ECE 35, Fall 2022

Your sequence number

Last name

Quiz 3

First + middle name(s)

/ 12

PID

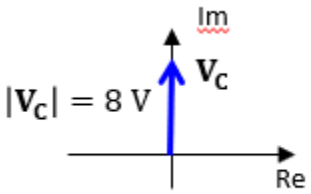
Instructions:

- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

(1) *(6 points)*

(a) Consider the circuit in Figure 1. It is in steady-state. The current source i_S is an AC source with $\omega = 5$ rad/s. In the diagram, we give you the phasor of $\boldsymbol{v_c}$. Find the current waveform $i_S(t)$.

$i_S(t)$



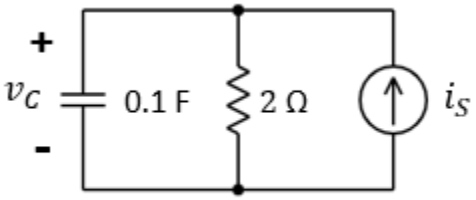


Figure 1

(b) Consider the circuit in Figure 2. It has the exact same components as the circuit in Figure 1 (including the same AC current source i_S). The only difference is that it contains two additional DC voltage sources. The circuit is in steady state. What is the value of v_x at time $t = \frac{\pi}{20}$ s?

$v_x(\frac{\pi}{20}$ s$)$

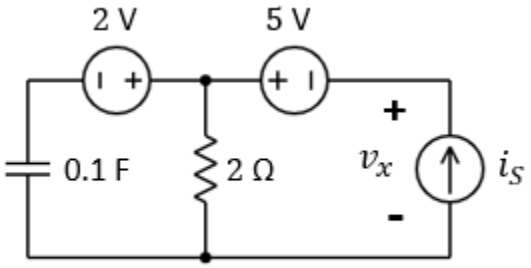
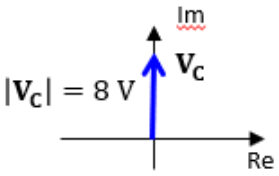


Figure 2

Copy of the circuits from the previous page …



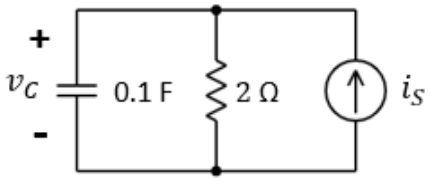


Figure 1

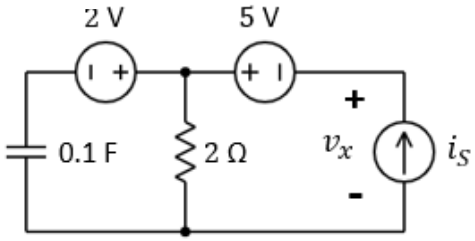


Figure 2

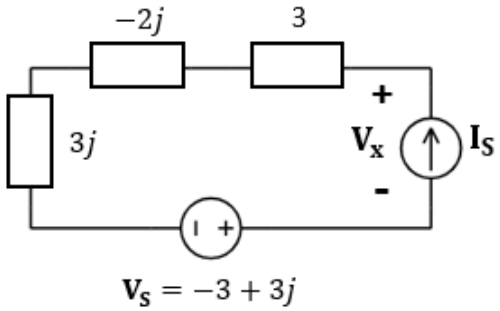
(2) *(6 points)* The circuit below represents an AC circuit in steady-state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). Both sources in the circuit have the same ω, but you are not told the value of ω. Each box represents the impedance of a single circuit element (a resistor, capacitor or inductor).

(a) Find the phasor $\mathbf{V_x}$. Your answer should be a complex number (can be in cartesian or polar form).

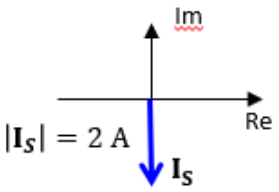
V_x [ ]

(b) What is the maximum value of the voltage waveform v_S(t)?

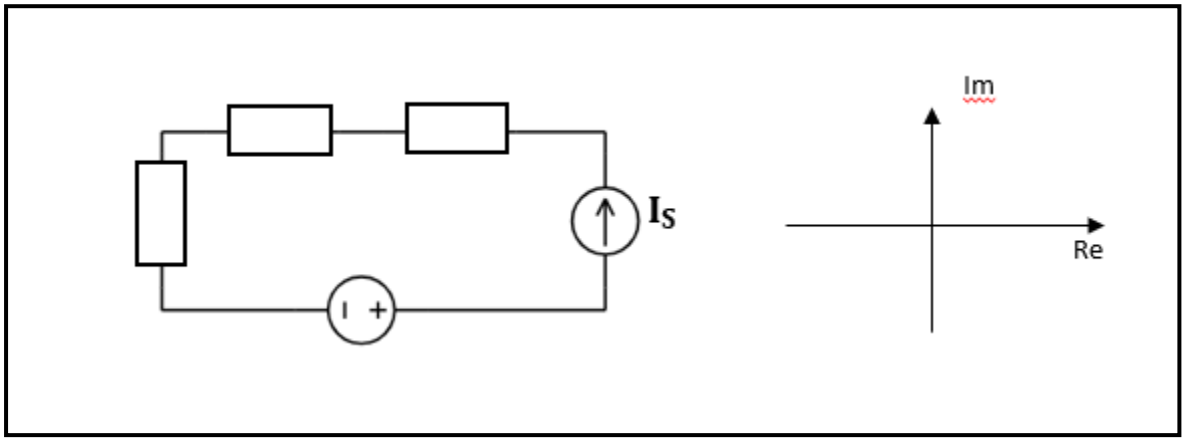
$v_{S\,max}$ [ ]



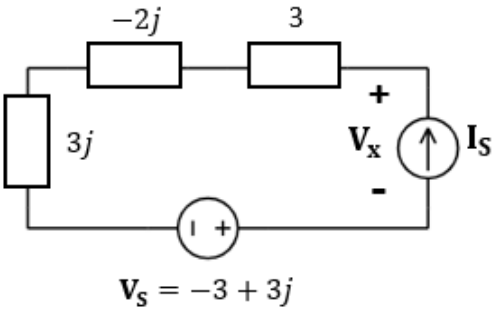
$\mathbf{V_S} = -3 + 3j$

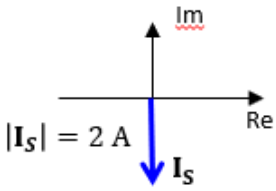


(c) We now <u>double ω of both sources</u> but keep everything else the same (such as the capacitor, inductor and resistor values; the amplitude and phase of the sources, etc.). In the drawing below, complete the circuit diagram for this new situation. I.e., add the new values of all the complex numbers and draw the new $\mathbf{I_S}$ vector (also label the angle and magnitude).



Copy of the circuit from the previous page …





ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $v_{ab} \triangleq \frac{dw}{dq}$ R l

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $Q = C \cdot v$ $w_C = \frac{1}{2} C v^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $B \sim i$ $w_L = \frac{1}{2} L i^2$

AC power: $p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m$

$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)$ $Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i)$ $X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha)$ $\cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$

$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$

$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
sin(α):	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
tan(α):	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞