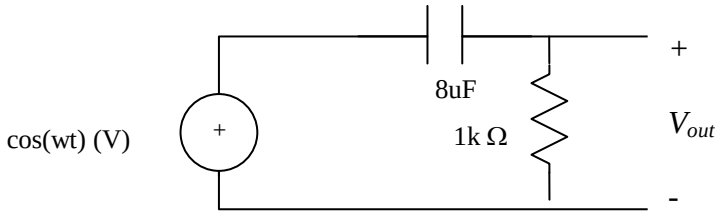
EEE 202, TEST 4 **NAME:___SOLUTIONS___**

Closed-book/notes, 2 problems, equal credit, 1 sheet of formulae allowed

Problem 1: RC-filters are often used to reduce the effect of high-frequency noise or low-frequency drift in circuits. In the following example, the voltage source represents a mid-frequency useful signal (e.g., voice) that is to be transmitted to the output (Vout) with little change, while the DC component is eliminated.

1. Write an expression for the steady-state V_{out}
2. Show that DC is eliminated, i.e., Vout = 0 for w = 0, at steady-state.
3. What is the amplitude of Vout at w = 40Hz?



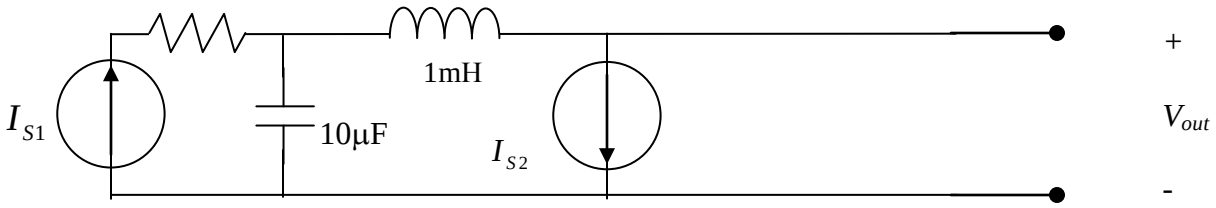
1. $V_{out} = \frac{R}{R+\frac{1}{sC}} V_{in} = \frac{RCs}{RCs+1} V_{in}\ with\ s = jw, V_{in} = 1\angle 0^o,$

$$V_{out} = \frac{RCw}{\sqrt{(RCw)^2+1}} \angle 90^o - \tan^{-1}(RCw)$$

2. From the expression above, the amplitude of V_{out} is 0 when $w = 0$.
3. At 40Hz, $w = 40 \times 2\pi = 251.3$. Evaluating the amplitude for RC = 8m, we find

$$|V_{out}| = 0.895$$

Problem 2. In the following circuit, $I_{S1}(t) = 0.001\cos(10t)$ (A), $I_{S2}(t) = 0.01\cos(10t+45^o)$ (~~V~~A). Write a set of equations to compute the voltage V_{out}.



Nodal Analysis: 3 nodes, left-to-right V_1, V_2, V_3, $V_{out} = V_3$:

1. $I_{S1} + \frac{V_2-V_1}{R} = 0,$ $\quad 0.001\angle 0 + \frac{V_2-V_1}{1k} = 0$
2. $\frac{V_1-V_2}{R} + \frac{0-V_2}{\left(\frac{1}{jwC}\right)} + \frac{V_3-V_2}{jwL} = 0,$ $\quad \frac{V_1-V_2}{1k} - V_2 j100\mu + \frac{V_3-V_2}{j10m} = 0$
3. $-I_{S2} + \frac{V_3-V_2}{jwL} = 0,$ $\quad -0.01\angle 45^o + \frac{V_3-V_2}{j10m} = 0$

Loop Analysis: 2 loops, left-to-right I_1, I_2 (CW)

1. $I_1 = I_{S1}, I_2 = I_{S2},$ $\quad \left(\frac{1}{jwC}\right)(I_2 - I_1) + jwL(I_2) + V_{out} = 0,$

$$V_{out} = \left(\frac{1}{j100\mu}\right)(0.001\angle 0 - 0.01\angle 45^o) - j10m0.01\angle 45^o +$$