ECE 311 - Homework #3

Phasors (review)

1) Find Y as a complex number

$$Y = \left(\frac{50s+3}{(s+2)(s+5)} \right)_{s=-1+j2}$$

Using Matlab (overkill - your calculator should also work. Especially on midterms...)

```
>> s = -1 + j*2;
>> Y = (50*s + 3) / ( (s+2)*(s+5) )

Y =

  10.0000 + 4.7000i
```

2) Find Y as a compex number

$$Y = \left(\frac{200}{s^3+6s^2+8s+50} \right)_{s=-3+j4}$$

```
>> s = -3 + j*4;
>> Y = 200 / ( s^3 + 6*s^2 + 8*s + 50)

Y =

   1.3626 + 0.9174i
```

3) Express y(t) in phasor form

real = cosine(), -imag = sine()

a) $y(t) = 3\cos(10t) + 7\sin(10t)$

Y = 3 - j7

b) $y(t) = -2\cos(50t) + 200\sin(50t)$

Y = -2 - j200

c) $y(t) = 20\sin(30t)$

Y = 0 - j20

4) Determine the phasor impedance of the following

a) 10mH inductor operating at 100Hz

100 Hz = 377 rad/sec

$$\omega = 2\pi f = 2\pi \cdot 100Hz$$

The impedance of an inductor is

$$Z = j\omega L = j \cdot 628 \cdot 10mH$$

$$Z = j6.28\Omega$$

b) 10mH inductor operating at 1000 Hz

$$\omega = 2\pi f = 6283$$

$$Z = j\omega L = j \cdot 6283 \cdot 10mH$$

$$Z = j62.8\Omega$$

for inductors, the impedance goes up with frequency

c) 0.1uF capacitor operating at 100Hz

$$Z = \frac{1}{j\omega C} = \frac{1}{j \cdot 628 \cdot 0.1\mu F}$$

$$Z = -j15,915\Omega$$

d) 0.1uF capacitor operating at 1000Hz

$$Z = \frac{1}{j\omega C} = \frac{1}{j \cdot 6283 \cdot 0.1\mu F}$$

$$Z = -j1,591\Omega$$

for capacitors, impedance goes down as frequency goes up

5) Assume Vin contains a DC and 16Hz (100 rad/sec) signal:

$$V_{in} = 10 + 3\sin(100t)$$

a) Determine the impedances of the inductor, capacitor, and resistor at DC and 100 rad/sec

DC (blue)

$\omega = 0$

$L \rightarrow j\omega L = 0$

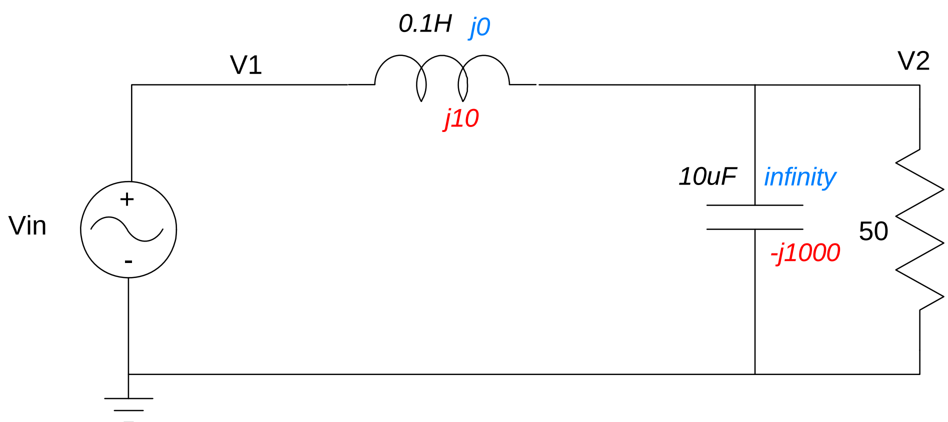
$C \rightarrow \frac{1}{j\omega C} = \infty$

AC (red)

$\omega = 100$

$L \rightarrow j\omega L = j10$

$C \rightarrow \frac{1}{j\omega C} = -j1000$



b) Determine the voltage, V2, using phasor analysis

Voltage node equation

DC

$V_{in} = 5$

$V_2 = V_{in} = 5$

AC

$V_{in} = -j3$ (3 sin(100t) => 0 - j3)

$$\left(\frac{V_2 - V_{in}}{j10}\right) + \left(\frac{V_2}{-j1000}\right) + \left(\frac{V_2}{50}\right) = 0$$

$V_2 = 2.97\angle -101^0$ *polar form*

$v_2(t) = 2.97\cos(100t - 101^0)$

$V_2 = -0.567 - j2.915$ *rectangular form*

$v_2(t) = -5.67\cos(100t) + 2.915\sin(100t)$

Total Answer:

$v_2(t) = 10 + 2.97\cos(100t - 101^0)$ *polar form*

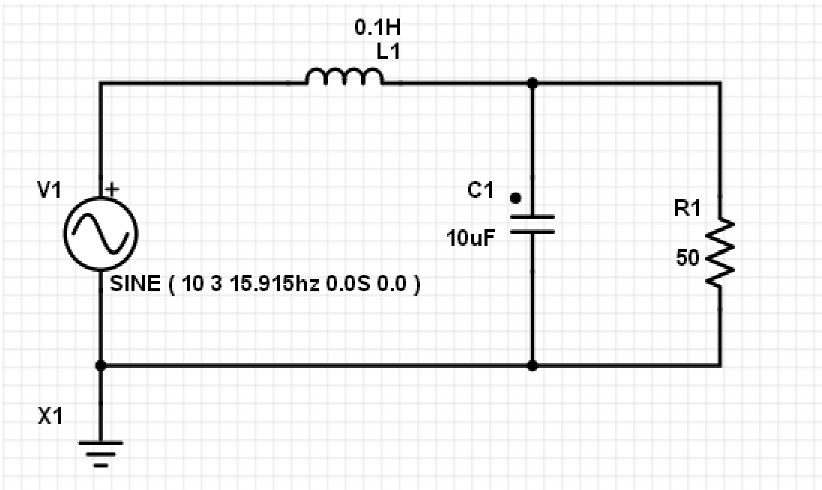
$v_2(t) = 5 - 5.67\cos(100t) + 2.915\sin(100t)$ *rectangular form*

Either answer is correct.

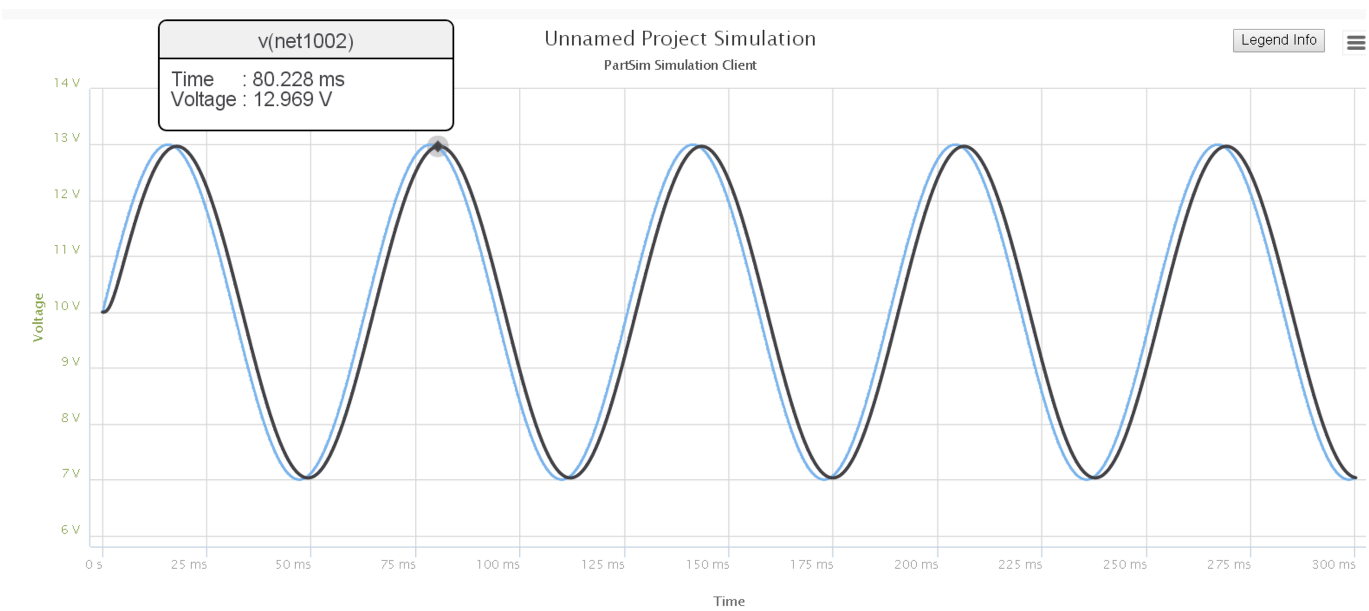
c) Check your answer using PartSim (or similar program)

Input the circuit in PartSim. Use a transient input (sinusoid) with a

- 10V DC offset
- 3V AC amplitude
- 15.915Hz (100 rad/sec)



Run a transient simulation for several cycles



The DC signal at the output (black) is 10V

The AC signal is 2.969Vp (vs. 2.97Vp computed)

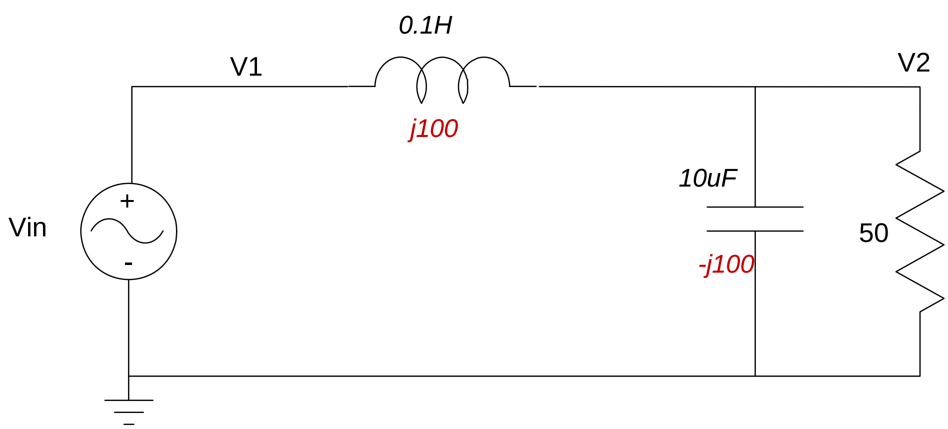
The AC signal has a small delay (-10 degrees computed)

6) Assume Vin contains a DC and 160Hz signal:

$$V_{in} = 5 + 3\sin(1000t)$$

a) Determine the impedances of the inductor, capacitor, and resistor at DC and 1000 rad/sec

DC	AC (1000 rad/sec)
no change	$\omega = 1000$
L = 0	$L \rightarrow j\omega L = j100$
C = infinity	$C \rightarrow \frac{1}{j\omega C} = -j100$
	$V_{in} = -j3$



b) Determine the voltage, V2, using phasor analysis

DC	AC
$V_2 = V_1 = 5$	$50 \| \| -j100 = 40 - j20$
	$V_2 = \left(\frac{40-j20}{(40-j20)+(j100)}\right)(0 - j3)$
	$V_2 = 1.5\angle 180^0$
	$v_2(t) = 1.5\cos(1000t + 180^0)$

Total answer: DC + AC

$$v_2(t) = 5 + 1.5\cos(1000t + 180^0)$$

Checking in PartSim (not required)