Final Exam

Jun. 18, 2019

Time: 10:30 ~ 11:50

Name _____

ID Number _____

Signature _____

- **If there is no answer, you can get only partial credit for your work.**
- **Don't forget the units of your answers**

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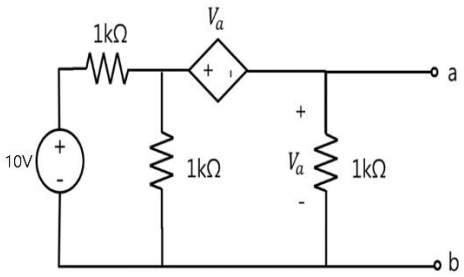
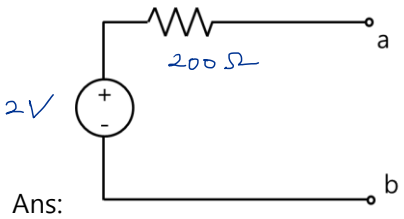
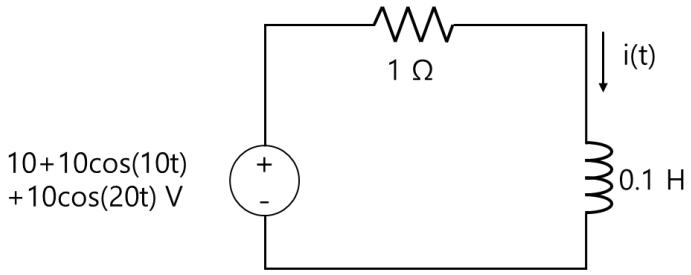
1. (10 points) Find the Thevenin equivalent circuit between terminal a-b of the following circuit.





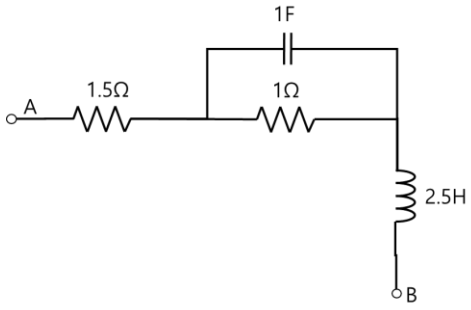
Ans:

2. (10 points) In the following ~~LC~~ circuit, find steady-state i(t). ($\frac{1}{1+j} \approx 0.7\angle -45^o, \frac{1}{1+2j} \approx 0.45\angle -63^o$)



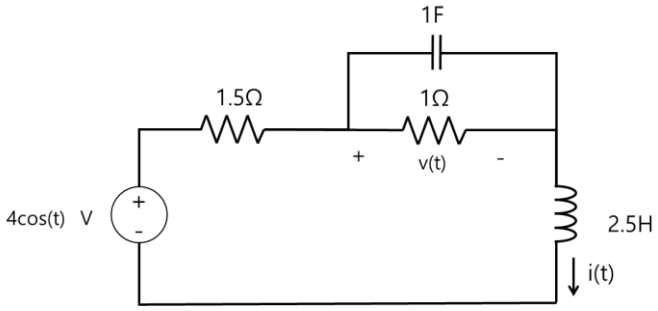
Ans.: $10 + 9\cos(10t - 45^\circ) + 4.5\cos(20t - 63^\circ)$

3. (a) (5 points) Find the total impedance between terminals A and B in the following figure.



Ans.: $1.5 + \frac{1}{1+j\omega} + j2.5\cdot\omega$

For (b) and (c), consider the following RLC circuit.



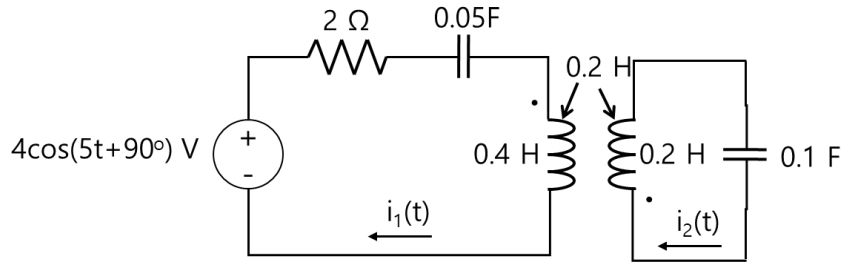
(b) (5 points) Find steady-state i(t). ($\frac{1}{1+j} \approx 0.7\angle -45^o$)

Ans.: $1.4\cos(t-45^\circ)$

(c) (5 points) Find steady-state v(t).

Ans.: $\cos(t-90^\circ)$

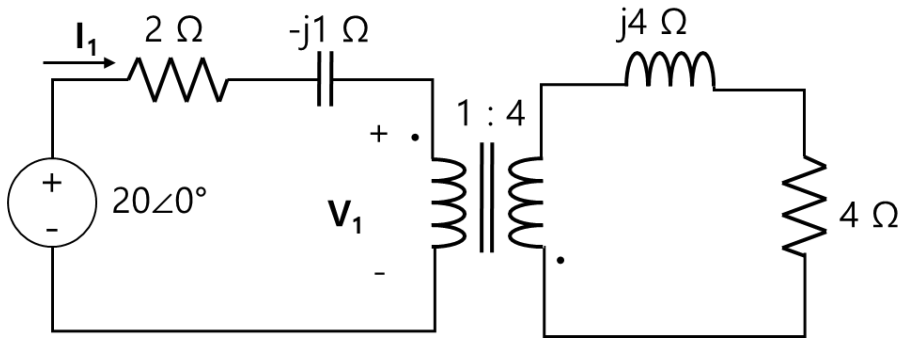
4. (10 points) Consider the following circuit.



Complete the following equations about phasor currents, $\mathbf{I}_1$ and $\mathbf{I}_2$ of $i_1(t)$ and $i_2(t)$, respectively.

2−2j	$\mathbf{I}_1$ +	j	$\mathbf{I}_2$ =	4j
j	$\mathbf{I}_1$ +	−j	$\mathbf{I}_2$ = 0	

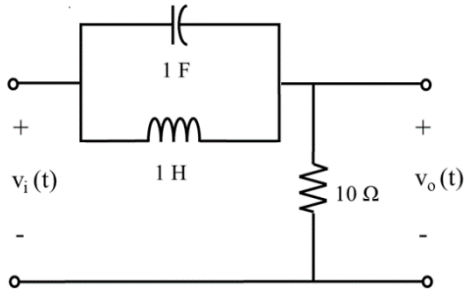
5. (10 points) Consider the following circuits with an ideal transformer.



Complete the following equations about phasor currents, $\mathbf{I}_1$ and $\mathbf{V}_1$.

2−j	$\mathbf{I}_1$ +	1	$\mathbf{V}_1$ =	20
−(1+j)	$\mathbf{I}_1$ +	4	$\mathbf{V}_1$ = 0	

6. (15 points) In the following circuit, the input signal is $v_i(t)$ and the output signal is $v_o(t)$.



(a) (6 points) Find the frequency response of $\mathbf{V}_o(j\omega)/\mathbf{V}_i(j\omega)$.

$$\frac{10}{10 + \frac{j\omega}{1-\omega^2}} = \frac{10(1-\omega^2)}{10(1-\omega^2)+j\omega}$$

Ans.: _____

(b) (3 points) Find the magnitude of the frequency response.

$$\frac{|10(1-\omega^2)|}{\sqrt{100(1-\omega^2)^2 + \omega^2}}$$

Ans.: _____

(c) (3 points) Find the phase of the frequency response.

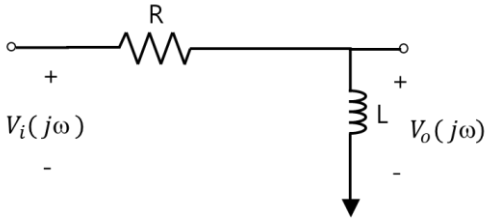
$$\begin{cases} \pi - \tan^{-1}\frac{\omega}{10(1-\omega^2)} & \omega^2 > 1 \\ -\tan^{-1}\frac{\omega}{10(1-\omega^2)} & \omega^2 < 1 \end{cases}$$

Ans.: _____

(d) (3 points) Determine the type of the filter. (low-pass filter, high-pass filter, bandpass filter, or band-rejection filter)

Ans.: band-rejection filter

7. (10 points) Consider the following circuit.



(a) (4 points) Find the frequency response, $\mathbf{V}_o(j\omega)/\mathbf{V}_i(j\omega)$.

$$\frac{j\omega L}{R+j\omega L} = \frac{1}{1+\frac{R}{j\omega L}}$$

Ans.: _____

(b) (3 points) Find 3 dB ~~bandwidth~~ frequency in the unit of rad/s.

$$\frac{R}{L}$$

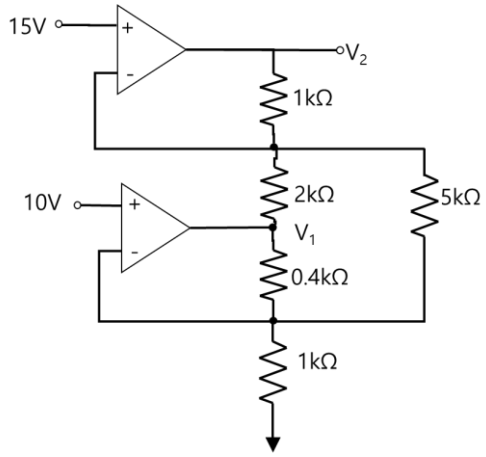
Ans.: _____

(c) (3 points) Find 3 dB ~~bandwidth~~ frequency in the unit of Hz.

$$\frac{R}{2\pi L}$$

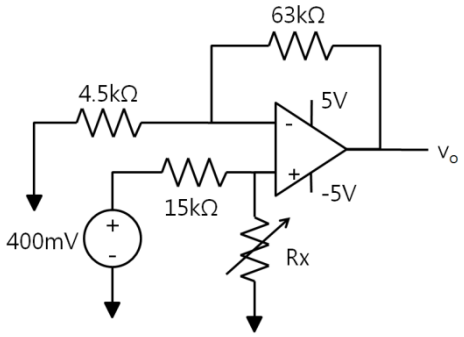
Ans.: _____

8. (10 points) The two op amps in the following circuit are ideal. Calculate v_1 and v_2.



Answers: v_1 = 13.6V, v_2= 6.7V

9. (10 points) Consider the following circuit which contains an ideal op amp. The power supplies for the op amp are +5 V and –5V.



(a) (5 points) Find v_0 when Rx is 15 kΩ.

Answers: v_0 = 3V

(b) (5 points) How large can Rx be before the amplifier saturates?

Answers: Rx = 25 kΩ