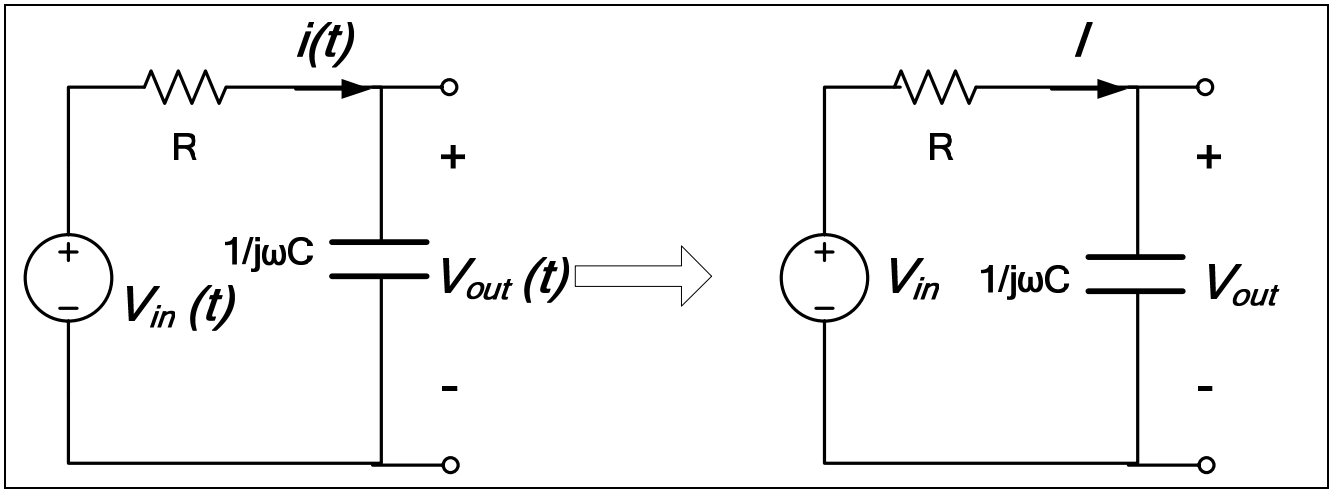
King Fahd University Of Petroleum & Minerals
Department of Electrical Engineering
2010-2011 first Semester (101)

EE204 – Design Problem

Name:	ID#:	SEC#:



Description

The above simple RC series circuit is a passive low pass filter. Low pass filters are used in many applications such as in your radio machine to extract a desired radio channel and reject other channel.

In this design problem, we will observe the importance of capacitor and inductor by studying one of their applications in the design of filter circuits.

Assume the following:

1. The input signal, $V_{in}(t)$, is given by: $V_{in}(t) = 1\cos(\omega t)$ where $\omega = 2\pi f$.
2. The parameters $R = 10\Omega$ and $C = 1\mu F = 10^{-6} F$ are fixed. The value $\frac{1}{RC}$ represents the bandwidth *BW* of the channel or the cutoff frequency. For this circuit $BW = 100k\ rad/s$, which is the typical bandwidth of each FM radio channel.

Part (a)

1. Define low pass filter.
2. Define the cutoff frequency.
3. What are other types of filter?

Part (b)

1. For the above circuit, find V_{out} (magnitude only), in the Phasor domain, in terms of the frequency ω.
2. Change ω from zero to 600,000 rad/s in steps of 40,000 rad/s. Record (in a table) the values of V_{out} for each value of ω. Plot (sketch) V_{out} versus ω.
3. Comment on the plot. Specifically, what do you observe at $\omega = 0$, $\omega = 100,000$, and $\omega = 600,000$. State your conclusion.
4. If you took V_{out} across the resistor instead of the capacitor, what is the type of filter you will have.

   Hint (repeat the previous 3 steps): find V_{out} (magnitude only) in terms of the frequency ω, check V_{out} at different values of ω say at $\omega = 0$, $\omega = 50,000$, $\omega = 100,000$, and $\omega = 400,000$, and then sketch V_{out} versus ω.

Part (c)

1. You can design another low pass filter by using one resistor and one inductor only. Draw such circuit and specify where you will take the output.
2. In this case, what is the cutoff frequency.
3. Take $R = 10\Omega$, Design the inductor (choose its value) such that the cutoff frequency is kept 100 *kHz*.