EECS/CSE 70A Network Analysis I

Homework #6

Due on or before

6/6/2017, Tuesday 6.00pm ONLINE ONLY

Problem 1 (20pts)

Part (a): $u = (A + jB)(C + jD)$

Find $\operatorname{Re}\{u\}$

$\operatorname{Im}\{u\}$

Express *u* as $u = x + iy$

$u = re^{j\phi}$

Find $\operatorname{Re}\left\{ue^{j\omega t}\right\}$

Part (b): $u = \dfrac{A + jB}{C + jD}$

Find $\operatorname{Re}\{u\}$

$\operatorname{Im}\{u\}$

Express *u* as $u = x + iy$

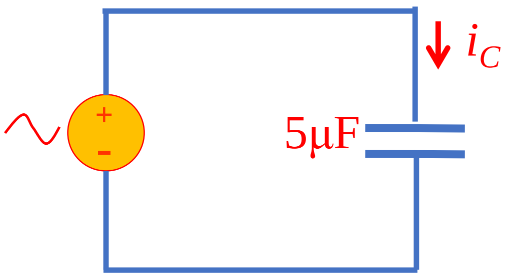
$u = re^{j\phi}$

Find $\operatorname{Re}\left\{ue^{j\omega t}\right\}$

Problem 2 (20pts.)

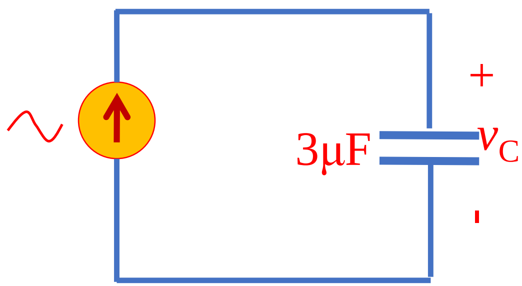
Part (a): Find the current $i_C(t)$ at the frequency 80Hz.

$$v(t) = 4\cos\left(\omega t - \frac{\pi}{3}\right)$$



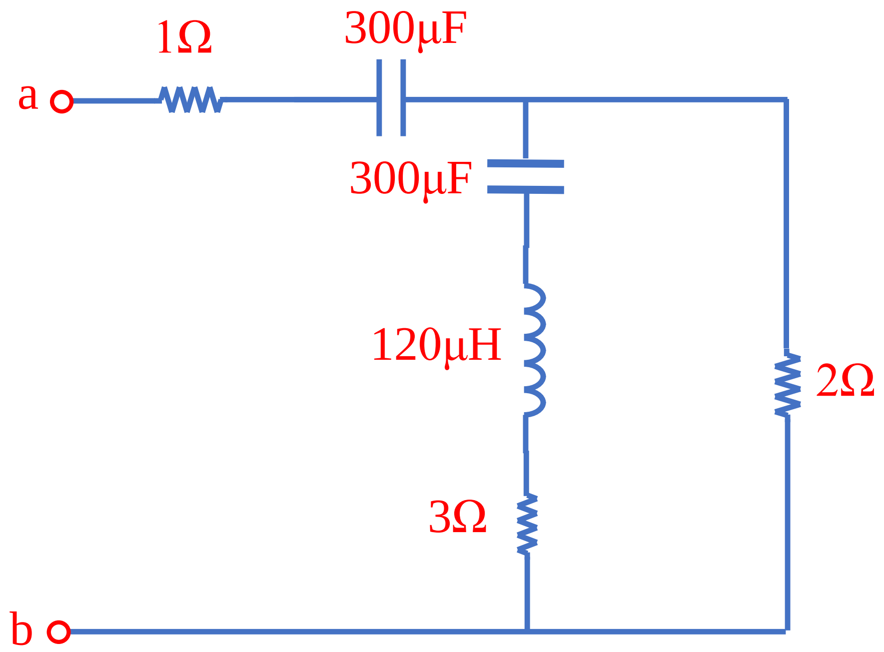
Part (b): Find the voltage $v_C(t)$ at the frequency 30Hz.

$$i(t) = 7\cos\left(\omega t + \frac{\pi}{8}\right)$$



Problem 3 (30pts.)

Part (a): Find the impedance seen from terminals a-b as a function of the angular frequency ω.



Part (b): Evaluate the impedance at 750Hz

Part (c): Evaluate the impedance at 3kHz

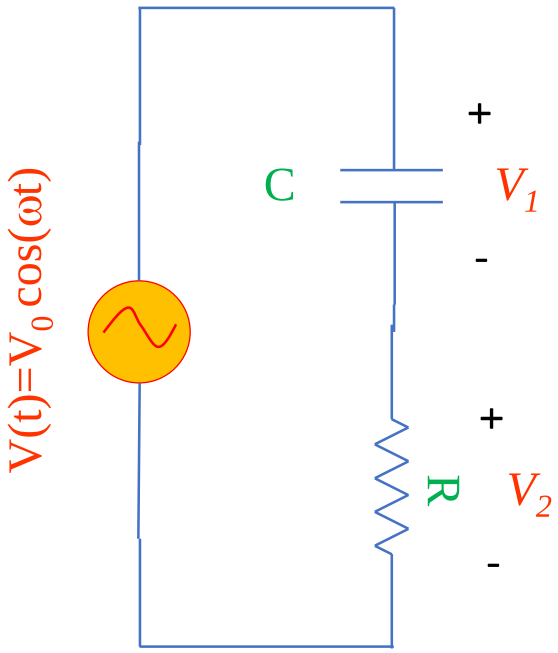
Problem 4: (20 pts)

Find the relationship of the phase shift between $i(t)$ and $v(t)$ in terms of the impedance Z for an element.

Problem 5: (40 pts)

For the circuit shown below, by writing all the steps, prove that

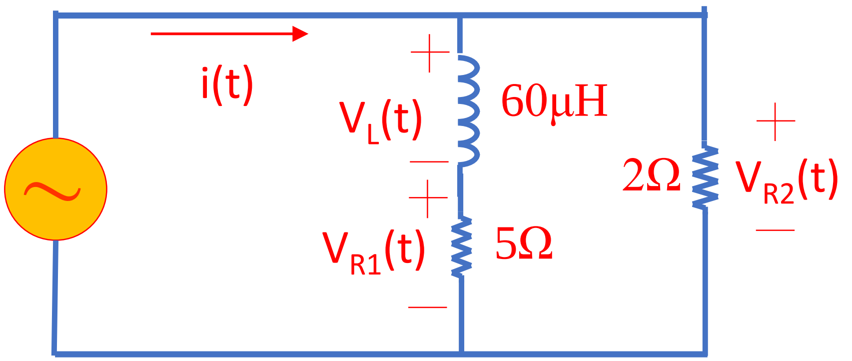
$$V_1(t) = \frac{V_0}{\sqrt{1+(\omega\tau)^2}}\cos(\omega t - \tan^{-1}(\frac{1}{\omega\tau})) \qquad ;\tau = RC$$



Problem 6: (20 pts)

For the circuit shown below, find i(t), $v_L(t)$, $v_{R1}(t)$ and $v_{R2}(t)$

$$v_S(t) = 12\cos(10 \times t + 30^\circ)$$



Problem 7: (20 pts)

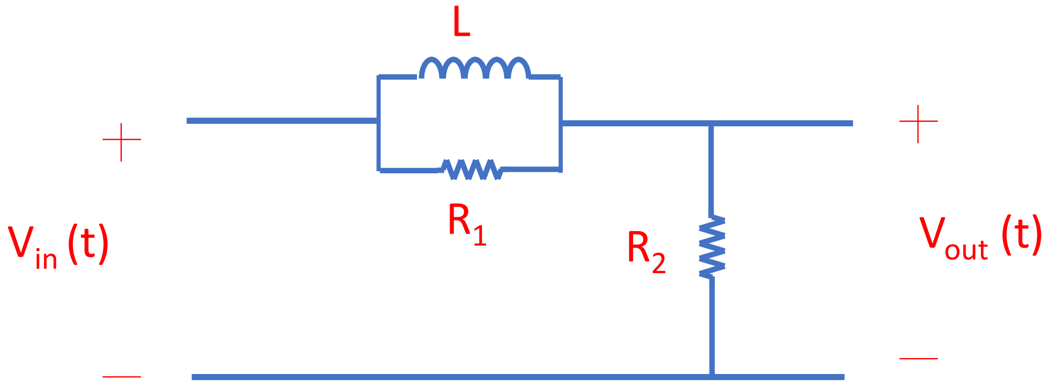
a) Determine the type of the filter shown below based on L, R_1 and R_2.

b) Plot V_{out} (t) versus V_{in}(t) for the following cases

i) $\omega \to 0$

ii) $\omega = 1/\tau$

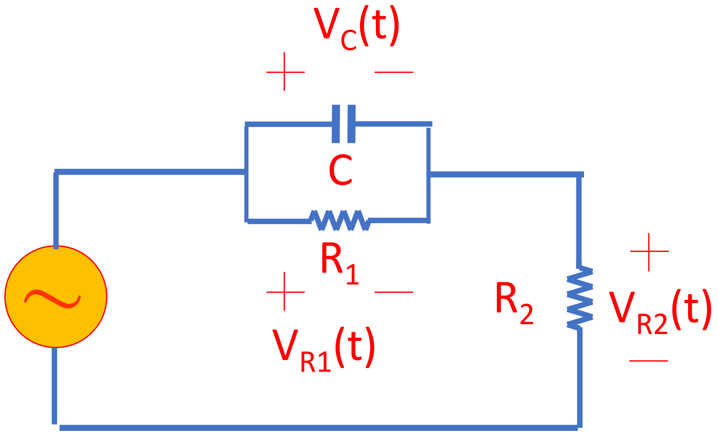
iii) $\omega \to \infty$



Problem 8: (20 pts)

For the circuit shown below, find $i_C(t)$, $v_C(t)$, $v_{R1}(t)$ and $v_{R2}(t)$

$$v_S(t) = 12\cos(20 \times t + 45^\circ)$$



Problem 9: (20 pts)

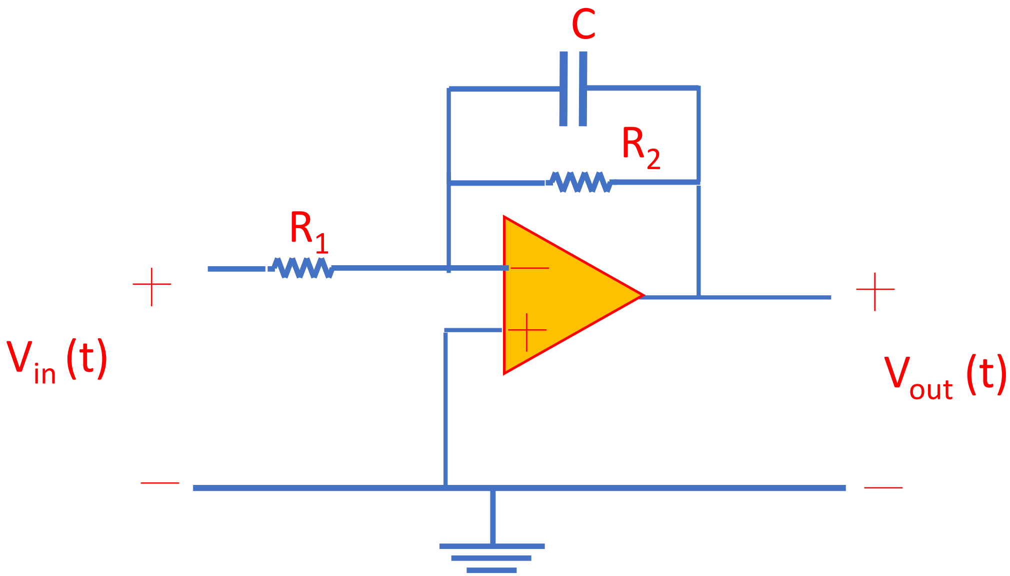
a) Determine the type of the filter shown below based on C, R_1 and R_2.

b) Plot V_{out} (t) versus V_{in}(t) for the following cases

i) $\omega \to 0$

ii) $\omega = 1/\tau$

iii) $\omega \to \infty$



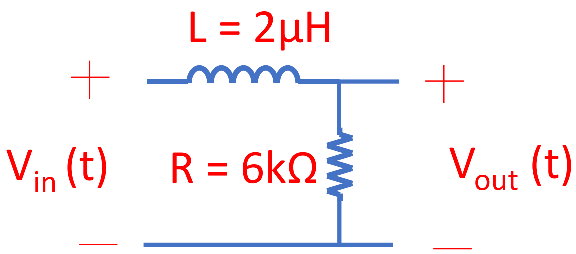
Problem 10: (90 pts)

For each of the circuits shown below

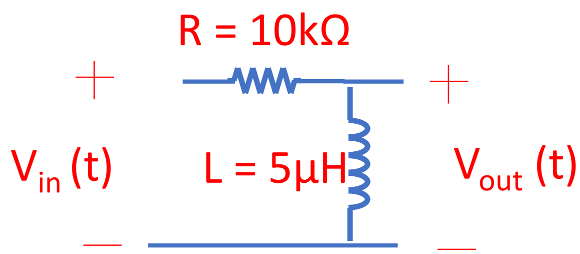
i) Find the transfer function $H(\omega)$, $|H(\omega)|$ and $\angle H(\omega)$

ii) Plot $|H(\omega)|$ for linear-linear and log-log scales.

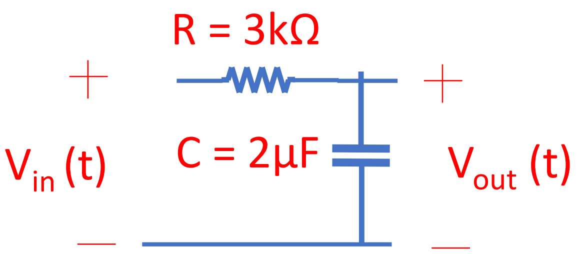
iii) Plot $\angle H(\omega)$ for linear-log scales.



(a)



(b)



(c)

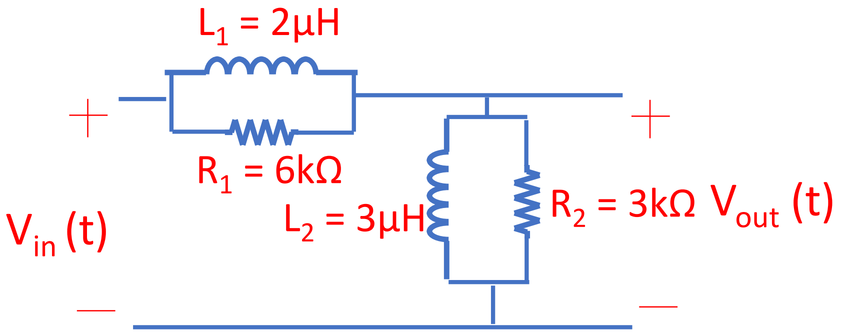
Problem 11: (30 pts)

For the circuit shown below

i) Find the transfer function $H(\omega)$, $|H(\omega)|$ and $\angle H(\omega)$

ii) Plot $|H(\omega)|$ for linear-linear and log-log scales.

iii) Plot $\angle H(\omega)$ for linear-log scales.



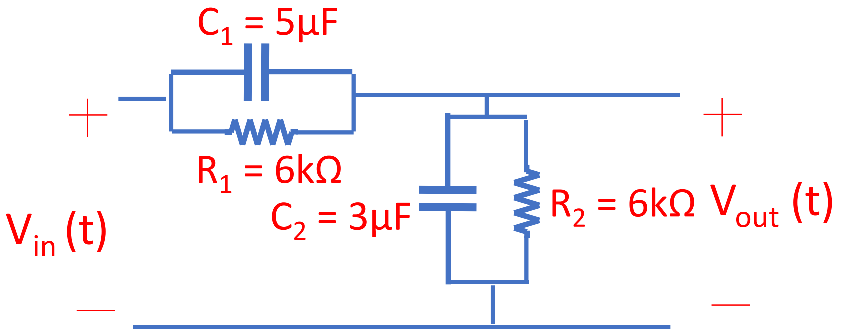
Problem 12: (30 pts)

For the circuit shown below

i) Find the transfer function $H(\omega)$, $|H(\omega)|$ and $\angle H(\omega)$

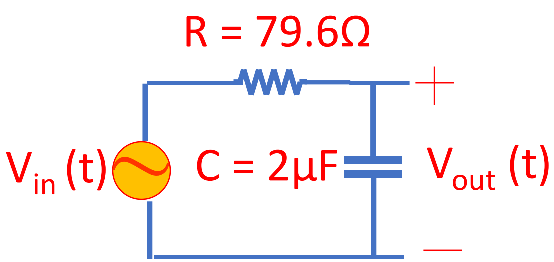
ii) Plot $|H(\omega)|$ for linear-linear and log-log scales.

iii) Plot $\angle H(\omega)$ for linear-log scales.

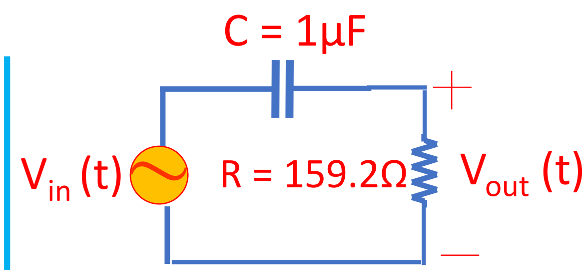


Problem 13: (60 pts)

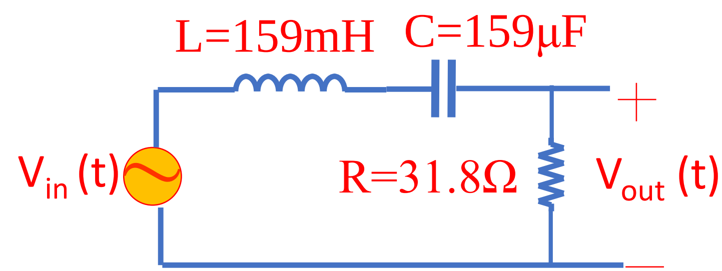
Find the output voltage as $V_{out}(t) = A^{\mathrm{V}}\cos(2\pi ft+\varphi)$ where φ is the phase and for $f = 1, 10, 100, 1\,\mathrm{k}, 10\,\mathrm{k}, 100\,\mathrm{kHz}$ if the input voltage is $V_{in}(t) = 1^{\mathrm{mV}}\sin(2\pi ft)$ for each of the following circuits.



(a)



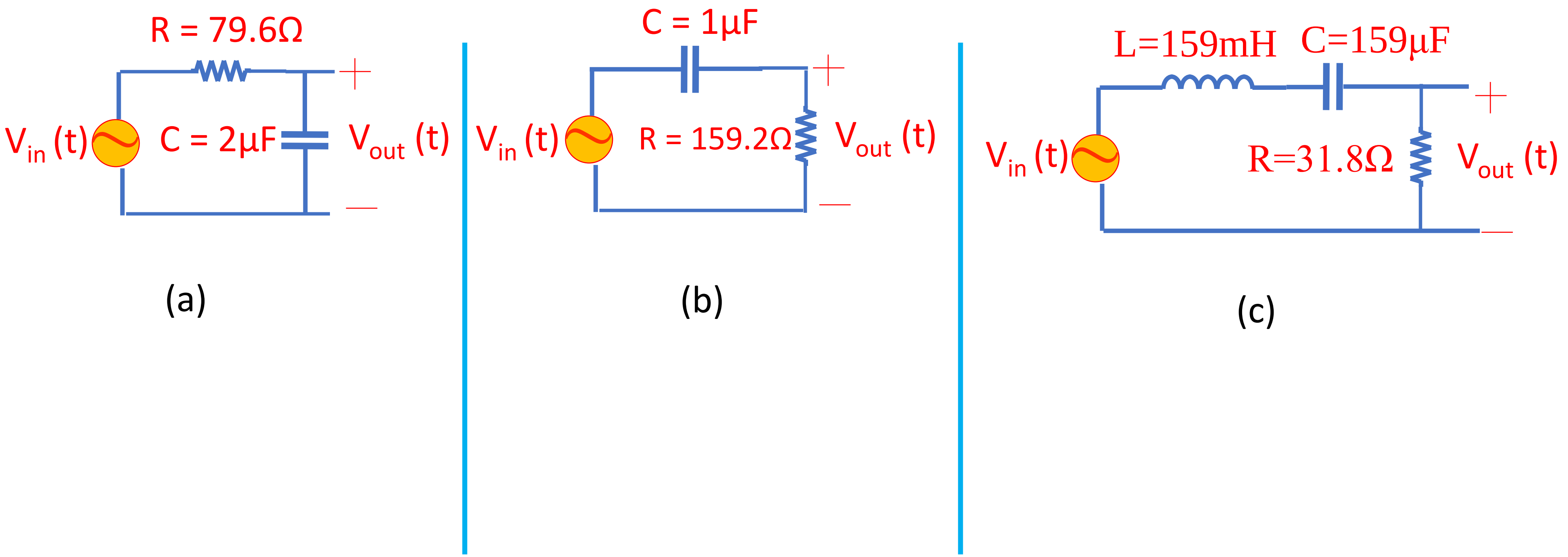
(b)



(c)

Problem 14: (60 pts)

Find the output voltage as $V_{out}(t) = A^{V} \cos(2\pi ft + \varphi)$ where φ is the phase, if the input voltage is $V_{in}(t) = \sum_{i} 1^{mV} \sin(2\pi f_i t);\ f_i = 1, 10, 100, 1k, 10k, 100\,kHz$ for each of the following circuits.



Problem 15: (20 pts)

Draw the Bode plot (magnitude only) for the following transfer function.

$$H(\omega) = \frac{1}{(1 + j\omega\tau)(1 + j\omega\tau)}$$

Extra credit: Try to design a circuit having such a transfer function. (40 pts)