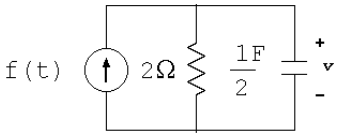
University of Illinois **Falll 2018**

ECE210 / ECE211 - Homework 05

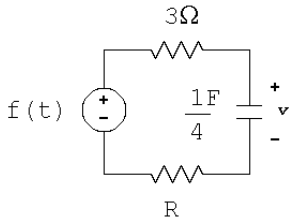
Due: Wednesday, October 3 at 6:00 p.m.

1. Consider the following circuit with $v(0^-) = 2\,V$ and let $f(t) = \cos\left(\sqrt{3}t + \frac{\pi}{3}\right)$ A. For $t > 0$, obtain:



   (a) the zero-state voltage across the capacitor's terminals, $v_{\rm ZS}(t)$,
   (b) the zero-input voltage across the capacitor's terminals, $v_{\rm ZI}(t)$,
   (c) the transient voltage across the capacitor's terminals, $v_{\rm tr}(t)$,
   (d) the steady state voltage across the capacitor's terminals, $v_{\rm ss}(t)$, and
   (e) the total voltage across the capacitor's terminals, $v(t)$.

2. Consider the following circuit with $f(t) = \frac{2}{\sqrt{3}}\cos(\omega t)$ volts and $v(0^-) = v_0$ volts.



   It is known that for $t > 0$, $v(t) = Ae^{-t} + B\cos\left(\frac{1}{\sqrt{3}}t\right) + D\sin\left(\frac{1}{\sqrt{3}}t\right)$ volts.

   (a) Write the ODE that governs this system for $t > 0$ in terms of R, $v(t)$, and ω.
   (b) Find the value of R.
   (c) What is the value of ω?
   (d) What are the values of B and D?
   (e) Identify $v_{tr}(t)$, the transient component of $v(t)$.
   (f) Identify $v_{ss}(t)$, the steady-state component of $v(t)$.
   (g) What is steady-state phasor V ?

3. The different parts of this problem are unrelated:

   (a) Express $\frac{e^{-j4t} - e^{j4t}}{j4}$ in terms of a cosine function.
   (b) Express $\frac{e^{-j2t} + e^{j2t}}{4}$ in terms of a sine function.
   (c) Express $\mathrm{Re}\{2e^{j\frac{\pi}{3}}e^{-j5t}\}$ in terms of a cosine function.
   (d) Determine the phasor F of $f(t) = -2\sin(2t - \frac{\pi}{3})$. Express F in both polar and rectangular coordinates.
   (e) Determine the phasor F of $f(t) = \cos(3t - \frac{\pi}{2})$. Express F in both polar and rectangular coordinates.
   (f) Express the phasor $F = 2 - j2$ in terms of a cosine function $f(t)$ having frequency $\omega = 9\,\frac{\rm rad}{\rm s}$.
   (g) Express the phasor $F = 3e^{-j\frac{\pi}{3}}$ in terms of a cosine function $f(t)$ having frequency $\omega = 9\,\frac{\rm rad}{\rm s}$.

4. Determine the phasor F of the following cosinusoidal functions $f(t)$:

   (a) $f(t) = 2\cos\left(2t + \frac{\pi}{3}\right)$.
   (b) $f(t) = A\sin(\omega t)$.
   (c) $f(t) = -5\sin(\pi t)$.

5. Determine the cosine function $f(t)$ with frequency $\omega = 2\text{rad/s}$, corresponding to the following phasors:

   (a) $F = j2$.

   (b) $F = 3e^{-j\frac{\pi}{6}}$.

   (c) $F = j2 + 3e^{-j\frac{\pi}{6}}$.

6. Use the phasor method to determine amplitude and phase shift (in rad) of the following signals when written as cosines:

   (a) $f(t) = 3\cos(4t) - 4\sin(4t)$.

   (b) $g(t) = 2\left[\cos(\omega t) + \cos\left(\omega t + \frac{\pi}{4}\right)\right]$.