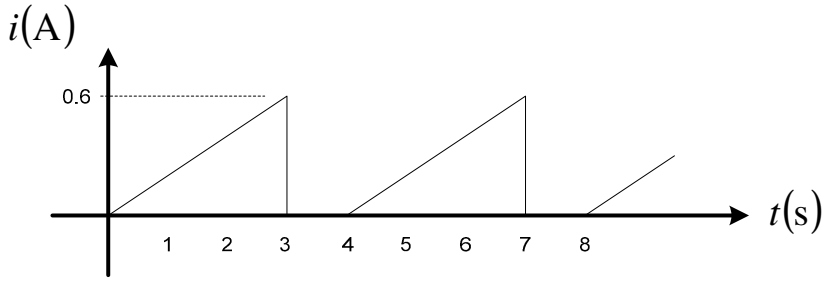
Ans:1.8 μJ

2. In the following circuit i(t) = 6t mA (t is in seconds), compute an expression for v(t) that's valid for t ≥0. The initial energy stored is zero. Also compute the energy delivered by the current source at t = 1ms.



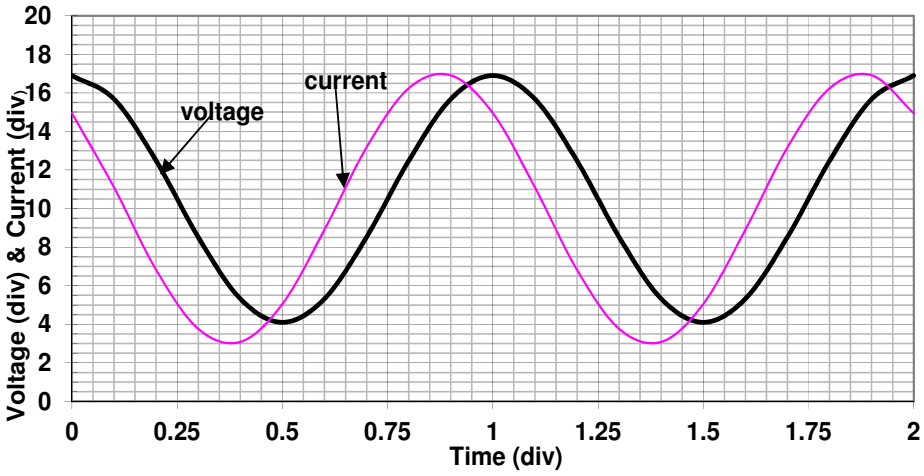
Ans: v(t) = 1000t^2 V; w=1.5 pJ

3. Determine the rms value for the given repetitive current pulse. Include appropriate units.



Ans: I_{RMS}=0.3 A

4. A trace from an oscilloscope is shown below. The voltage channel was set on 10 V/div, while the current channel was set on 5 A/div. Note that there are 20 divisions on the "y" axis and 2 divisions on the "t" axis. The time-base was set at 10 msec/div.



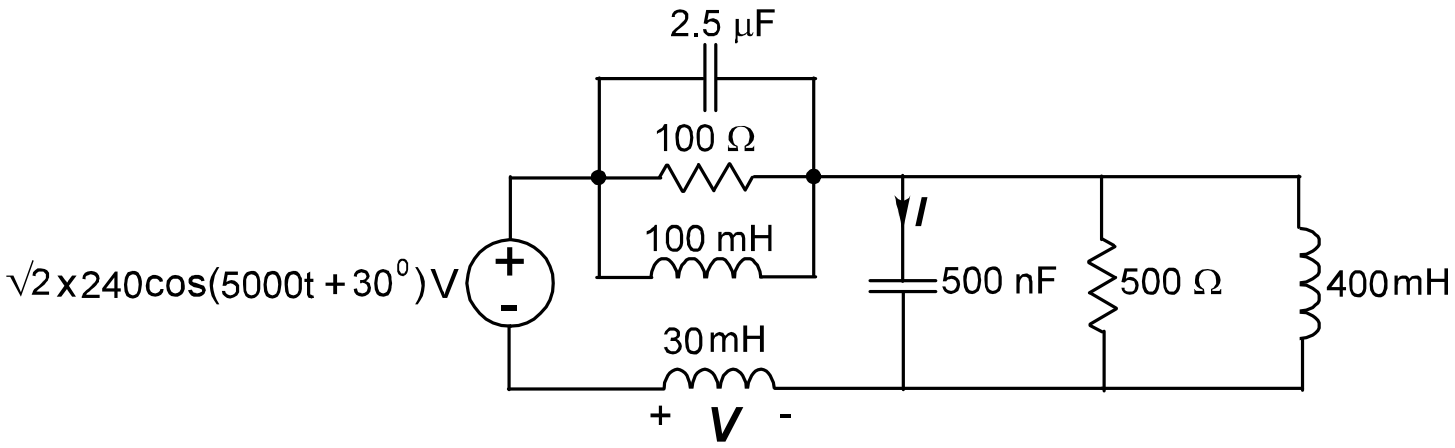
Find the following quantities:

a) The frequency
b) The rms values of the voltage and current
c) The voltage and current phasors reported in polar form
d) The equivalent impedance measured reported in rectangular form. Is this a capacitive or inductive load?
e) The value of resistance if the elements are in series.
f) The value of the resistance if the elements are in parallel.

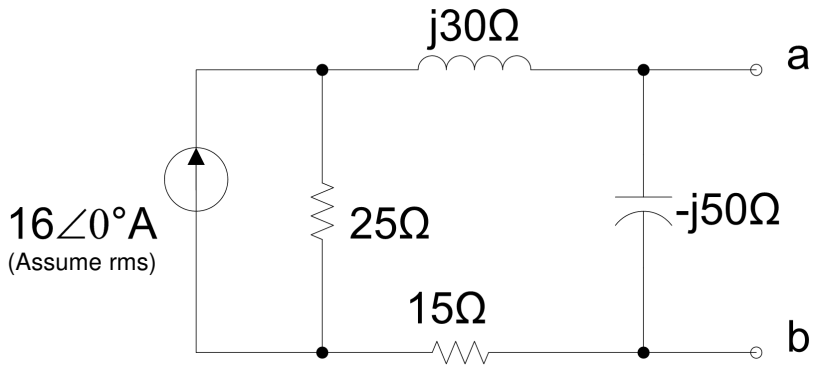
*Ans: f=100 Hz, V_{rms} = 45.96V, I_{rms} = 24.75 A, **V** = 45.96∠0° V_{rms}, **I** = 24.75∠45 V_{rms}; Z = 1.313-j*1.313 Ω; R_{series} = 1.313 Ω; $R_{parallel}$ = 2.626 Ω*

5. For the following circuit:

a) Determine the rms phasor ***V*** by voltage division. *Ans:* **V** = 108∠146.7° V
b) Determine the rms phasor ***I*** by current division. *Ans:* **I** = 0.6366∠101.7° V

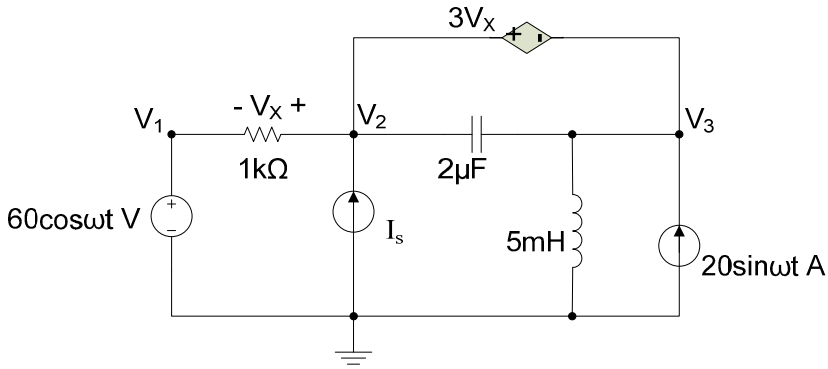


6. Determine the Thevenin & Norton Equivalents at terminals a—b. Report your answers in the time-domain form assuming the frequency of operation is 1000 r/s. Then calculate the maximum power that can be dissipated by any load.



Ans: $\mathbf{V_{th}}$ = 447.2∠-63.4 V

7. In the following circuit, assume that all sources act with the same frequency. The current source I_s has a ***peak-to-peak*** value of 6A and 0 phase offset, the period is 12.57 msec. Draw the circuit in the phasor domain and write the nodal equations (you don't need to solve them).



Ans: check your equations with the values of node voltage by plugging;
$\mathbf{V_2}$ = 65.1∠-3.3° V, $\mathbf{V_3}$ = 50.6∠8.5 V, $\mathbf{V_x}$ = 6.28∠-36.8° V

8. Solve the following set of equations to find the mesh currents. Report your answer in polar phasor form with 3 sig. digits and 1/10th of a degree precision.

$$50\cdot(I_2-I_1) - 50\angle 45^\circ + I_2\cdot j50 + I_2\cdot 30 - j50\cdot(I_2 - I_3) = 0$$

$$I_1(-j40) + (I_1-I_2)\cdot 50 + 50\angle 45^\circ + (I_1 - I_3)\cdot 40 = 0$$

$$(I_3 - I_1)\cdot 40 + (I_3 - I_2)\cdot(-j50) + I_3\cdot j75 = 0$$

Ans: $\mathbf{I_1}$ = 0.613∠-112.2° A, $\mathbf{I_2}$ = 0.229∠85.7° A, $\mathbf{I_3}$ = 0.502∠-116.8° A